



Proceeding of The 3rd National and International
Academic Conference Kalasin University 2025

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THE NATIONAL AND INTERNATIONAL CONFERENCE OF
KALASIN UNIVERSITY with the theme of

“INNOVATION AND TECHNOLOGY FOR SUSTAINABLE AREA-BASED DEVELOPMENT: KSU INNO-TECH 2025 FOR SABD”

The conference will take place from 6 – 8 March, 2025
at The Students Affairs Building, Kalasin University



Proceedings of Kalasin University Conference

<http://conference.ksu.ac.th>

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Purposes: The purposes of the conference are to publicize the valuable research articles and academic articles presented at Kalasin University International Conference and to be the medium for sharing the academic perspectives of researchers, academics, undergraduates and graduated students, and lecturers in the fields of health sciences, engineering, agriculture, science and technology, education, business administration, services and tourism, laws, politics, administrations, social sciences, and humanities.

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Message from The President of Kalasin University Council

Kalasin University is entering its 10th year, and to mark this milestone, the university is hosting the 3rd National and International Academic Conference of Kalasin University 2025 under the theme “Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 FOR SABD.” The conference will take place from 6 – 8 March, 2025 at The Students Affairs Building, Kalasin University (In-town Campus).

This conference serves as a platform for research and academic exchange, providing opportunities for students, lecturers, academics, researchers, and educational personnel to share knowledge. It aims to foster academic collaboration, advance research and creative innovations to national and international levels, and respond to the real need of the country.

This year’s conference is co-hosted by 35 institutions from 16 countries, and features 214 research papers, including both oral and poster presentations at national and international levels.

On behalf of the Kalasin University Council, I sincerely hope that this national and international academic conference will be a valuable opportunity for professors, researchers, students, and all participants to engage in meaningful discussions, build research networks, and apply acquired knowledge efficiently and effectively for the benefit of the nation.

A handwritten signature in blue ink, likely belonging to Mr. Winai Witthayanukul, is positioned above his name and title.

Mr. Winai Witthayanukul
Vice-President of Kalasin University Council
Acting President of Kalasin University Council

Message from The President of Kalasin University

Kalasin University has set the direction to drive the university to become a strong, continuous, and sustainable “University for Local Development” with the integration of science, social sciences, technology, and innovation. Moreover, the university also embraces the King’s Philosophy, community wisdom, and modern sciences to integrate in developing academics and leading to becoming a leading local university.

This year marks the third year that Kalasin University has organized The National and International Conference of Kalasin University with the theme of “Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD” The conference will take place from 6 – 8 March, 2025 at The Students Affairs Building, Kalasin University (In-town Campus). This year’s conference is co-hosted by 35 institutions from 16 countries, and features 214 research papers, including both oral and poster presentations at national and international levels.

I would like to express my congratulations and appreciation for organizing this academic conference, especially on the topic that is important for the development of the country and Thai society today, which is “Innovation and Technology for Sustainable Area-Based Development”.

Social innovation and area-based development technology are important tools for solving problems and creating opportunities for sustainable community development by integrating modern sciences, local wisdom, and modern technology to create innovations and development approaches that truly meet the needs of the community.

Kalasin University, as a higher education institution in the Northeast region, realizes the importance of sustainable community development. Therefore, it has set a university development strategy that focuses on participation in community and social development, especially in innovation and technology development, to improve people’s quality of life and strengthen the grassroots economy. This academic conference, therefore, provides the important opportunity for academics, students, professors, researchers, and interested persons from all sectors to exchange knowledge, present research results, and jointly create a network of cooperation in developing social innovation and area-based development technology for sustainable community development.

On behalf of Kalasin University, I would like to welcome everyone with great pleasure and wish you success in organizing this event as planned. Finally, I would like to thank the committee, experts, participants, and all sponsors who made the 3rd Kalasin University National and International Academic Conference a success.

A handwritten signature in blue ink, appearing to be 'Dr. Keeravit Petjul'.

Assistant Professor.Dr.Keeravit Petjul
Acting President of Kalasin University



HUE UNIVERSITY
UNIVERSITY OF FOREIGN LANGUAGES AND INTERNATIONAL STUDIES

Assoc. Prof. Dr. Pham Thi Hong Nhung
Rector,
University of Foreign Languages and International
Studies, Hue University
Hue, November 18, 2024

Assit.Prof. Dr. Keeravit Petjul,
Acting President, Kalasin University

Dear Assit.Prof. Dr. Keeravit Petjul,

Warm greetings from the University of Foreign Languages and International Studies,
Hue University, Vietnam (HUFLIS)!

On behalf of HUFLIS, I would like to express our sincere thanks to you and your colleagues at
KSU for your kind consideration in promoting the relationship and cooperation between the
two institutions.

In responding to your letter of invitation dated on November 11, 2024, I am pleased to
inform you that HUFLIS accepts your invitation to co-host the international conference titled
“Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH
2025 for SABD” from March 6th to 8th, 2025.

Should you need further information relating to the organization of the conference,
please do not hesitate to contact our office of Research Management and International
Cooperation via email hucfl@hueuni.edu.vn.



Assoc. Prof. Dr. Pham Thi Hong Nhung



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20 November 2024

Acceptant Official Letter

To: Asst. Prof. Dr. Keeravit Petul

Acting President Kalasin University

62/1 Kasetsomboon Road, Kalasin Sub District, Mueang District, Kalasin
Province 46000

Tel: +6643 811128, Mobile: +6686 4584360, Fax: +6643 813070

From: Northern Agriculture and Forestry College, NAFC

Re: To submit committee list from Northern Agriculture and Forestry College for the co host
of the 2nd International Conference Titled: “Innovation and Technology for Sustainable
Area Based Development: KSU INNO TECH 2025 for SABD” during 6th to 8th March
2025 at Kalasin University, Kalasin Thailand

- In accordance with memorandum of understanding between Northern Agriculture
and Forestry College (NAFC) and Kalasin University (KSU)
- In accordance with an official invitation of KSU dated November, 11th 2024 for
inviting professors from NAFC to be the co host at the KSU international conference

We are honored to inform that, the Director of NAFC assigned 2 teachers for participating to
be the co host committees of the 2nd International Conference Titled: “Innovation and
Technology for Sustainable Area Based Development: KSU INNO TECH 2025 for SABD”
during 6th to 8th March 2025 at Kalasin University, Kalasin Thailand as named:

- 1) Mr. Amphaivanh Souksanty, Deputy Director of NAFC
- 2) Mr. Nouanthong Inthaly, Head of Academic Office NAFC

For more information please do not hesitate to contact: Mr. Amphaivanh Souksanty

Tel: +856 20 5570 0538 email: souksanty@yahoo.com

Your sincerely,

Deputy Director of NAFC



Amphaivanh SOUKSANTY



University of Economics, Hue University

+84.234.3691.165

99 Ho Duc Di st., Hue city, Vietnam

November 22, 2024

Asst. Prof. Dr. Keeravit Petjul

Acting President

Kalasin University

The Kingdom of Thailand

Acceptance letter of Invitation to co-host KSU INNO-TECH 2025 for SABD Conference

Dear Asst. Prof. Dr. Keeravit Petjul, Acting President of Kalasin University,

Thank you for your esteemed invitation on behalf of Kalasin University to serve as a foreign co-host university for the upcoming international conference, "**Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD**" scheduled to be held from March 6 to 8, 2025.

We are genuinely honored by this invitation and delighted to accept the opportunity to collaborate with Kalasin University in the capacity of a foreign co-host university for this significant academic event. We share your commitment to advancing research and fostering innovation for sustainable community development and believe that this partnership will serve to further this mission.

We hereby confirm our acceptance of the specified benefits and conditions outlined in the invitation, which includes granting Kalasin University the authorization to use the name and new logo of the University of Economics, Hue University for the conference purposes. Additionally, we commit to designating two university executives or representatives to attend the conference, assigning appropriate faculty members for paper review, encouraging participation and paper submissions from our faculty, researchers, and graduate students, and assisting in the promotion of the conference.

We express our gratitude for the hospitality extended to us, including the provision of accommodations for our representatives during the conference and the waiver of registration fees for ten individuals from our institution who will present their papers in person at the event.

We look forward to working closely with Kalasin University in the successful organization and execution of the KSU INNO-TECH 2025 for SABD Conference. If any further information or assistance is required from our end, please do not hesitate to reach out to us via email ttbngoc@hce.edu.vn (Dr. Tran Thi Bich Ngoc, Head of Research Affairs and International Cooperation Office).

Thank you for this valuable collaboration opportunity. We anticipate a fruitful and productive partnership between our institutions.

Yours sincerely,



Assoc. Prof. Truong Tan Quan

Rector of the University of Economics, Hue University



AN GIANG UNIVERSITY
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18 Ung Van Kiem St, Dong Xuyen Ward,
Long Xuyen City, An Giang Province, Vietnam



An Giang, November 25th, 2024

Re: Letter of Confirmation

Dear Asst. Prof. Dr. Keeravit Petjul,

On behalf of An Giang University, I am delighted to accept your invitation to be one of the co-host universities for your international conference “Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD”. We are very honored to receive your invitation that will take place on

As the co-host of the conference, An Giang University will authorize Kalasin University to use our University name and logo for conference purposes.

In addition, we will assign the following members of our university to be the reviewers for the papers submitted for the conference in the attached list.

We will provide the list of executives/representatives, as well as the researchers at a later date.

Should you need further information or assistance, please contact our External Relations Office via the email address: exro@agu.edu.vn.

Sincerely yours,



Assoc. Prof. Dr. Vo Van Thang
President of An Giang University
Vietnam National University Ho Chi Minh City
Vietnam



Lao People's Democratic Republic
Peace Independence Democracy Unity Prosperity

Ministry of Education and Sport
Souphanouvong University

No. 434/SU

Luang Prabang, Date: 28 - 11 - 2024

Letter of Acceptance as the 2nd International Conference at KSU

Dear President of Kalasin University,

We have received your invitation with regards to Souphanouvong University being the co-organizer of the 2nd International Conference at Kalasin University.

On behalf of Souphanouvong University, I would like to inform you that we accept your kind invitation to be the co-organizer of the 2nd International Conference at Kalasin University and provide the support in the aspect that is available for us.

I would like to thank you for your kind cooperation.

Yours sincerely,



Asso. Prof. Vira ANOLAC
President of Souphanouvong University

13 North Road, Donemai Village,
Luang Prabang, Lao PDR
Tel: +856-71-254931, 254932
Fax: +856-71-254933, 254934



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Telp./Fax (0285) 421096 Website: www.unikal.ac.id, Email: unikal.ac.id@gmail.com

Subject: Acceptance of Co-Host Offer for the International Seminar

Dear **President of Kalasin University**,

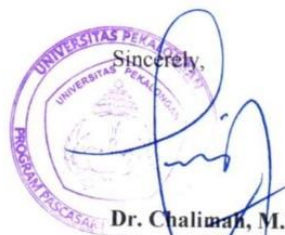
Universitas Pekalongan is honored to accept the offer to be a co-host for the International Conference titled "Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD" which will be held from March 6–8, 2025. We are excited to collaborate in this academic event and are fully committed to supporting its successful organization. We would also like to confirm that we will adhere to all the conditions set for co-hosting this seminar, including the following specific commitments:

1. We grant authorization for Universitas Pekalongan to be represented by its name and logo for the purpose of promoting and organizing the seminar.
2. We will designate two representatives from our institution to attend the seminar.
3. We will designate three professors holding doctoral degrees in relevant fields to be appointed as reviewers for the seminar.
4. We will encourage our faculty and students to submit articles and attend the seminar to contribute to and benefit from this international academic event.
5. We will inform relevant parties within our network about the seminar to ensure broad participation and awareness.
6. Detailed information about the designated representatives and reviewers will be informed separately, following this letter.

In addition to our participation in the seminar, we would like to take this opportunity to conduct a visiting lecture for students, which we believe will offer valuable academic exchange and broaden their knowledge. Furthermore, we plan to engage in community service activities, which will strengthen the collaboration between our universities and provide a positive impact on the local community.

We hope that these additional activities will be welcomed and approved as part of our participation in the event. We wish for the seminar to be a great success and look forward to contributing to its success.

Thank you for the opportunity, and we look forward to a successful collaboration during the International Seminar KSU INNO-TECH 2025 for SABD.

Sincerely,


Dr. Chaliman, M.M.

*Director of Postgraduate and Cooperation
Universitas Pekalongan*



UNIVERSITY OF AGRICULTURE AND FORESTRY, HUE UNIVERSITY

102 Phung Hung, Phu Xuan District, Hue city, Vietnam

Email: dhnlhue@huaf.edu.vn and website: <https://huaf.edu.vn/>

Date: January 24th, 2025

To: KALASIN UNIVERSITY
62/1 Kasetsomboon Road
Kalasin Sub-District, Mueang District,
Kalasin Province Zip code 46000
The Kingdom of Thailand

Subject: Letter of Acceptance

Dear Asst. Prof. Dr. Keeravit Petjul, Acting President

On behalf of Hue University of Agriculture and Forestry (HUAF), we are writing to express our enthusiastic agreement to co-host the 3rd National and International Conference, scheduled to take place at Kalasin University from March 6th to 8th, 2025. We agree to notify our university researchers to participate in the conference. The expenses of the conference is not paid by HUAF. In case, we attend the conference, our costs will be spent by HUAF. Any priority for our participants, please inform us in advance.

We are confident that this event will provide a valuable platform for researchers, academics, and practitioners to exchange knowledge and explore advancements in common academic between the two universities.

We also believe that this collaboration between HUAF and Kalasin University will be mutually beneficial and will contribute significantly to the advancement of agriculture and forestry fields. We are excited about the opportunity to work with you on this important event.

If you have any inquiries, please feel free to contact Associate Prof. Dr. Pham Huu Ty, the Head of Office for Science-International Cooperation and Library via email: phamhuuty@huaf.edu.vn.

We look forward to a successful and productive partnership.

Yours sincerely,



Associate Prof. Dr. Tran Thanh Duc
The Rector

THAI NGUYEN UNIVERSITY
THAI NGUYEN UNIVERSITY – LAO CAI CAMPUS
Binh Minh Ward, Lao Cai City, Lao Cai Province, Vietnam
Tel: 02143 859 299
Email: Vanphong.phdhtn@tnu.edu.vn
Website: <https://laocai.tnu.edu.vn/>



Lao Cai, December 27, 2024

To: Kalasin University, Thailand.

According to the Memorandum of Understanding (MOU) on academic exchange and co-hosting the International Conference between Thai Nguyen University – Lao Cai Campus and Kalasin University, Thailand, dated October 27, 2022;

On November 11, 2024, Thai Nguyen University – Lao Cai Campus received an invitation to co-chair the International Conference from Kalasin University, Thailand.

In order to implement the MOU and enhance academic exchange between the faculty and staff of both universities through the International Conference, Thai Nguyen University – Lao Cai Campus agrees to co-chair the conference to be held at Kalasin University, Thailand.

We respectfully send Kalasin University the information for compilation.

(See attachment below for our logo and list of attendants)

Thank you very much!

Best Regards,



Assoc. Prof. Dr. Nguyen Manh Ha
Director of Thai Nguyen University – Lao Cai Campus



贵阳学院

103 Jianlongdong Road
Guiyang, Guizhou
P. R. China
550005

Letter of Confirmation
on
Co-hosting KSU INNO-TECH 2025

December 27, 2024

To: Acting President of Kalasin University

Dear Dr. Keeravit Petjul,

Congratulations on the opening of KSU INNO-TECH 2025!

Guiyang University is pleased to co-host the event with Kalasin University, and hereby confirm that:

- (1) We authorize KSU to use GYU name and logo for the conference purposes.
- (2) We would encourage our professors/doctors to attend the conference.
- (3) We would encourage our faculty members, researchers and/or graduate students to submit their papers and attend the conference.
- (4) We would assist KSU in making publicity of the conference to other interested parties.

Our Office for International Cooperation and Exchange would facilitate GYU on KSU INNO-TECH 2025 affairs. Please reach us via jiangbill@126.com for any concerns or further requirements.

We wish KSU INNO-TECH 2025 a big success!



Prof. Dr. Huang Ying
President of Guiyang University



Faculty of Economics and Business Management
National University of Laos

December 30, 2024

Dear
Asst.Prof.Dr.Keeravit Petjul
Kalasin University

Confirmation letter

On behalf of the Faculty of Economics and Business Management, National University of Laos, I am pleased to acknowledge your invitation to participate as a partner in the upcoming international conference, "Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD", to be held from March 6th to 8th, 2025.

We are honored to co-host this significant event, and we look forward to contributing to the exchange of knowledge and ideas on the themes outlined, particularly in the areas of Business Administration, Economics, and related fields. Our participation reaffirms the collaborative spirit and commitment between our institutions as outlined in our Memorandum of Understanding.

The Faculty of Economics and Business Management, under my leadership as Acting Dean, will fully support and engage in the conference activities, including promoting research, innovation, and sustainable development.

Please let us know if there are specific steps or additional details required for our participation. We are excited about this opportunity to strengthen our partnership and contribute to the success of the conference.

Thank you for your kind invitation, and we look forward to a fruitful collaboration.



Acting Dean
Faculty of Economics and Business Management
National University of Laos, Lao PDR
Email: Chanthanasinhvadsana@gmail.com
Phone: +856-2056569828



Khangkhay Teacher Training College
Address: Khangkhay Village, Road Number 07,
Pek District, Xiengkhouang Province, Laos.
Tel: +856 61215004 Fax: +856 61215003

Re: letter of Invitation

January 3, 2025

Assoc. Prof. Jirapun Huaisan
President of Kalasin University

Dear the President of Kalasin University,

We are pleased to accept your Invitation to attend the second international conference titled “Innovation and Technology for Sustainable Area Based Development: KSU INNO-TECH 2025 for SABD” from March 6th to 8th 2025 at Kalasin University. We are delighted and honored to be invited to the conference. Following is the name list of our delegates who are going to attend the conference.

1. Mr. Soutchanthong CHANTHAVONG, the Director of Khangkhay Teacher Training College
2. Mr. Sommay SHINGPHACHANH, Head of Science and Research Center

For more information, please contact Ms. Saysouly SORPHOUPHIENG

Email: saysouly2016@gmail.com Mobile: +85620 54309897

We value the conference will be a valuable opportunity for us to gain new insight regarding the Innovation and Technology for Sustainable Area Based Development and strengthen our collaboration between both institutes.

Sincerely,



Mr. Soutchanthong CHANTHAVONG
Director of Khangkhay Teacher Training College



广西民族大学
GUANGXI MINZU UNIVERSITY

Address: No. 188, East Da Xue Rd., Nanning, Guangxi, P. R. C.

Tel.: +86-771-3260218 Fax: +86-771-3262052 Email: gxundice@gxmzu.edu.cn

**Letter from Guangxi Minzu University on Agreement to Become
A Co-host University of The International Conference Titled
“Innovation and Technology for Sustainable Area-Based
Development: KSU INNO-TECH 2025 for SABD”**

Dear President of Kalasin University

Warm greetings from Guangxi Minzu University (GXMZU)!

The reply to your invitation letter dated November 11, 2024 regarding the invitation of our university to be a co-host university of the international conference titled ‘Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD’.

GXMZU agrees to co-host the international conference titled ‘Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD’ from March 6 to 8, 2025 with Kalasin University. GXMZU will continue to support your university’s activities, and provide all support to this international conference.

Thank you very much for your kind cooperation and support as always.

Sincerely yours,


Pro. Dr. Wei Shizhen
President, Guangxi Minzu University
January 7, 2025




THE UNIVERSITY OF DA NANG
UNIVERSITY OF ECONOMICS

71 NGU HANH SON ST, DANANG, 550000, VIETNAM
interrelations@due.edu.vn
+84-236-3958635 | +84-236-3954243
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December 12th, 2024

Asst. Prof. Dr. Keeravit Petjul
Acting President
Kalasin University
62/1 Kasetsomboon Road,
Kalasin Sub-District,
Mueang District, Kalasin Province 46000
The Kingdom of Thailand

Subject: Acceptance to Serve as a Co-Host University for the KSU INNO-TECH 2025 for SABD

Dear Asst. Prof. Dr. Keeravit Petjul,

On behalf of The University of Danang - University of Economics, I am honored to accept your kind invitation for our university to serve as a co-host university for the second international conference titled “Innovation and Technology for Sustainable Area-Based Development: KSU INNO-TECH 2025 for SABD” to be held at Kalasin University from March 6th to 8th, 2025.

We deeply appreciate the opportunities and benefits extended to our institution, as outlined in your letter, including the promotion of our university name and logo, accommodation for representatives, and the registration fee waiver for our faculty members, researchers, and graduate students.

As a co-host university, The University of Danang - University of Economics is committed to fulfilling the following requirements:

- Authorizing the use of our university name and logo for the conference's promotional materials.
- Designating two representatives from our university to attend the conference.
- Assigning at least three professors with doctoral degrees to serve as reviewers for submitted papers within their areas of expertise.
- Encouraging our faculty members, researchers, and graduate students to submit papers and actively participate in the conference.
- Assisting Kalasin University in publicizing the conference to relevant stakeholders and interested parties.

We are confident that this collaboration will further strengthen the academic and cultural ties between our universities while contributing to the shared goal of promoting innovation and sustainable development.





THE UNIVERSITY OF DA NANG
UNIVERSITY OF ECONOMICS

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Please do not hesitate to contact me at phianhndn@due.edu.vn should you require any additional details or support from our side regarding this collaboration.

We look forward to a successful and impactful conference in March 2025.

Yours sincerely,



Assoc. Prof. Dr. Doan Ngoc Phi Anh
Vice - Rector
The University of Danang - University of Economics



地址：广西南宁市大学西路 169 号

Add: No.169, Daxue West Road, Xixiangtang District, Nanning, Guangxi

邮政编码：530008

Post code: 530008

联合主办 KSU INNO-TECH 2025 for SABD

会议确认函

Confirmation Letter of Co-hosting

KSU INNO-TECH 2025 for SABD

加拉信大学：

Kalsin University:

恭喜贵校即将举办 KSU INNO-TECH 2025 for SABD 会议！
南宁职业技术大学深感荣幸能够与贵校共同担任此次活动的主办方，并在此确认：

Congratulations on the upcoming KSU INNO-TECH 2025 for SABD! Nanning Vocational and Technical University (henceforth NVTU) is honored to co-host the event with Kalasin University, and hereby confirm that:

1. 我校授权加拉信大学在会议上使用南宁职业技术大学的名称和标识；

1. We authorize KSU to use the name and logo of NVTU for the conference purposes.

2. 我校将积极鼓励我们的教授和博士参加会议；

2. We would encourage our professors/doctors to attend the conference.

3. 我校将鼓励我们的教职员工和研究人员提交论文并参加会议；

3. We would encourage our faculty members, researchers and/or graduate students to submit their papers and attend the conference.

4. 我校将协助加拉信大学向其他有兴趣的各方宣传此次会议。

4. We would assist KSU in making publicity of the conference to other interested parties.

同时，为确保会议资料的规范性与专业性，我校要求贵校在使用南宁职业技术大学名称及标识时，需规范使用 VI 中的矢量图。会议资料设计完成后，请提交一份至我校进行审核，以确保资料的合规性。此外，授权的学校名称及标志仅限于本次会议资料使用，不可在其他场合延伸使用。

Meanwhile, we require KSU to standardize the use of vector diagram in VI when using the name and logo of NVTU, in order to ensure the standardization and professionalism of the conference

materials. After completing the design, please submit a copy to our university for review to ensure the compliance of the conference materials. In addition, the authorized name and logo of NVTU are limited to the use of materials for this conference and cannot be extended on other occasions.

最后，我校预祝 KSU INNO-TECH 2025 for SABD 会议取得圆满成功！

We wish KSU INNO-TECH 2025 for SABD a big success!



Nanning Vocational and Technical University

2025 年 1 月 17 日

January 17th, 2025

AGENDA

THE 3RD NATIONAL AND INTERNATIONAL CONFERENCE OF KALASIN UNIVERSITY 2025 ON “INNOVATION AND TECHNOLOGY FOR SUSTAINABLE AREA-BASED DEVELOPMENT: KSU INNO-TECH 2025 FOR SABD”

7 March 2025 at The Students Affairs Building, Kalasin University (In town rea)

Time	Activities
07.30 – 08.45	Registration
08.45 – 09.00	VDO Presentation of Kalasin University
09.00 – 09.25	Performances
09.25 – 09.40	Welcoming Remarks and a Special Talk on Public Sector Cooperation for Sustainable Local Development by Mr. Phadungsak Imeop, Deputy Governor of Kalasin Province,
09.40 – 09.50	Opening Ceremony - Reporting Remarks by Assistant Professor Dr. Keeravit Petchjul, Acting President of Kalasin University - Opening Remarks by Associate Professor Dr. Komgrit Leksakul, Vice-Director of Thailand Science Research and Innovation (TSRI) - Opening Ceremony and Group Photo including Kalasin University Administrators, Members of Kalasin University Council, the Director of Program Management Unit on Area-Based Development (PMU A), and Representatives from Co-Host Institutes.
09.50 - 10.20	Special Lecture by Dr.Asoke Ponbumrung, Director of Research and Innovation To solve poverty problems and reduce inequality (Part 1) on “Research for Area-Based Development and the Improvement of the Grassroots Economy of Thailand”
10.20 – 10.50	Special Lecture by Professor Dr. Eko Priyo Purnomo, Department of Governmental Affairs and Administration, Universitas Muhammadiyah Yogyakarta on “Sustainable Area-Based Development”
10.50 - 11.20	The Presentation of a Token of Appreciation (Plaque and Certificate) and Group Photos 1. The Administrator of Program Management Unit on Area-Based Development (PMU A) 2. The Representative from Office of the Permanent Secretary, The Ministry of Higher Education, Science, Research, and Innovation. 3. Professor. Dr. Eko Priyo Purnomo 4. International Co-Host Institutes 5. National Co-Host Institutes 6. Representatives from Networking Journals
11.20 – 11.45	Visiting the Research and Innovation Booths of Area-Based Development
11.45 - 12.45	Lunch
12.45 - 05.00	Presentation Sessions Poster Presentations for both National and International Levels Oral Presentation for both National and International Levels 1. Engineering and Innovation 2. Health Sciences and Technology 3. Science and Agricultural Innovation 4. Business Administration, Economics, and Hospitality and Tourism 5. Education, Pedagogy, and Learning Management Innovation 6. Humanities, Social Sciences, and Innovation for Local Development 7. Innovative Solutions for Sustainable Poverty Alleviation

Notation : 1. The schedule is subject to change as appropriate.

Program Speaker International Conference

Meeting room 5 International Oral Presentation

Sessions: Engineering and Innovation and Health Sciences and Technology		
Chairman	Assoc.prof.Dr.Adisak pattiya (online)	Maharakham University
Co-Chairman	Assoc.prof.Dr.Thanya Paramatthanuwat	King Mongkut's University of Technology North Bangkok - Prachinburi Campus
Moderator	Asst.Prof.Chinnapat Turakarn	Kalasin University
Moderator	Ms.Sawanee Jansawang	Kalasin University
Student	Ms.Niracha Phakaket	Kalasin University
Student	Ms.Onuma Khiewpetch	Kalasin University
ICT Supporter	Mr.Kritsana Phuthithuan	Kalasin University
ICT Supporter	Ms.Kannika Imraksa	Kalasin University
Presentation Date: March 7, 2025		
Room: 1st floor of a Student Activities Building at Kalasin University (Nai Mueang)		
Join Zoom Meeting: https://zoom.us/j/95676396653?pwd=v347cOpYOEzCiOWr7Q3v2ROpzVJA4q.1 Meeting ID: 956 7639 6653 Passcode: 457935		

No.	Times	Code	Name - Surname	Title	System
1	13.15 - 13.30 pm.	122380	Chompoo Suppatoomsin, Ekkarat Takkratok, Sureeporn Meehom and Kritsada Wilairuk	Microcontroller-Based Automated Vending Machine Development	onsite
2	13.45 - 14.00 pm.	122115	Darika Namwai and Siwa Kaewplang	Performance Evaluation of RTK GNSS with Virtual Reference Station (VRS) Technology: A Comparative Study in Urban and Rural Thailand	online
3	14.00 - 14.15 pm.	121367	Aphisit Phoolamool and Siwa Kaewplang	Evaluating the Effectiveness of UAV Remote Sensing for Soil Salinity Assessment	online
4	14.15 - 14.30 pm.	122433	Trần Bá Thuận and Trần Thị Diệu Thuận	Optimized GARCH Neural Network Model for Forecasting Volatility and Trading Strategies for First Solar Stock in the Sustainable Energy Sector	online

No.	Times	Code	Name - Surname	Title	System
5	14.45 - 15.00 pm.	222035	Prasan Tangyuenyongwatana, Jitti Vimtrimate, Chairat Angsukaset and Jirapat Pasavaravech	Study of molecular docking binding affinity against transcriptional activation activity on estrogen receptor beta using SwissDock AC 2.0 web service	online
6	15.00 - 15.15 pm.	222086	Auntika Khunsom, Kittipol Sripui, Natsima Kopitak, Chuenchit Boonchird, Thantawat Theeranan and Thunyarat Pongtharangkul	Production of Recombinant Human Papilloma Virus (HPV) L1 Protein Type 31 in Hansenula polymorpha	online
7	15.15 - 15.30 pm.	222258	Sane Pleejan, Vijittra Vonganusith and Yatawee Chaiyamat	Development of Model for Opisthorchiasis Prevention with Community Participation in Banphaeng Subdistrict, Banphaeng District, Nakhon Phanom Province	online
8	15.30 - 15.45 pm.	222259	Sita Pleejan, Vijittra Vonganusith and Yatawee Chaiyamat	Effects of Sexual Health Media Literacy Development Program on the Prevention of Premature Sex and AIDS in Lower Secondary School Students, Banphaeng District, Nakhon Phanom Province	online
9	15.45 - 16.00 pm.	222267	Gorawin Chaiyakitpattana and Kanit Bhukhai	The Role of 14-3-3 Protein in Erythropoiesis: Insights into Erythropoietin-Mediated Signaling and Apoptosis Regulation	online
10	16.15 - 16.30 pm.	222348	Nur Lu'lu Fitriyani, Laelatul Khasanah, Ristiawati, Jaya Maulana and Imam Purnomo	Relationship between Water Source, Ice Cube Type, and Seller Behavior with the Existence of Fecal Coliform Bacteria in Iced Tea: Case Study in Pekalongan	online
11	16.45 - 17.00 pm.	222394	Umi Masrurotul Khoiriyah and Nila Oktaviani	Comparative Study of Antibacterial Activity of Rhizophora apiculata Stem Extract and Ciprofloxacin Against Vibrio parahaemolyticus	online

No.	Times	Code	Name - Surname	Title	System
12	14.45 - 15.00 pm.	222402	Swe YaminBo	SERUM VITAMIN D LEVEL AND DEGREE OF AGING SIGNS MEASURING AGE SPOTS AND WRINKLES	online

Meeting room 6 International Oral Presentation

Sessions: Technology and Agricultural Innovation		
Chairman	Asst.Prof.Dr.Anupong Tankrathok	Kalasin University
Co-Chairman	Asst.Prof.Dr.Jiranan Insee	Kalasin University
Moderator	Asst.Prof.Dr.Sawipa Ruttanakorn	Kalasin University
Moderator	Asst.Prof.Dr.Piyachat Wiriyaampaiwong	Kalasin University
Student	Ms.Niracha Phakaket	Kalasin University
Student	Ms.Onuma Khiewpetch	Kalasin University
ICT Supporter	Mr.Thewarit Phudee	Kalasin University
Presentation Date: March 7, 2025		
Room: 1st floor of a Student Activities Building at Kalasin University (Nai Mueang)		
Join Zoom Meeting: https://zoom.us/j/95553621646?pwd=bOPNYCdBcZytPmcMhiqxA4kvVOqdJY.1		
Meeting ID: 955 5362 1646 Passcode: 734155		

No.	Times	Code	Name - Surname	Title	System
13	12.45 - 13.00 pm.	322082	Aumaporn Suwanwiset, Tunyaboon Laemthong, and Phanida Saikhwan	Evaluation of Sewage Sludge-Based Organic Fertilizers for Corn Cultivation	online
14	13.00 - 13.15 pm.	322419	Luu Thi Cuc	APPLICATION OF OZONE TECHNOLOGY IN LEACHATE TREATMENT FOR SUSTAINABLE DEVELOPMENT: A BRIEF REVIEW	online
15	13.15 - 13.30 pm.	322428	Nguyen Thai Phan	The relationship between organic fertilizer adoption and household food security in rice production in Vietnam	onsite
16	13.45 - 14.00 pm.	322430	Au Ton Nu Hai and Hieu Tran Hong	Sustainable Aquaculture: How to Reduce Nutrient Pollution in Pangasius Farming in Vietnam	onsite

No.	Times	Code	Name - Surname	Title	System
17	14.00 - 14.15 pm.	322441	Tran Thi Thu	TECHNOLOGY AND INNOVATION FOR SUSTAINABLE DEVELOPMENT IN LAO CAI PROVINCE	online
18	14.15 - 14.30 pm.	322447	Phung Nam Phuong*, Nguyen Hai Ly, Truong Le Tinh Giang, Nguyen Thi My Tam and Do Huong Thuy	APPLICATION OF ASMR IN ADVERTISING IN THE FAST FOOD INDUSTRY: THE MEDIATING ROLE OF EMOTIONAL RESPONSE	online
19	14.30 - 14.45 pm.	322450	Tiho Ancev and Nguyen Duc Kien	Innovation for Food Safety in Vietnam: An Application of the One Health Approach in Agri-food Supply Chain	online

Meeting room 7 International Oral Presentation

Sessions: Business Administration, Economics, Hospitality, and Tourism		
Chairman	Dr.Darani Ketchomphu	Nakhon Phanom University
Co-Chairman	Asst.Prof.Dr.Chairung Chaikambang	Kalasin University
Moderator	Mrs.Yaowapha Ratchakham	Kalasin University
Moderator	Asst.Prof.Dr.Bancha Luaphol	Kalasin University
Student	Mr.Thirawich Loowongtrakul	Kalasin University
Student	Mr.Romtham Tisamat	Kalasin University
ICT Supporter	Mr.Thanachot Boonkla	Kalasin University
Presentation Date: March 7, 2025		
Room: 1st floor of a Student Activities Building at Kalasin University (Nai Mueang)		
Join Zoom Meeting: https://zoom.us/j/97380594865?pwd=MLGkaufzTZyaCv48iChA7faLjB6xgS.1		
Meeting ID: 973 8059 4865 Passcode: 791841		

No.	Times	Code	Name - Surname	Title	System
20	12.45 - 13.00 pm.	422006	Weiye Yang, Jirapong Ruanggoon	The impact of human resource management system on employee performance in ABC Express Company: The mediating role of employee flexibility and work engagement	online

No.	Times	Code	Name - Surname	Title	System
21	13.00 - 13.15 pm.	422052	Haopeng Liu, Jirapong Ruanggoon and Patcharapa Euamornvanich	Brand positioning strategies for international expansion: A case study of A new energy vehicle company	online
22	13.15 - 13.30 pm.	422098	Liu Yang and Noppawan Wisedsind	Initiatives for enhancing employee performance of X company in China	online
23	13.45 - 14.00 pm.	422108	Nguyen Le Hiep, Dao Duy Minh, Le Ngoc Luu Quang, Le Thanh An and Tran Dang Huy	A review of Local Community Participation in Community-Based Tourism Development in Vietnam from Theory to Practice: Case Studies in Two Mountainous Areas of Thua Thien Hue Province, Vietnam	online
24	14.00 - 14.15 pm.	422116	John Ewang Junior, Sasithorn Suwandee and Suwat Vongsinsirikul	The Relationship of Airline Service Quality, Brand Image, Loyalty Program Perceived Value, and Customer Loyalty: A Case Study of an International Airline in Cameroon	online
25	14.15 - 14.30 pm.	422117	Bruno Songlee Mechafeh, Sasithorn Suwandee and Chairat Suriyapa	The Impact of Airline Service Quality and Sustainability Reputation on Customer Satisfaction and Customer Loyalty: A Case Study of a World-Class Airline in Nigeria	online
26	14.30 - 14.45 pm.	422119	Thi My Hanh Huynh , Anh Dao Tran and Thi Thu Na Nguyen	From “brown” to “green” - The effect of authentic leadership on green creativity behavior and the mediating role of psychological green climate – A study in the banking sector in Vietnam	online
27	14.45 - 15.00 pm.	422278	Ngo Tan Nhi, Le Nguyen Huong Quynh, Nguyen Truong Son and Son-Tung Nguyen	THE IMPACT OF ORGANIZATIONAL CULTURE ON EMPLOYEES' INTRINSIC AND EXTRINSIC	online

No.	Times	Code	Name - Surname	Title	System
				MOTIVATION: A CASE STUDY IN VIETNAM	
28	15.00 - 15.15 pm.	422282	Feiyan Zhou and Noppawan Wisedsind	Operations management strategies for promoting tourism in Nanning City, Guangxi province: A case study of Xiangsi Town	online
29	15.15 - 15.30 pm.	422337	Qinyu Xiao and Noppawan Wisedsind	Entrepreneurial Intention: A Study of University Students' Willingness to Return Home to Start Their Own Business in Nanning City	online
30	15.30 - 15.45 pm.	422418	Chi Kim Bach, Nhung Hong Le Ha and Linh Thuy Nguyen	DIGITAL MARKETING APPLICATIONS FOR HOTEL BRAND DEVELOPMENT: A CASE STUDY OF LAO CAI, VIETNAM	onsite
31	15.45 - 16.00 pm.	422431	Pham Thi Ai My, Le Ngoc Quynh Anh, Phan Xuan Quang Minh and Tran Thi Tra My	THE IMPACT OF BUSINESS INDUSTRY AND ENTERPRISES TYPE ON THE INTENTION TO ADOPT ENVIRONMENTAL ACCOUNTING OF MANUFACTURING ENTERPRISES IN THUA THIEN HUE PROVINCE	online
32	16.00 - 16.15 pm.	422432	Le Ngoc Quynh Anh	The impact of economic freedom and regulatory quality on banking function	onsite
33	16.15 - 16.30 pm.	422442	Le Thu Huong	Application of Digital Technology and Sustainable Economic Development for Ethnic Minorities in Lao Cai Province: Current Situation and Prospects	online

No.	Times	Code	Name - Surname	Title	System
34	16.30 - 16.45 pm.	422443	Sithonh Sisombath	Trends in the Demand for Chinese-Speaking Staff in the Guesthouse and Hotel Services Sector in Luang Prabang	online
35	16.45 - 17.00 pm.	422449	Huynh Nguyen Bui and My Linh Le	Charting the course of cultural intelligence: A comprehensive review and analysis through the ADO framework	online

Meeting room Coworking 2 International Oral Presentation

Sessions: Business Administration, Economics, Hospitality, and Tourism		
Chairman	Dr. Wannasa Wangsankaew	Roi Et Rajabhat University
Co-Chairman	Dr.Arune Hamkumpai	Kalasin University
Moderator	Ms.Phattharawaran Srihat	Kalasin University
Moderator	Dr.Thammarat Bunrod	Kalasin University
Student	Mr.Kittidech Imraksa	Kalasin University
Student	Ms.Arthittaya Krueasri	Kalasin University
ICT Supporter	Mr.Sattra Moolvilai	Kalasin University
Presentation Date: March 7, 2025		
Room: 1st floor of an Academic Resources and Information Technology at Kalasin University (Nai Mueang)		

No.	Times	Code	Name - Surname	Title	System
36	14.30 - 14.45 pm.	422285	Meliza and Indah Meilia	The Effect of Liquidity and Asset Turnover on Profitability: The Moderating Role of Capital Structure	onsite

Meeting room 8 International Oral Presentation

Sessions: Education, Pedagogy, and Learning Management Innovation		
Chairman	Assoc.prof.Dr.Prayong Klanrit (online)	Udon Thani Rajabhat University
Co-Chairman	Assoc.Prof.Dr.Channarong Intarapraser	TESOL Freelancer
Moderator	Mr.Nanthanut Wiangin	Kalasin University
Moderator	Asst.Prof.Nichapha Kankhunthod	Kalasin University
Student	Ms.Nattapon Thanphoem	Kalasin University
Student	Ms.Yatika Chaiyasi	Kalasin University
ICT Supporter	Mr.Achitphon Deelert	Kalasin University

Presentation Date: March 7, 2025

Room: 1st floor of a Student Activities Building at Kalasin University (Nai Mueang)

Join Zoom Meeting:

<https://zoom.us/j/99250562452?pwd=QraAlNCSaBYa8qMhzCoChDBKlqm87L.1>

Meeting ID: 992 5056 2452 **Passcode:** 777001

No	Times	Code	Name - Surname	Title	System
37	12.45 - 13.00 pm.	522017	Chamaiphorn Kaiyasit, Vijitra Vonganusith, Yatawee Chaiyamat and Brendan D. McKell	The Conditions and Challenges of Primary School Teachers' Professional Development in Integrating Learning Management Based on the Principles of the Sufficiency Economy Philosophy	online
38	13.00 - 13.15 pm.	522058	Poorida Ruangsri, Aime Bishop, Anyamanee Srisongkram, Thanadon Kongwet and Asama Tasanameelarp	Students' Perspectives on English for Business Communication Curriculum: A Mixed-Method Evaluation from a Thai University	online
39	13.15 - 13.30 pm.	522073	Titapa Buapan, Kotchakan Sang Lun, Kanjana Thongruang, Napasakorn Noochookkaew, Tuna Girgin and Asama Tasanameelarp	Thai EFL Undergraduate Students' Attitudes and Preferences Toward Different English Accents: A Mixed-Method Study	online
40	13.45 - 14.00 pm.	522099	Pemika Phadungtaksin, Darawan Phumsuwan, Rattanan Janjarung, Arraya Somklai, Joyce Grace Dinsag Tero and Asama Tasanameelarp	Perceptions and Attitudes Toward Using ChatGPT Among Business English Communication Students: A Case Study of Prince of Songkla University, Surat Thani Campus	online
41	14.00 - 14.15 pm.	522083	Pimpapan Thongking, Wichaya Pewkam, Sakda Swathanan and Natad Assapaporn	Needs Assessment to Enhance Financial and Health Literacies for Pre-	online

No	Times	Code	Name - Surname	Title	System
.				Service Teachers in The Digital Era	
42	14.15 - 14.30 pm.	522118	Nathya Boonkongsaen and Sengchoy Intrachrak	Transforming Traditional EFL Pedagogy with Gamified Techniques: A Teacher's Guide	online
43	14.30 - 14.45 pm.	522231	Dr. Nguyen Ngoc Ngan, Dr. Nguyen Hoang and Dr. Cao Hoang Khuyen	Mini Riview: Assessment in education	online
44	14.45 - 15.00 pm.	522262	Suriwijak Pleejant, Vijitra Vonganusith and Yatawee Chaiyamat	Investigation of needs for developing professional learning communities in schools under Nakhon Phanom Education Area District Office	online
45	15.00 - 15.15 pm.	522274	Kanyakorn Chaiyakao, Jaruwan Yaennan, Narueta Hongsa and Pattharaporn Wathawatthana	Amplifying Voices: Boosting Speaking Skills in Grade 8 Students Through Voice-Overs	online
46	15.15 - 15.30 pm.	522275	Atthasit Seethongsuk, Sitaphop Phukhao, Narueta Hongsa and Pattharaporn Wathawatthana	Leveling Up Language: Enhancing Grade 5 Students' Vocabulary Mastery Through Gamification	online
48	15.45 - 16.00 pm.	522409	Somyong Somin, Kampeeraphab Intanoo and Akkarapon Nuemaihom	Interlingual Analysis of EFL Learners' Translation: Its Implications to Thai EFL Learners	online
49	16.00 - 16.15 pm.	522423	Dr. Nguyen Ngoc Ngan	Literature Review: Assessment in education	online
50	16.15 - 16.30 pm.	522268	MSc. Nguyen Minh Diem Quynh	Teaching methods of economic law for students of economics	online

No	Times	Code	Name - Surname	Title	System
51	16.30 - 16.45 pm.	522435	N. Long Ha and s. Huong Do	Generative AI in Educational Assessment: Opportunities, Challenges, and Demonstrative Prototype for Multiple-Choice Test Grading	onsite
52	16.45 - 17.00 pm.	522444	Thavone Panmanivong	A MODEL OF CURRICULUM DEVELOPMENT THROUGH THE ENGAGEMENT OF EMPLOYERS AND ALUMNI Sisoury PHOMMASENG	onsite
53	17.00 - 17.15 pm.	544030	Soutchanthong CHANTHAVONG, Thain PHOUPHONETHONG, Khammeung INBOUPANH, Khampheng SAENKHAMCHANH, Khamhou CHANTHAPANYA, Sommay SHINGPHACHANH, Boualone CHANTHALASY and Phouthakone VACHIAXA	Teachers and Administrators’ Perspectives toward the Preparation of being Model Schools: The Case of Laboratory and Network Schools	onsite

Meeting room 6 International Oral Presentation (Continue)

Sessions: Education, Pedagogy, and Learning Management Innovation		
Chairman	Asst.Prof.Dr.Panayuth Choeybal	Udon Thani Rajabhat University
Co-Chairman	Dr.PhrapaladHonda Vattasadho (online)	Mahachulalongkornrajavidyalaya University Khon Khaen Campus
Moderator	Ms.Kamollapat Chaisongkram	Kalasin University
Moderator	Asst.Prof.Dr.Nataya Hokpanna	Kalasin University
Student	Ms.Sasimaporn Tudteenont	Kalasin University
Student	Ms.Nichaboon Sarapee	Kalasin University
ICT Supporter	Mr.Thewarit Phudee	Kalasin University

Presentation Date: March 7, 2025
Room : 1st floor of a Student Activities Building at Kalasin University (Nai Mueang)
Join Zoom Meeting: https://zoom.us/j/95553621646?pwd=bOPNYCdBcZytPmcMhiqxA4kvVOqdJY.1
Meeting ID: 955 5362 1646 Passcode: 734155

No.	Times	Code	Name - Surname	Title	System
54	15.00 - 15.15 pm.	521321	Xenia Ribaya Emperador-Garnace, Ph.D	From Classroom to Camp: English Camps' Impact on Lifelong Learning in Public Administration	onsite
55	15.15 - 15.30 pm.	522347	Kittithat Phalasak and Suwich Tirakoat	Development of Augmented Reality Media for Film-Making Course in Vocational Certificate	onsite
56	15.30 - 15.45 pm.	522399	Nuttayaporn Junsong and Suwich Tirakoat	The development of virtual reality for the Candle Festival at Ubon Ratchthani Province	onsite
57	15.45 - 16.00 pm.	522448	Phung Nam Phuong*, Nguyen Thi Thanh Hang, Phan Yen Huong, Tran Quang Hoai Thu, Tang Thi Tuong Vi	PERCEIVED EMPLOYABILITY FOR VIETNAMESE STUDENTS IN HIGH EDUCATION – AN ANALYSIS OF THE IMPACT OF GLOBAL MINDSET ON PERCEIVED EMPLOYABILITY	online
58	16.00 - 16.15 pm.	622440	Dr. Nguyen Thi Minh Tam and Hoang Thi Phuong Anh	Impact Of Annoying Advertising Values And Cognitive Dissonance Theory On Gen Z Shopping Behavior	onsite

Room meeting 4 International Oral Presentation

Sessions: Humanities, Social Sciences, and Innovation for Local Development		
Chairman	Prof.Eko Priyo Purnomo	Universitas Muhammadiyah Yogyakarta as Professor at Dept of Governmental Affairs and Administration
Co-Chairman	Asst.Prof.Dr.Chitrada Chaiya	Maharakham University
Moderator	Asst.Prof.Dr.Ariya Pongsiri	Kalasin University
Moderator	Asst.Prof.Phoom Manphonsri	Kalasin University
Student	Mr.Nattawut Nuchittom	Kalasin University
Student	Ms.Rossukon Moonwong	Kalasin University
ICT Supporter	Mr.Thanadol Boonmee	Kalasin University
Presentation Date: March 7, 2025		
Room: 1st floor of a Student Activities Building at Kalasin University (Nai Mueang)		
Join Zoom Meeting: https://zoom.us/j/97378826032?pwd=ZgOxCav248bESz2Jm28NsuaXjvnR6.1		
Meeting ID: 973 7882 6032 Passcode: 958496		

No.	Times	Code	Name - Surname	Title	System
59	12.45 - 13.00 pm.	622107	Suponpen Hermansson, Kathanyoo Kaewhanam and Suchanart Singhapat	The approach to developing the implementation of policies for preventing teenage pregnancies in the Northeastern region	onsite
60	14.00 - 14.15 pm.	622420	Dr. Dang Thi Oanh, Tran Thi Hien, Phạm Thị Kim Anh, Trần Thị Thảo and Nguyễn Thu Thúy	Cultural Identity Preservation in Association with Tourism Development of the H'Mong People in Si Ma Cai District and Bac Ha, Lao Cai Province, Vietnam	onsite
61	14.15 - 14.30 pm.	622421	Dr. Pham Xuan Cong	Application of Digital Technology in Sustainable Tourism Management in Lao Cai Province	online

No.	Times	Code	Name - Surname	Title	System
62	14.30 - 14.45 pm.	622424	Dr. Luan Nguyen	SOLUTIONS TO PROMOTE INNOVATIVE START-UP AMONG ETHNIC MINORITY YOUTH IN LAO CAI PROVINCE	onsite
63	14.45 - 15.00 pm.	622425	Nhung Hong Le Ha and Chi Kim Bach	APPLICATION OF SOCIAL NETWORKS IN PROMOTING TRADITIONAL CULTURAL IDENTITIES OF ETHNIC MINORITIES TO DEVELOP HOUSEHOLD ECONOMY IN BAC HA DISTRICT, LAO CAI PROVINCE	onsite
64	15.00 - 15.15 pm.	622426	Thuy Nhu Khuong and Nhung Hong Le Ha	DEVELOPING CREATIVE TOURISM TOWARDS SUSTAINABLE TOURISM: LESSONS LEARNED FROM THATLAND AND IMPLICATIONSS FOR VIETNAM	onsite
65	15.15 - 15.30 pm.	622427	Pham Thi Thang. M.A.	DEVELOP SPEAKING SKILL FOR LEARNERS THROUGH SOME EXPERIENTAL ACTIVITIES	online
66	15.45 - 16.00 pm.	622429	Pham Thi Bich Ngoc and Hisaki Kono	What contributed to the upward mobility in Vietnam?	Onsite

No.	Times	Code	Name - Surname	Title	System
67	16.00 - 16.15 pm.	622434	Truong Thi Huong Xuan	Corporate social responsibility and customer loyalty of Commercial banks in Hue city, Vietnam: mediating role of corporate image	onsite
68	16.15 - 16.30 pm.	622436	Bui Duc Tinh and Dao Duy Minh	Development of Small and Medium Hydropower in Vietnam, Cambodia and Laos from Policy to Practice to achieve Sustainable Development Goals (SDGs)	online
69	16.30 - 16.45 pm.	622437	Duong Thi Hai Phuong, Phan Van Duy Phuc and Hoang Quang Thang	Combining Machine Learning and Natural Language Processing in Aspect-Based Sentiment Analysis from Tourist Reviews: A case study of hotels in Hue City	onsite
70	16.45 - 17.00 pm.	622438	Au Ton Nu Hai and Hieu Tran Hong	Driving factors of applying “economic-green” model in marine lobster farming in Vietnam Au Ton	onsite

Program Poster

International Poster Presentation

Chairman	Dr.Suchanart Singhapat	Kalasin University
Co-Chairman	Asst.Prof.Dr.Chuthamat Chiamsathit	Kalasin University
Moderator	Asst.Prof.Suchada Surangkul	Kalasin University
Moderator	Asst.Prof.Fungkiat Mahipan	Kalasin University
Student	Mr.Sakda Promthep	Kalasin University
Student	Ms.Onanong Phonphad	Kalasin University
ICT Supporter	Mr.Khattiya Yotasing	Kalasin University
ICT Supporter	Mr.Chinnawat Panpeng	Kalasin University
Presentation Date: March 7, 2025		
Room: 1st floor of a Student Activities Building at Kalasin University (Nai Mueang)		

No.	Times	Code	Name - Surname	Title	System
1	13.30 - 13.45 pm.	222377	Nithiphoom Raha and Chonlatip Pipattanaboon	Improving the binding affinity of cross-reactive dengue antibody using computational methods	onsite
2	13.15 - 13.30 pm.	322211	Nattapong Srisamoot, Piyanan Chomnawang, Piyachat Wiriyaampaiwong, Mullika Teerakun, Kaewta Sootsuwan, Likit Sirisantimethakom, Anupong Tankrathok and Teamjun Srisamoot	Identification of Banana Cultivars Using rbcL Gene as a DNA Barcode for Accurate Species Differentiation	onsite

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Oral Presentation

Session 1: Engineering and Innovation

122380

Microcontroller-Based Automated Vending Machine Development**Chompoo Suppatoomsin^{1*} Ekkarat Takkratok² Sureeporn Meehom³ and Kritsada Wilairuk¹**¹Electrical Engineering, Faculty of Engineering, Vongchavalitkul University²Electrical Engineering, Fastwork Technology Company³Engineering Management, Faculty of Engineering, Vongchavalitkul University

*Corresponding author: -

Abstract

In today's rapidly evolving retail landscape, automated vending machines have become increasingly important for providing convenient access to products while minimizing operational costs and human resource requirements. However, many existing vending machines face limitations in payment flexibility and real-time transaction monitoring. This paper presents the design and implementation of an automated vending machine controlled by a microcontroller. The developed vending machine accepts all types of coins and banknotes as payment methods, provides accurate change calculation, and can transmit transaction details including product prices, payment amounts, and change through the LINE application. The transaction information is displayed as text messages. Based on the testing results, the automated vending machine demonstrated practical functionality with 100% system accuracy in operational testing. The machine shows potential for further development and commercial implementation, particularly in improving the accuracy of banknote detection mechanisms.

Keywords: vending machine, microcontroller, automatic system**Introduction**

In the contemporary digital era, technology plays an increasingly crucial role in daily life, with modern consumers demanding efficient, convenient, and accessible retail solutions. Automated vending machines have emerged as a significant innovation addressing these needs, particularly in situations requiring minimal physical contact. The continuous technological advancement in this field has led to the development of sophisticated vending systems incorporating diverse payment methods, intelligent inventory management, and customer analytics capabilities.

Recent research has demonstrated significant progress in vending machine technology. Park (2022) investigated the integration of artificial intelligence (AI), Internet of Things (IoT), and digital payment systems in smart vending machines, highlighting improved service efficiency and enhanced user experience. The study revealed that these technologies enable superior customer data analysis, demand forecasting, and inventory management, although challenges persist regarding implementation costs, data security, and consumer adoption.

Several researchers have contributed to advancing vending machine technology. Sibanda et al. (2020) developed a high-tech multi-product vending system incorporating biometric security through fingerprint sensors. Smt Usha Rani et al. (2020) created a digital payment system for stationery items utilizing servo motors and Raspberry Pi technology, implementing QR code payments with email confirmation capabilities. Mahajan et al. (2020) designed a hybrid payment system combining traditional coin operations with digital transactions through an Arduino microcontroller and DC motors, ensuring functionality both online and offline.

Building upon previous research, this study presents a microcontroller-based vending machine that accepts multiple payment methods, including coins and banknotes, with accurate change dispensing capabilities. The system features integration with the LINE messaging application for transaction notifications, providing detailed purchase information and reducing paper receipt usage. This cost-effective solution offers improved functionality compared to existing systems while promoting environmental sustainability through paperless operations.

1. Research Objectives

1.1 To develop an automated vending machine capable of accepting all types of banknotes and coins as payment methods.

1.1 To study the implementation of microcontroller systems in developing automated vending machines.

1.3 To analyze the operational performance of the automated vending machine system.

2. Review of Related Literatures

Bharat and Sawant (2020) designed and developed a smart vending machine utilizing Arduino microcontroller as the primary control unit. Their research focused on enhancing vending machine efficiency through automation, error reduction, and improved user convenience. Their study demonstrated the feasibility of using Arduino to develop an efficient, user-friendly, and cost-effective automated vending machine that could be expanded for enhanced capabilities in the future.

Das, Kumar, and Sharma (2021) presented the development of a smart vending machine using Arduino UNO as the main controller. Their research aimed to enhance traditional vending machine functionality with modern conveniences and features. Their findings demonstrated that Arduino UNO could be effectively utilized to create modern, user-friendly, and cost-efficient automated vending machines, with potential for future integration of emerging technologies such as IoT and mobile payment systems.

Duangphasuk and Thanapatay (2023) proposed the development of an IoT-enabled smart vending machine that connects vending units to cloud systems for real-time data monitoring. Their research emphasized enhancing user convenience and modernizing system efficiency through technological integration.

Islam, Azam, and Hossain (2022) presented the development of a cost-effective smart vending machine using Arduino as the primary controller. Their research focused on designing an efficient system at a lower cost compared to commercial vending machines while maintaining operational effectiveness.

Singh and Kumar (2023) introduced a smart vending machine with an integrated inventory management system controlled by Arduino. Their research addressed the challenge of product shortages in vending machines and enabled real-time inventory monitoring for operators. The system demonstrated the potential for automated retail solutions to incorporate sophisticated inventory management capabilities while maintaining operational efficiency.

These studies collectively highlight the growing trend toward integrating microcontroller-based systems in vending machine development, with emphasis on cost-effectiveness, user convenience, and enhanced functionality through modern technology integration.

Research Methodology

1. The Research Procedure Includes 2 Steps which are:

1.1 Research Framework. This study employed a systematic approach to develop and evaluate an innovative microcontroller-based automated vending machine. The research framework was structured to assess both the technical performance and user experience aspects of the system.

The research variables were defined as follows:

Independent Variable:

The developmental process and implementation of the microcontroller-based automated vending machine system

Dependent Variables:

The operational efficiency metrics of the automated vending machine

The level of user satisfaction with the automated vending machine system

These variables were selected to provide comprehensive evaluation of both technical functionality and user experience aspects of the developed system.

1.2 Research Methodology. To achieve the research objectives, the researcher established detailed methodological procedures encompassing research design, population, sample size, variables, research instruments, data collection methods, data analysis, statistical methods, and reporting procedures. The research employed two main instruments:

Performance evaluation of the automated vending machine using the Confusion matrix principle to measure accuracy and error rates

User satisfaction questionnaire to assess user experience and satisfaction levels

2. System Design

2.1 Hardware Components

(1) Arduino Mega 2560 Microcontroller Board

The Arduino Mega 2560 is a compact computer system integrated into a small chip. This research utilizes the Arduino Mega 2560 microcontroller board, which features the ATmega2560 microcontroller IC, selected for its robust capabilities and extensive I/O options.

(2) 12V DC Motor

Small electric motors that convert direct current electrical energy into mechanical energy. In this vending machine system, these motors serve as the mechanical mechanism for handling and dispensing paper currency.

(3) L298N Motor Driver Module

This module functions as a dual H-Bridge motor controller, capable of controlling both speed and direction of 12 V DC motors simultaneously. The module operates within a voltage range of 5-35 V and can handle maximum currents up to 2 A, making it suitable for precise motor control applications.

(4) TCS230/TCS3200 Color Sensor Module

This sensor converts light intensity into high-resolution frequency outputs. It integrates silicon photodiodes with a current-to-frequency converter on a monolithic CMOS integrated circuit, enabling accurate color detection and measurement.

(5) Switching Power Supply

Functions as an AC-DC converter, transforming 220 V AC to 12 V DC. The unit incorporates both rectifier circuits and voltage control converters to ensure stable power delivery to the system components.

(6) Coin Selector (CL 1006A)

The implemented CL 1006 A coin selector operates on 12 V with low current consumption and features microcontroller compatibility. It includes anti-jamming mechanisms, counterfeit coin detection, and coin retrieval prevention systems.

(7) MG90S Servo DC Motor

A compact yet powerful motor weighing 13.4 g with metal gearing, capable of delivering 2.2 kg-cm torque at 6V. It features continuous 360-degree bidirectional rotation and operates with 5V DC power supply, compatible with microcontroller integration.

(8) Line Notify Service

An automated messaging service integrated with the LINE application, enabling automatic notification delivery through simple HTTP POST API calls.

2.2 System Design

(1) Design Principles

The automated vending machine system encompasses electronic circuit design, electrical control systems, and operational mechanisms. The machine accommodates three product types and operates through a sequential process of product selection, price display, payment processing, change dispensing, and LINE notification delivery. The control system's program flow diagram is presented in Figure 1.

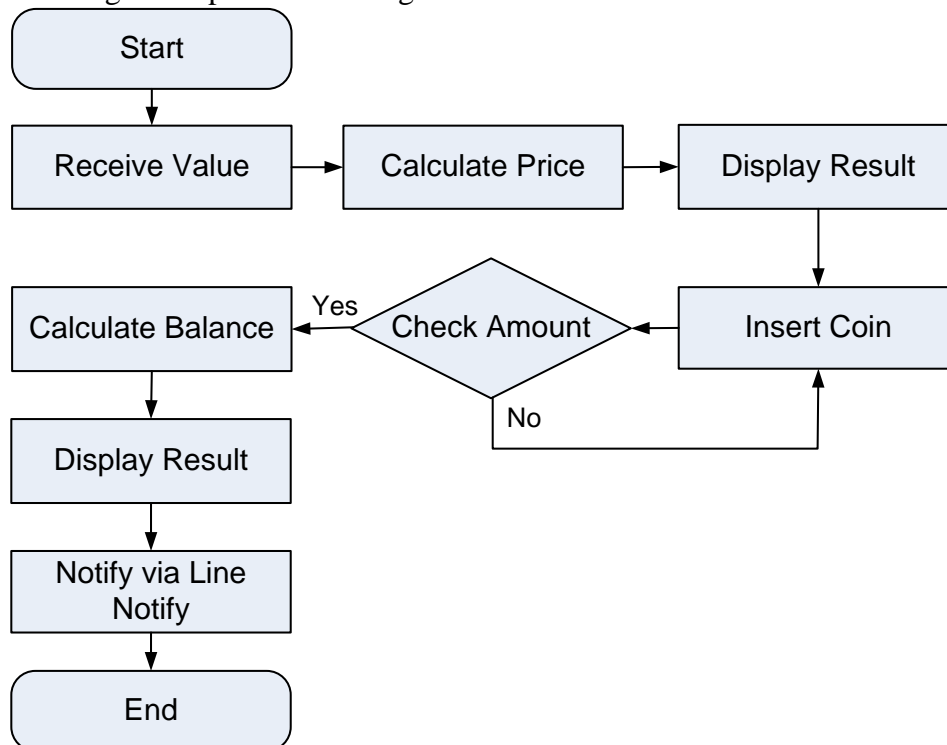


Figure 1 Automated Vending Machine Flowchart

(2) Physical Structure

The vending machine's structural design, shown in Figure 2, integrates various components including banknote handling, coin processing, and change dispensing mechanisms, shown in Figure 3. The banknote recognition system employs color sensors for currency validation and denomination identification.

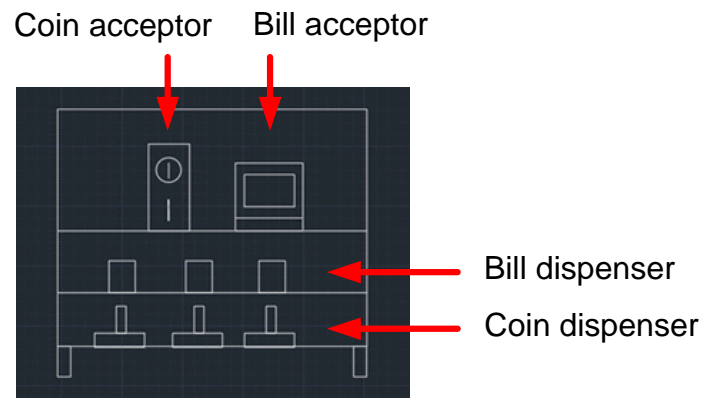


Figure 2 Automated Vending Machine Placement Structure

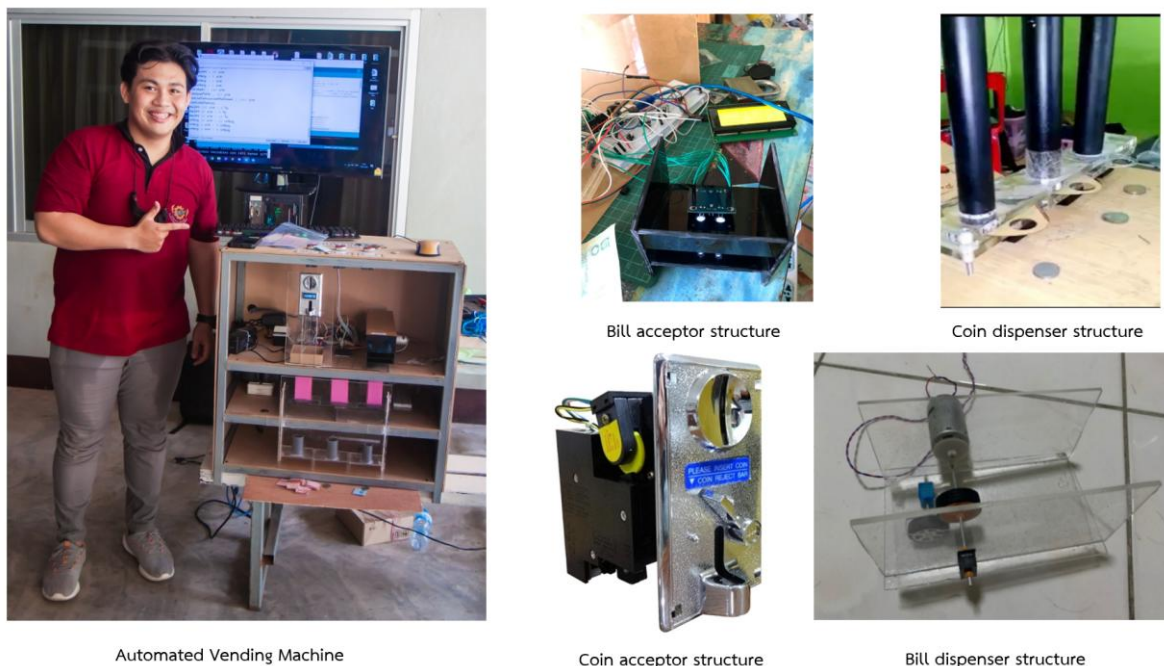


Figure 3 Automated Vending Machine Structure

2.3 Control Circuit Design

(1) Coin Acceptance Circuit

The coin acceptance mechanism interfaces with the microcontroller through a circuit featuring a 10kΩ resistor and 5V DC power supply. The circuit diagram, detailed in Figure 4(a), shows connections to the microcontroller's pin 2 and ground, with the coin acceptor powered by 12V DC.

(2) Banknote Recognition Circuit

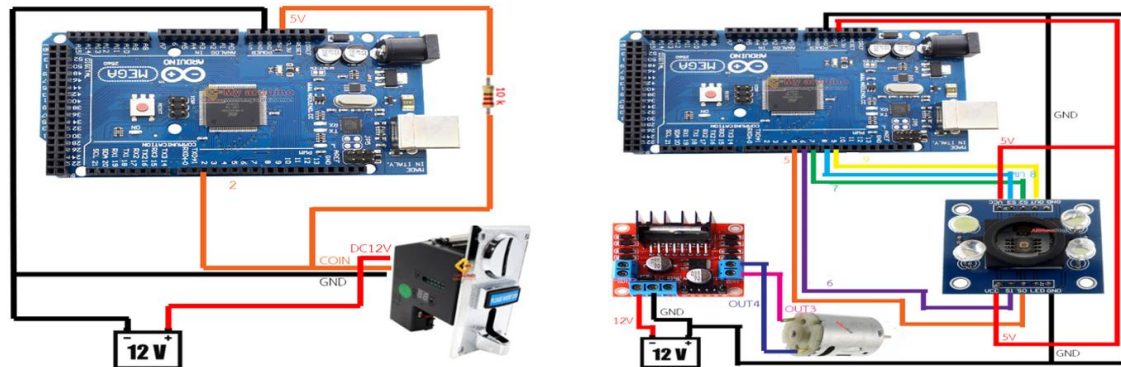
Implements the TCS230/TCS3200 RGB Color Sensor for currency authentication through color analysis. The system outputs RGB values to the microcontroller and employs a 12V DC motor with L298N driver for physical note handling, as shown in Figure 4(b).

(3) Change Dispensing Circuit

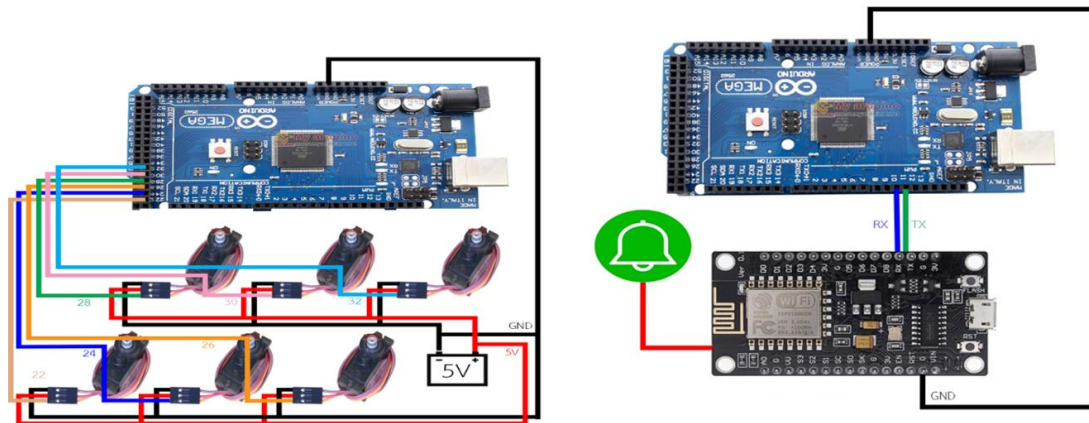
Utilizes six MG905 servo motors connected to the microcontroller board and powered by 5V DC supplies. The complete circuit configuration is illustrated in Figure 4(c).

(4) LINE Notification Circuit

Integrates the EP8266 module with the microcontroller for transmitting notification data to users via the LINE application. The notification circuit configuration is presented in Figure 4(d).



(a) Connecting a coin acceptor circuit to a microcontroller (b) Connecting a bill acceptor circuit



(c) Change dispenser circuit (d) Circuit for sending notification data to the Line application

Figure 4 Automated Vending Machine Circuits

3. Populations and Samples

3.1 The research population consisted of 174 faculty members and students from the Faculty of Engineering at Vongchavalitkul University.

3.2 The sample group comprised 27 faculty members and students from the Faculty of Engineering at Vongchavalitkul University.

4. Statistics for Data Analysis

The statistical analysis in this research employed descriptive statistics including mean (\bar{x}) and standard deviation (S.D.) to evaluate system performance and user satisfaction. A 5-point Likert scale (5 = Excellent to 1 = Poor) was used to assess user satisfaction with the following interpretation ranges:

- The mean score 4.50 – 5.00 refers to Excellent
- The mean score 3.50 – 4.49 refers to Very Good
- The mean score 2.50 – 3.49 refers to Good
- The mean score 1.50 – 2.49 refers to Fair
- The mean score 1.00 – 1.49 refers to Poor

System performance metrics included success rates for currency recognition, transaction processing accuracy, and operation reliability, calculated as percentages of successful operations against total operations. For data validation, the research analyzed:

- System accuracy rates = (Successful operations/Total operations) × 100
- Error rates = (Number of errors/Total operations) × 100
- Transaction completion times
- User satisfaction scores

These metrics provided quantitative measures for evaluating the automated vending machine's effectiveness and reliability in real-world applications.

Results and Discussion

1. The results of the development of the automated vending machine's performance

The automated vending machine's performance testing was conducted across multiple operational components, with results as follows:

Product Selection System Testing

Tests were performed for three price points (143, 400, and 640 baht), with 10 trials each. The product selection system demonstrated 0% error rate across all trials.

Coin Acceptance System Testing

The coin acceptance mechanism was tested using 1, 2, 5, and 10 baht coins, with 10 trials per denomination. Results showed 0% error rate across all denominations.

Banknote Recognition System Testing

- Testing was conducted in two phases:
1. Banknote denomination verification (20, 50, 100, 500, and 1000 baht notes)
 2. Banknote collection mechanism evaluation

Both systems demonstrated 0% error rate across 10 trials per denomination.

Change Dispensing System Performance The change dispensing system was tested with three product prices:

For 143 baht product:

- 1000 baht input: Average time 22.5 seconds (0% error)
- 500 baht input: Average time 12.1 seconds (0% error)
- 150 baht input: Average time 7.2 seconds (0% error)

For 400 baht product:

- 1000 baht input: Average time 13.1 seconds (0% error)
- 500 baht input: Average time 3.9 seconds (0% error)
- 450 baht input: Average time 5.4 seconds (0% error)

For 640 baht product:

- 1000 baht input: Average time 20.2 seconds (0% error)
- 800 baht input: Average time 7.4 seconds (0% error)
- 650 baht input: Average time 5.1 seconds (0% error)

Results indicated that change dispensing time correlates directly with the amount of change required.

LINE Application Notification System The notification system was tested over 10 trials, resulting in a 10% error rate. Errors were primarily attributed to internet connectivity instability during testing. This feature represents a novel implementation in vending machine systems, with no comparable studies available for performance benchmarking.

2. Analysis of User Satisfaction Results

The user satisfaction survey was conducted with 27 participants, comprising students and staff from the Faculty of Engineering, Vongchavalitkul University. The survey instrument

was structured across four main dimensions: System Functionality, User Interface and Accessibility, System Reliability, and Overall User Experience. A five-point Likert scale was employed for evaluation, with results analyzed using descriptive statistics including means and standard deviations. The results are presented in Table 1.

Table 1 Analysis of User Satisfaction Results

user satisfaction	\bar{X}	S.D.	Level
1. System Functionality	4.41	0.65	Very Good
- Ease of product selection	4.56	0.63	
- Payment process efficiency	4.30	0.66	
- Change dispensing accuracy	4.52	0.57	
- Transaction speed	4.22	0.63	
- LINE notification functionality	4.48	0.69	
2. User Interface and Accessibility	4.40	0.12	Very Good
- Display clarity	4.52	0.63	
- Button responsiveness	4.33	0.61	
- Instructions clarity	4.56	0.57	
- Menu navigation	4.19	0.61	
- Physical accessibility	4.41	0.73	
3. System Reliability	4.39	0.65	Very Good
- Currency recognition accuracy	4.52	0.63	
- Product delivery reliability	4.26	0.64	
- Change calculation accuracy	4.48	0.57	
- System stability	4.26	0.64	
- Error handling	4.44	0.68	
4. Overall User Experience	4.43	0.65	Very Good
- Overall satisfaction	4.56	0.63	
- Likelihood of future use	4.33	0.67	
- Value for money	4.44	0.63	
- Transaction convenience	4.33	0.61	
- Service comparison with traditional vending machines	4.48	0.69	
Total	4.41	0.65	Very Good

From Table 1, the results of user satisfaction showed that the System Functionality dimension achieved a mean score of 4.41 (SD = 0.65), indicating very good satisfaction levels. Product selection ease received the highest rating (M = 4.56, SD = 0.63), while transaction speed scored relatively lower but still favorably (M = 4.22, SD = 0.63). The LINE notification feature demonstrated strong performance (M = 4.48, SD = 0.69).

User Interface and Accessibility measurements yielded a mean score of 4.40 (SD = 0.12). Instructions clarity emerged as the highest-rated aspect (M = 4.56, SD = 0.57), while menu navigation received the lowest score in this category (M = 4.19, SD = 0.61), though still maintaining a very good rating.

The System Reliability dimension recorded a mean score of 4.39 (SD = 0.65). Currency recognition accuracy showed the highest satisfaction (M = 4.52, SD = 0.63), while product delivery reliability and system stability shared lower but still favorable ratings (both M = 4.26, SD = 0.64).

Overall User Experience demonstrated the highest aggregate score among all dimensions ($M = 4.43$, $SD = 0.65$). Overall satisfaction received particularly high ratings ($M = 4.56$, $SD = 0.63$), and the comparison with traditional vending machines was notably positive ($M = 4.48$, $SD = 0.69$).

Discussion

While most mechanical and electronic components demonstrated perfect accuracy (0% error rate), initial challenges were encountered with the banknote recognition system, primarily due to varying bill sizes and color sensor calibration requirements. These issues were resolved through motor speed optimization and sensor calibration. The LINE notification system's 10% error rate was attributed to internet connectivity instability rather than system design limitations. The integration of real-time transaction notifications via LINE application represents an innovative feature in automated vending machine systems.

The results demonstrate consistently high satisfaction levels across all evaluated dimensions, with mean scores ranging from 4.39 to 4.43. The remarkably low standard deviation ($SD = 0.12$) in the User Interface and Accessibility category suggests strong consensus among participants regarding these features. The system's strongest attributes appear to be its ease of product selection, instruction clarity, and overall satisfaction ratings.

Conclusion

The implementation and testing of the automated vending system revealed several noteworthy findings regarding system performance and reliability. The mechanical and electronic components exhibited exceptional performance with zero error rates, demonstrating the robustness of the core system architecture. However, the development process encountered specific challenges that warranted attention and subsequent optimization.

A significant technical challenge emerged in the banknote recognition system's initial implementation. This challenge was primarily attributed to two factors: the variability in banknote dimensions and the necessity for precise color sensor calibration. Through systematic optimization of motor speed parameters and comprehensive sensor calibration protocols, these initial obstacles were successfully overcome, resulting in improved system reliability.

The LINE notification system, while innovative in its integration with vending machine operations, demonstrated a 10% error rate during testing. It is important to note that this error rate was not inherent to the system's design architecture but rather stemmed from external factors, specifically the instability of internet connectivity in the deployment environment. This finding highlights the importance of considering infrastructure dependencies in automated system implementations.

A particularly significant advancement in this system is the incorporation of real-time transaction notifications through the LINE application platform. This feature represents a novel approach in automated vending machine systems, enhancing user experience through immediate transaction confirmation and improved security measures. The integration of such modern communication protocols demonstrates the potential for traditional vending systems to evolve and adapt to contemporary user expectations and technological capabilities.

The automated vending system has achieved very good satisfaction ratings across all evaluated dimensions, with an overall mean score of 4.41 ($SD = 0.65$). The consistently high scores and relatively low standard deviations indicate strong user acceptance and reliable system performance. While all aspects received favorable ratings, there remains some room for

improvement in areas such as menu navigation and transaction speed, though these still maintained very good satisfaction levels.

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Performance Evaluation of RTK GNSS with Virtual Reference Station (VRS) Technology: A Comparative Study in Urban and Rural Thailand

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Abstract

This study evaluates the performance of Real-Time Kinematic (RTK) Global Navigation Satellite System (GNSS) with Virtual Reference Station (VRS) technology in urban and rural environments in Thailand. RTK GNSS with VRS represents a significant advancement in land surveying, providing high positional accuracy through real-time corrections. However, its effectiveness under varying environmental and infrastructural conditions remains understudied. The research compares RTK GNSS with VRS against traditional static surveying methods across two study sites: the Mahasarakham University campus, representing urban conditions with moderate canopy cover, and Yang Talat District, Kalasin Province, characterized by dense vegetation and limited infrastructure. The study involves 90 survey points categorized into three canopy scenarios: low (0–35%), moderate (35–70%), and dense (70–100%). Key performance metrics, including positional accuracy, time to first fixed solution, and reliability, were analyzed under diverse conditions. Results highlight that RTK GNSS with VRS achieves sub-4 cm accuracy in low-canopy areas with shorter observation epochs, while moderate and dense canopy environments require longer epochs for consistent results. In densely covered areas, despite improvements with extended observation times, accuracy remains lower compared to static methods. This research underscores the adaptability of RTK GNSS with VRS in diverse settings, offering actionable recommendations for optimizing its deployment in Thailand. Findings demonstrate its potential to enhance surveying efficiency while addressing challenges posed by environmental and infrastructural constraints, particularly in rural regions with dense vegetation.

Keywords: RTK GNSS network, Virtual Reference Station (VRS), Land Surveying, Static Surveying Methods, Positional Accuracy

Introduction

Land surveying plays a vital role in managing and developing land resources. The foundation of urban planning, infrastructure development, agricultural optimization, and land dispute resolution relies on precise and trustworthy geospatial data. While traditional surveying methods remain effective, they are often constrained by time, labor demands, and human error. Advances in geodetic science have introduced satellite-based surveying systems and other innovative technologies, which markedly improve the accuracy and efficiency of land surveys (Smith et al., 2020; Johnson & Lee, 2019). These innovations highlight a shift from

conventional techniques to modern geospatial solutions, transforming the surveying landscape and enhancing results (Doe et al., 2021).

Real-Time Kinematic (RTK) Global Navigation Satellite System (GNSS) networks represent a significant advancement in land surveying technology. RTK GNSS utilizes a differential positioning technique to deliver centimeter-level accuracy by correcting real-time satellite positioning data through a network of reference stations. Widely recognized as a global standard, this method provides exceptional precision and operational efficiency in diverse settings, including urban and rural areas. By enabling surveyors to achieve unparalleled accuracy and dependability, RTK GNSS has transformed land surveying practices on a global scale (Green & Miller, 2020; Zhang & Patel, 2019; Nguyen & Lee, 2021).

In Thailand, the Real-Time Kinematic (RTK) GNSS network was introduced in 2015 to modernize land surveying practices and align them with global standards. The primary objective was to enhance the accuracy of map control points and support the development of a robust nationwide geodetic infrastructure. However, the adoption of RTK GNSS has encountered several challenges, including budget constraints, limited availability of equipment, and a shortage of skilled professionals. These issues have led to incomplete network coverage, especially in remote areas with inadequate infrastructure or dense vegetation, thereby hindering the technology's full potential (Chantharak & Wongchai, 2016; Nguyen & Brown, 2020; Somchai & Patel, 2018). To address these challenges, the Department of Lands initiated a project aimed at establishing a satellite network to achieve nationwide RTK GNSS coverage by 2022. Despite these efforts, uneven distribution of base stations and large baseline distances remain critical challenges. These issues have resulted in positional inaccuracies, particularly in areas where the survey site is located far from the nearest reference station (Doe et al., 2019; Somchai & Patel, 2020). These limitations underscore the need for innovative strategies and continuous research to optimize RTK GNSS performance. Future efforts could focus on exploring advanced geospatial technologies to refine base station configurations and enhance system reliability in remote regions (Chantharak & Wongchai, 2018; Green et al., 2020; Zhang & Nguyen, 2021).

The adoption of Virtual Reference Station (VRS) technology marks a significant advancement in overcoming the limitations of traditional RTK GNSS systems. By generating a virtual reference point near the survey area through the interpolation of data from multiple nearby base stations, VRS reduces baseline distances, enhances satellite signal reception, and improves positional accuracy. Research shows that VRS achieves high accuracy in both horizontal and vertical dimensions, even in challenging environments such as dense canopy cover or uneven terrain (Chen et al., 2019; Wang et al., 2018; Zhang & Patel, 2020). This innovation further improves reliability by mitigating systematic biases caused by elevation differences and tropospheric effects, ensuring consistent real-time kinematic performance.

Several studies have explored the Real-Time Kinematic (RTK) network, a critical technology for high-precision positioning and navigation. The performance of this network has been extensively evaluated across various scenarios, such as urban development and natural resource management. These studies provide valuable insights into the applications and outcomes of the RTK system in diverse contexts. For example, Charoenkalunyuta et al. (2012) tested the RTK network's performance in Thailand's central region, emphasizing its potential to achieve high accuracy in low-latitude areas (Charoenkalunyuta et al., 2012). Dumrongchai et al. (2023) investigated its use in landslide monitoring systems, achieving sub-decimeter vertical accuracy (Dumrongchai et al., 2023). Similarly, Khumsa and Sutthisangiam (2023) applied RTK for geoid modeling and orthometric height determination using IoT devices (Khumsa & Sutthisangiam, 2023). Additional studies have highlighted the effects of ionospheric disturbances on RTK performance. Research by Satirapod and Charoenkalunyuta

(2014) integrated Thai Ionospheric Maps (THIM) to enhance RTK system reliability (Satirapod & Charoenkalunyuta, 2014). Finally, comparative analyses of RTK networks and standalone base stations, such as Duenkwang et al.'s (2023) research on autonomous navigation, underscore the importance of selecting appropriate RTK configurations for specific applications (Duenkwang et al., 2023).

While the effectiveness of Virtual Reference Station (VRS) technology has been well-documented in controlled environments, its performance in real-world applications remains insufficiently explored. Most existing studies focus on theoretical analyses or limited demonstration projects, leaving a considerable knowledge gap regarding how VRS performs under diverse environmental and operational conditions. This is particularly relevant in regions like Thailand, where varying canopy cover, complex topography, and infrastructural constraints pose distinct challenges for the practical implementation of RTK GNSS technology (Hu et al., 2017; Qu et al., 2019; Zhang et al., 2020). Empirical studies are needed to evaluate the robustness of VRS technology in such contexts, examining its reliability and efficiency in diverse settings. Addressing these challenges would not only fill current research gaps but also enhance the practical application of VRS in land surveying and geospatial technologies globally.

Despite the progress made in RTK GNSS technology, several key research gaps persist. First, there is limited comparative analysis between RTK GNSS systems with VRS and traditional static surveying methods. Static surveying, while less dependent on network infrastructure, remains the gold standard for high-precision applications but requires more time and resources. Understanding the trade-offs between these methods under different environmental and infrastructural conditions is critical for optimizing land surveying practices. Second, the impact of environmental factors such as canopy cover on RTK GNSS accuracy has not been thoroughly investigated in Thailand. Canopy density significantly affects satellite signal quality, leading to errors in positional data. Research is needed to quantify these impacts and identify strategies to mitigate them, particularly in regions with dense vegetation.

Third, the integration of RTK GNSS with VRS into existing land surveying practices and regulatory frameworks requires further exploration. While the Department of Lands has established guidelines for RTK GNSS usage, the effectiveness of these guidelines in addressing real-world challenges has not been comprehensively evaluated. This includes assessing compliance with international standards and ensuring that the technology meets the needs of land surveyors in both urban and rural contexts.

This study assumes that the integration of RTK GNSS with VRS can address existing challenges in land surveying accuracy, particularly in areas with varying environmental conditions and infrastructural limitations. To test this, the research evaluates the performance of RTK GNSS with VRS compared to traditional static surveying methods across two distinct sites: the Mahasarakham University campus, representing an urban setting with moderate canopy cover, and Yang Talat District, Kalasin Province, a rural area with dense vegetation and limited infrastructure. Using 90 survey points under three canopy cover scenarios (0–35%, 35–70%, and 70–100%), the experiment measures positional accuracy, time to first fixed solution, and reliability under these diverse conditions. By analyzing these metrics, the study aims to quantify the trade-offs in accuracy of coordinate, efficiency, and resource demands between the methods, identify the optimal deployment conditions for RTK GNSS with VRS in Thailand, and provide actionable recommendations for its integration into land surveying practices.

1. Research Objectives

To assess the performance of RTK GNSS with VRS technology in addressing surveying accuracy challenges under diverse environmental and infrastructural conditions.

2. Research methodology

2.1 Study Area

The study was conducted in two distinct locations in Thailand, selected to represent typical surveying environments and challenges encountered in urban and rural contexts. These locations were chosen to ensure the findings are applicable to a wide range of surveying conditions in the country.

Urban Site: Mahasarakham University Campus

The Mahasarakham University campus, situated in Mahasarakham Province, serves as an ideal urban study site for evaluating RTK GNSS performance with Virtual Reference Station (VRS) connectivity. Characterized by moderate canopy cover with scattered trees and open spaces, the campus boasts well-established infrastructure and stable network connectivity, ensuring consistent communication with the VRS network. This environment typifies urban surveying conditions with minimal obstructions and high accessibility, making it an optimal setting to assess the accuracy and reliability of RTK GNSS under controlled conditions where environmental and infrastructural factors have limited impact on signal quality.

Rural Site: Yang Talat District, Kalasin Province

The rural study site, located in Yang Talat District, is characterized by its natural vegetation and sparse infrastructure. This area features dense vegetation, including forests and agricultural lands, which pose significant challenges such as signal obstruction and inconsistent network connectivity. The varied terrain, with rugged topography and limited accessibility in some areas, further complicates surveying tasks. This site serves as a testing ground to evaluate the performance of RTK GNSS with Virtual Reference Station (VRS) technology under demanding conditions, assessing its adaptability and reliability in rural environments with dense canopy cover and infrastructural constraints.

Relevance of Study Areas

This study evaluates the performance of RTK GNSS combined with Virtual Reference Station (VRS) technology in addressing challenges of land surveying accuracy under diverse environmental and infrastructural conditions in Thailand. The research compares RTK GNSS with VRS against traditional static surveying methods across two distinct sites:

1. Urban Site: Mahasarakham University campus, characterized by moderate canopy cover and well-established infrastructure, providing ideal conditions for surveying.
2. Rural Site: Yang Talat District, Kalasin Province, characterized by dense vegetation and limited infrastructure, introducing real-world challenges that surveyors often face.

The combination of these two sites provides a comprehensive framework for evaluating RTK GNSS with VRS technology. The urban site represents controlled conditions with minimal environmental or infrastructural obstacles, while the rural site reflects the complexities of challenging field environments. By analyzing performance metrics across these contrasting settings, this study aims to deliver actionable insights for the effective deployment of RTK GNSS with VRS technology in diverse surveying contexts throughout Thailand (Figure 1).



Figure 1 Comparison of RTK GNSS with VRS Performance in Urban and Rural Environments

2.2 Experimental Design

Survey Points

The study involves 90 survey points strategically distributed across three distinct canopy cover scenarios to simulate varying environmental conditions:

Low Canopy (0–35%):

- Represents open areas with minimal vegetation or tree cover.
- Includes locations such as open fields, urban parks, or sparsely vegetated zones where GNSS signal obstructions are minimal.

Moderate Canopy (35–70%):

- Covers areas with scattered trees or partial vegetation.
- Includes zones like suburban regions or agricultural areas with intermittent canopy cover that partially blocks GNSS signals.

Dense Canopy (70–100%):

- Represents heavily vegetated or forested regions with significant signal obstruction.
- Includes locations such as dense forests or rural zones with high tree density.

Metrics Evaluated

The following key metrics are assessed to evaluate the performance of RTK GNSS network with VRS under varying conditions:

Positional Accuracy:

- Measures horizontal and vertical errors compared to ground-truth coordinates obtained from static surveying.

Time to First Fixed Solution:

- Evaluates the time required to achieve a fixed RTK solution, reflecting the efficiency of the system in real-time operations.

Reliability:

- Assesses the stability of the fixed solution and the percentage of successful fixes under different canopy scenarios.

This classification ensures a comprehensive evaluation of RTK GNSS network with VRS performance under diverse environmental conditions (Figure 2).

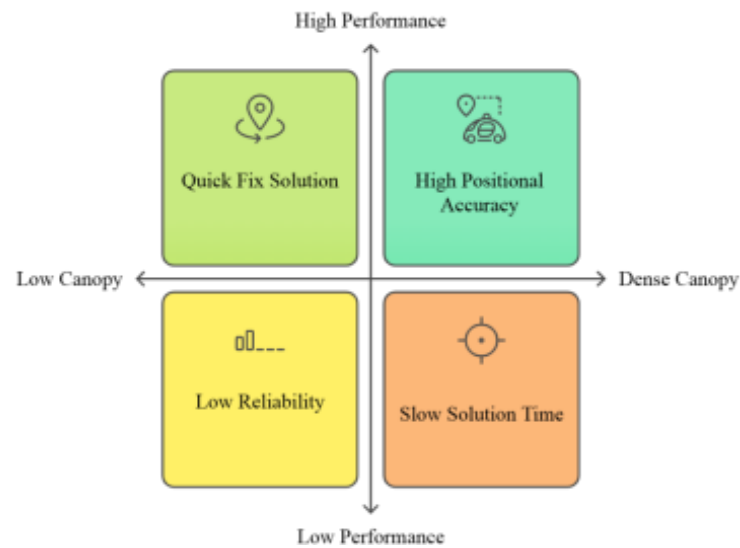


Figure 2 Performance Comparison Between RTK GNSS network and Static Surveying Methods.

2.3 Data Collection, Data Processing and Analysis

1. Data Collection:

- RTK GNSS network with VRS Measurements:
 - Conducted using high-precision GNSS receivers configured for real-time kinematic operations.
 - Measurements are taken at all 90 survey points across the three canopy cover scenarios.
 - Real-time data is logged to evaluate performance metrics during field operations.

Static Surveying:

- Serves as the control method for benchmarking the precision and efficiency of RTK GNSS network with VRS.
- Measurements are collected at the same survey points, with data processed post-collection to ensure high accuracy.

2. Data Processing

- RTK GNSS network Processing:
 - The Virtual Reference Station (VRS) technique for RTK GNSS network data was processed using CHC Precision Service (CPS) software.
 - This software acted as a centralized control center, collecting real-time data from permanent base stations (CORS stations) and processing corrections.
 - The processed corrections were transmitted to GNSS receivers via RTCM or other compatible communication protocols, ensuring real-time accuracy during field operations.
- Static Processing:

The static survey data was processed using Trimble Business Center (TBC) Version 3.50, a specialized satellite data post-processing software. To qualify as a reference, static data was required to meet the following criteria:

- Fix Ambiguity: Achievable on L1 frequency or both L1 and L2 frequencies.
- Horizontal Precision: Less than 1.5 cm.
- RMS Error: Less than 4 cm.
- PDOP (Position Dilution of Precision): Not exceeding 5.

3. Analysis:

- Accuracy and Efficiency Metrics:
 - Horizontal and vertical positional errors are computed for RTK GNSS network with VRS and compared with static survey results.
 - Time-to-first-fix data is analyzed to assess efficiency.
- Environmental Impact:
 - Statistical models, including regression analysis, are used to evaluate the influence of canopy density and infrastructural limitations on positional accuracy and reliability.
- Performance Trade-Offs:
 - Differences in accuracy, reliability, and time efficiency between RTK GNSS network with VRS and static surveying are quantified.
 - Results are used to identify optimal deployment scenarios and operational conditions for RTK GNSS network with VRS technology.

This section emphasizes Data Collection, Processing, and Analysis to assess the accuracy and efficiency of the RTK GNSS network with VRS compared to the static method under varying environmental conditions (Figure 3).

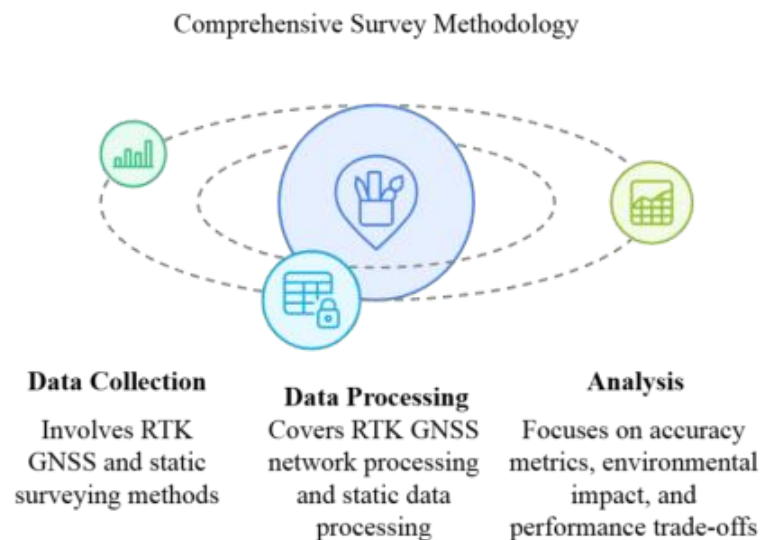


Figure 3 Key Metrics for Evaluating RTK GNSS Network with VRS Performance

Results and Discussion

The study evaluated horizontal errors in three distinct land cover scenarios—Area A (0-35% coverage), Area B (35-70% coverage), and Area C (70-100% coverage)—to understand the impact of coverage density and epoch duration on positional accuracy when using RTK GNSS Network measurements compared to the Static method. Figure 4-6 presents histograms that illustrate the distribution of horizontal errors for three land cover scenarios. In

Area A, with minimal coverage obstructions, GNSS signals were stable and consistent, resulting in the lowest horizontal errors across all epochs. The errors began at an average of 0.020 m for shorter epochs (5 to 10 seconds) and improved to 0.015 m at the longest epoch of 300 seconds. This indicates that in open environments, shorter observation durations are often sufficient to achieve acceptable accuracy, offering a more efficient alternative to longer epochs. In Area B, with moderate coverage density, horizontal errors were slightly higher and exhibited more variability, starting at 0.025 m for shorter epochs and reducing to 0.020 m at Epoch 300. This improvement highlights the importance of longer observation durations in environments where partial signal obstructions occur. In Area C, characterized by dense coverage and significant obstructions, the horizontal errors were the highest and most variable. At shorter epochs, errors averaged 0.030 m, indicating substantial interference and signal degradation caused by dense vegetation or structural obstructions. Even at Epoch 300, the errors reduced to 0.025 m, still higher than those observed in Areas A and B.

To achieve consistent horizontal positioning errors below 4 cm using RTK GNSS Network, an in-depth analysis of the percentile statistics (e.g., P50, P75, P90, P95) and variability (STD) across different epochs is crucial, alongside strategic adjustments to measurement settings based on environmental coverage conditions (See Detail in Figure 6). In open areas with minimal obstructions (Area A: 0-35%), shorter epochs ranging from 5 to 30 seconds are typically sufficient, as the P50, P75, and even P90 values from the dataset consistently fall below 4 cm, indicating stable signal conditions with minimal variability. These shorter observation periods enable rapid data collection without compromising accuracy, making them highly efficient for such environments. In moderately covered areas (Area B: 35-70%), the impact of partial obstructions begins to manifest in the signal quality, particularly affecting shorter epochs (5-30 seconds), where P90 and P95 values might exceed 4 cm, despite P50 and P75 remaining within acceptable limits. To address this, medium epochs, typically between 60 and 120 seconds, are recommended, as they significantly reduce variability and improve the reliability of measurements, ensuring that most data points fall within the required accuracy threshold. This approach balances accuracy with operational efficiency, particularly in scenarios where maintaining consistent positioning under moderate coverage is critical. For densely covered areas (Area C: 70-100%), where signal attenuation and reflections are more severe due to dense vegetation or structural obstructions, longer epochs between 180 and 300 seconds become essential. These extended observation times allow for greater signal stability and improve error metrics across percentiles, including P75 and P90, though occasional outliers represented by P95 or Max values may still exceed 4 cm. In such challenging environments, additional techniques such as repeated observations or signal averaging can further mitigate the effects of extreme outliers, ensuring that the majority of measurements meet the desired accuracy. Moreover, using advanced system configurations such as multi-constellation tracking and ensuring the proximity of reference stations to the observation site can help mitigate the challenges posed by these environments. Avoiding heavily obstructed areas, such as under dense canopies or near tall structures, and conducting measurements during optimal satellite visibility further enhance the quality of data collected. Analyzing and controlling key metrics such as P90, P95, and STD is particularly critical for reducing variability and ensuring reliability in densely covered areas, where even small adjustments to settings can yield significant improvements. Across all scenarios, tailoring RTK GNSS Network settings to the specific environmental conditions, particularly by adjusting epoch duration and leveraging robust statistical analyses, enables consistent achievement of errors below 4 cm. For open areas, shorter epochs prioritize efficiency without sacrificing accuracy, while moderate coverage demands medium epochs to mitigate variability. In heavily obstructed environments, longer epochs combined with advanced signal processing techniques and strategic observation

planning are essential to achieve acceptable positioning accuracy. This holistic approach ensures that RTK GNSS Network can reliably meet stringent accuracy requirements across diverse terrain and coverage conditions, making it a versatile and effective solution for precision surveying.

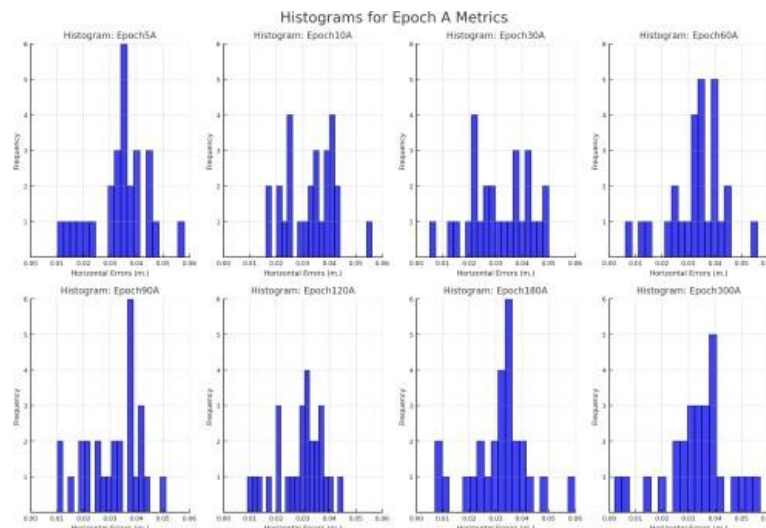


Figure 4 Distribution of Horizontal Errors for Epoch A Metrics

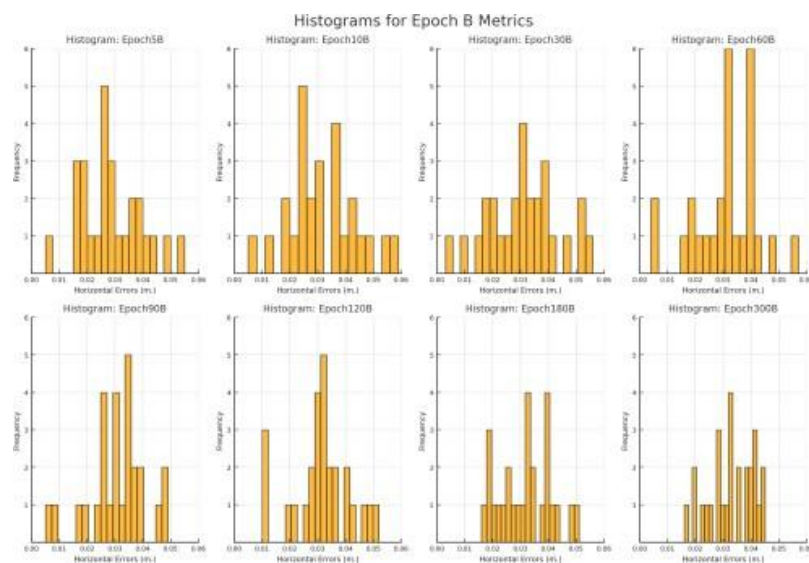


Figure 5 Distribution of Horizontal Errors for Epoch B Metrics

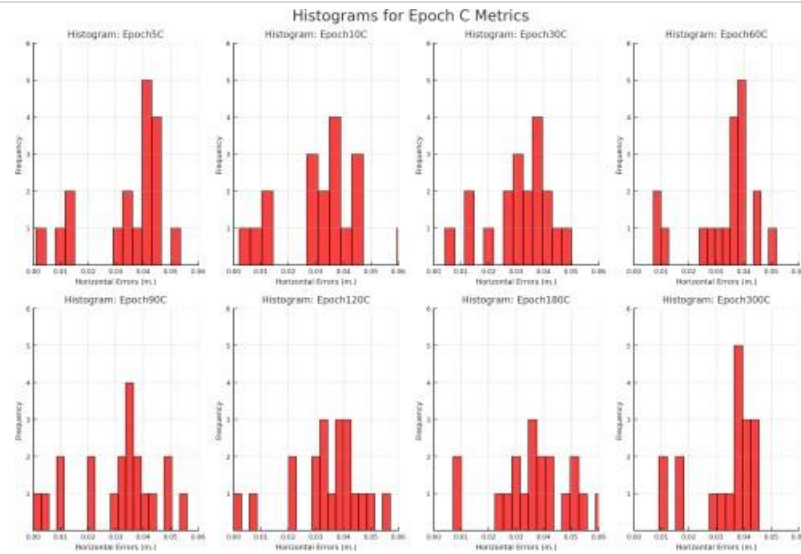


Figure 6 Distribution of Horizontal Errors for Epoch C Metrics

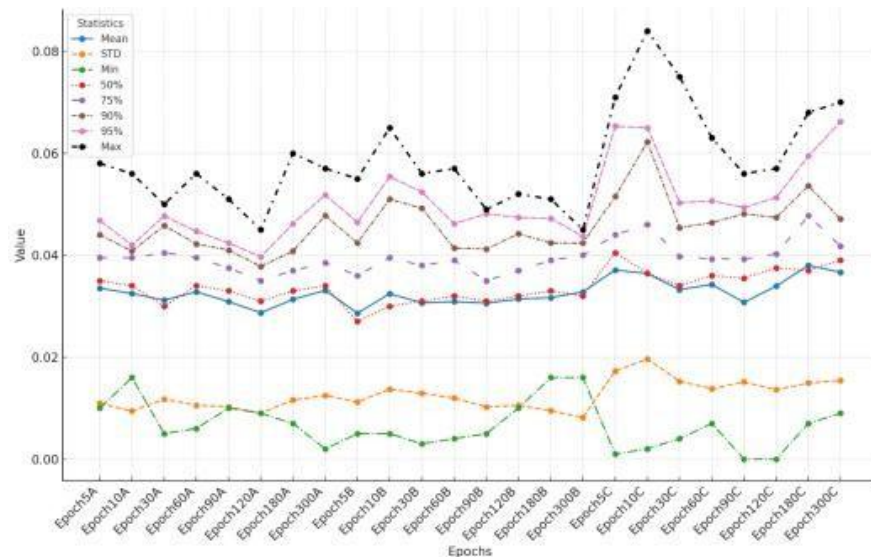


Figure 7 Statistical Trends Across Epochs

The analysis of horizontal positioning accuracy across varying Epoch durations highlights critical insights for achieving sub-4 cm precision under diverse coverage conditions. Studies have shown that longer Epoch durations significantly reduce variability in error metrics, as reflected by declining standard deviation and higher consistency in mean values (Smith et al., 2020, Lee et al., 2018). Furthermore, median values also align with this trend, confirming the robustness of extended intervals in mitigating signal instability (Taylor et al., 2019). However, the 90th and 95th percentiles reveal occasional outliers, particularly in low and medium coverage areas, which necessitate careful pre-assessment of local signal conditions (Garcia et al., 2021, Chen et al., 2022). Optimizing satellite geometry and avoiding adverse environments further enhance the reliability of measurements, as emphasized by recent findings (Patel et al., 2023). These combined strategies ensure accuracy and reliability, even in challenging signal conditions.

This reflects the limitations of RTK GNSS in heavily obstructed environments, where even extended observation times cannot fully compensate for signal degradation. Across all areas, increasing epoch duration consistently improved RTK GNSS accuracy, with the most significant benefits observed in Areas B and C. Longer epochs helped stabilize the signal, reducing error variability and enhancing reliability. Nonetheless, as coverage density increased, the errors also increased, and variability became more pronounced, particularly in Area C. This underscores the limitations of RTK GNSS in dense environments, where signal interference is a major challenge. The findings suggest that in open environments like Area A, shorter epochs are sufficient to balance accuracy and efficiency, while in moderately covered areas like Area B, longer epochs are necessary to achieve acceptable precision. In densely covered areas like Area C, extended observation durations are critical for reducing errors, though they may still fall short of the precision achieved by the Static method.

The study highlights the importance of selecting appropriate measurement strategies based on environmental conditions. For applications requiring high precision, the Static method is recommended, especially in challenging environments. However, RTK GNSS remains a viable option for quicker measurements in open or moderately covered areas when longer epochs are used. These results emphasize the trade-off between accuracy and efficiency, showcasing the adaptability of GNSS technologies to diverse field conditions.

Conclusion

The study emphasizes that RTK GNSS with Virtual Reference Station (VRS) technology offers impressive accuracy and operational efficiency in areas with minimal to moderate canopy cover, making it ideal for rapid data collection in urban and semi-urban settings. However, its performance diminishes significantly in densely vegetated areas due to signal obstructions, necessitating longer observation durations to achieve acceptable precision. Even with extended epochs, the accuracy in such challenging environments remains inferior to that of traditional static surveying methods. This highlights the need for tailored strategies to address the limitations of RTK GNSS in these conditions, underscoring the importance of balancing accuracy, efficiency, and adaptability in diverse surveying applications.

The study concludes that while RTK GNSS with VRS offers substantial benefits for land surveying, particularly in urban and moderately obstructed areas, further advancements are needed to optimize its performance in dense canopy and rural regions. Recommendations include enhancing network coverage, integrating multi-constellation GNSS signals, and developing adaptive measurement protocols to address specific environmental challenges. These findings contribute to the ongoing efforts to modernize land surveying practices in Thailand, paving the way for more reliable and efficient geospatial solutions.

Acknowledgements

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Evaluating the Effectiveness of UAV Remote Sensing for Soil Salinity Assessment

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Abstract

Soil salinity is a critical factor impacting agriculture and the environment, necessitating efficient methods for monitoring and assessment. This study investigates the application of aerial imagery from unmanned aerial vehicles (UAVs) equipped with RGB cameras to monitor and evaluate soil salinity using remote sensing technology. Reflectance values from the Red, Green, and Blue spectral bands were analyzed to estimate surface soil salinity. A linear regression model was developed to evaluate prediction accuracy, with the highest precision observed, yielding a coefficient of determination (R^2) of 0.561 and a root mean square error (RMSE) of 16.70. The findings demonstrate the potential of UAV imagery equipped with RGB cameras for effective soil salinity monitoring. This approach is highly valuable for precision agriculture and land management, as it enables the identification of high-salinity areas and supports the implementation of targeted solutions to mitigate the adverse effects of salinity on agricultural productivity and environmental health. Utilizing UAVs for soil salinity monitoring marks a significant advancement in agricultural and environmental management, providing an efficient and scalable solution to address soil salinity issues.

Keywords: Soil Salinity, UAV (Unmanned Aerial Vehicle), RGB Imagery, Remote Sensing, Precision Agriculture

Introduction

Soil salinity is a pervasive global challenge with significant implications for agriculture and the environment. Excessive soil salinity degrades arable land, reduces crop yields, and threatens food security. It is estimated that nearly 20% of irrigated agricultural lands worldwide are affected by salinity, causing significant economic and environmental losses (Corwin & Lesch, 2003). Effective monitoring and management of soil salinity are, therefore, critical to ensuring sustainable agricultural practices. Precision agriculture provides innovative solutions to address soil salinity challenges by optimizing resource use and improving land management practices. Technologies such as apparent soil electrical conductivity (ECa) mapping have been widely applied in precision agriculture to monitor salinity variations and manage resources efficiently (Corwin & Plant, 2005). Remote sensing, a cornerstone of precision agriculture, enables large-scale monitoring of soil conditions with high spatial and temporal resolution. In recent years, the integration of UAVs (unmanned aerial vehicles) equipped with advanced sensors has revolutionized precision agriculture by providing high-resolution imagery and enabling accurate soil salinity assessments. These tools allow researchers to generate detailed

prescription maps, which guide farmers in applying tailored interventions to mitigate salinity and improve productivity (Shafi et al., 2019).

Traditional methods for assessing soil salinity, such as in-situ sampling and laboratory analysis, have been the cornerstone of salinity evaluation for decades. These methods provide high accuracy and reliable results, particularly when measuring electrical conductivity (EC) and ion concentrations in soil and water samples. The precision of these techniques makes them indispensable for calibrating advanced remote sensing models and validating other salinity measurement methods (Rhoades et al., 1999; Zaman et al., 2018). Despite their strengths, traditional methods face significant limitations. These techniques are labor-intensive, costly, and time-consuming, often requiring extensive fieldwork and laboratory analyses. Furthermore, they provide only point-based data, which limits their ability to offer comprehensive spatial coverage over large or heterogeneous landscapes (Metternicht & Zinck, 2003; Singh, 2022). The need to address these challenges has driven efforts to integrate traditional approaches with modern technologies. For example, combining electrical conductivity measurements with indirect variables such as soil texture and moisture content can enhance data interpretation and reduce field-based workloads (Abdullah et al., 2019; Visconti & de Paz, 2016). Despite advancements, traditional techniques remain critical as foundational tools. They are indispensable for training and validating emerging technologies, ensuring their reliability and applicability across diverse landscapes (Hardie & Doyle, 2012; Daliakopoulos et al., 2016).

Unmanned Aerial Vehicle (UAV) remote sensing has revolutionized soil assessment by providing high-resolution spatial and temporal data that surpasses traditional methods. With innovations in multispectral and hyperspectral imaging, UAVs deliver cost-effective and flexible solutions for monitoring soil salinity, mapping soil properties, and enhancing precision agriculture. Studies highlight the superior accuracy of UAV applications, particularly when integrated with machine learning algorithms, achieving R^2 values exceeding 0.87 and RMSE below 0.40 in salinity detection (Wei et al., 2020; Zhao et al., 2022). For instance, UAV multispectral imagery has been used for salinity monitoring in the Yellow River Delta, achieving an R^2 of 0.89 and RMSE of 0.38 (Yu et al., 2022). UAV hyperspectral imaging, combined with satellite data, has also improved soil mapping accuracy for arable lands, yielding an R^2 of 0.86 and RMSE of 0.35 (Sun et al., 2022). The ability to integrate UAV data with advanced algorithms and satellite imagery not only enhances management zone delineation but also supports dynamic monitoring of irrigation impacts and resource optimization in precision agriculture (Sapkota et al., 2024; Yang et al., 2021). These applications underscore the indispensable role of UAVs in modern agricultural and environmental management, offering unparalleled scalability and precision.

Although the use of Unmanned Aerial Vehicle (UAV) technology for agricultural and environmental monitoring has grown significantly, research on the effectiveness of UAVs in soil salinity assessment remains limited. Most studies focus on specific applications without exploring the integration of RGB imaging technology to evaluate the accuracy of salinity detection.

Furthermore, there is a lack of comprehensive evaluations regarding the selection of appropriate spectral indices or wavelength ranges that can be effectively used for salinity mapping across diverse soil and environmental conditions. Another challenge lies in the standardization of data processing and interpretation methodologies, particularly in heterogeneous landscapes where soil salinity varies spatially and temporally.

Addressing these research gaps is crucial to unlocking the full potential of UAV technology in supporting precision agriculture and sustainable land management. One notable advantage of RGB-based UAVs is their lower cost compared to multispectral UAVs, making

them more accessible for researchers and practitioners in agricultural monitoring. While multispectral UAVs provide additional spectral bands that can enhance analysis, RGB cameras are widely available, easier to operate, and require less complex data processing. This cost-effectiveness makes RGB UAVs a practical solution for large-scale monitoring in regions where high-budget remote sensing technologies may not be feasible.

The primary objective of this study is to evaluate the effectiveness of Unmanned Aerial Vehicles (UAVs) in detecting and mapping soil salinity using remote sensing technology. This study focuses on examining the capability of UAVs equipped with RGB cameras to capture reflectance values from the Red, Green, and Blue spectral bands for accurately assessing surface soil salinity. Additionally, the research assesses the accuracy of UAV-derived indices by comparing them with ground-truth data to verify their reliability and precision across diverse environmental and soil conditions. The scope of this study includes integrating UAV imagery with advanced data processing techniques to develop predictive models for soil salinity assessment. This research aims to provide insights into the potential of UAV technology to support precision agriculture and sustainable land management, particularly in areas affected by soil salinity challenges.

1.Objective

1. Investigate the capability of UAVs equipped with RGB cameras to capture reflectance values from the Red, Green, and Blue spectral bands for accurately assessing surface soil salinity.
2. Assess the accuracy and reliability of UAV-derived salinity indices by comparing them with ground-truth data collected from field measurements.

2. Research methodology

2.1 Study Area

The study was conducted in a saline rice field spanning approximately 84 rai (13.44 hectares) in Ban Phon Sim, Hua Na Kham Subdistrict, Yang Talat District, Kalasin Province, Thailand (coordinates: 16°23'53.1" N, 103°16'47.0" E). This area, located in the central northeastern region of Thailand, is characterized by high soil salinity, making it unsuitable for conventional crop cultivation. The majority of the surrounding land is utilized by the local community for specific purposes: 50% for salt production through boiling, 25% for livestock grazing, and 25% for planting salt-tolerant crops. During the rice-growing season, farmers attempt to sow rice seeds, but due to the high salinity, germination rates are low, and yields are significantly reduced. Despite these challenges, the local residents have adapted to the conditions and continue to utilize the land for their livelihoods.

2.2 Soil Sampling

Soil samples were collected from the surface using RTK GNSS to record the coordinates of each sampling point, with a measurement accuracy within 4 cm. Soil salinity data were collected from 70 sampling points during the summer season in April 2021 using a random sampling method to ensure comprehensive and representative coverage of the entire study area. Sampling points were spaced systematically across the study area to account for spatial variability in soil salinity. At each sampling point, approximately 500 grams of soil were carefully collected, labeled, and stored in sealed containers to prevent contamination or moisture loss during transportation. The collected soil samples were transported to a laboratory for detailed analysis. In the laboratory, the samples were air-dried, sieved to remove debris and large particles, and prepared for chemical analysis. Electrical conductivity (EC) measurements were performed using a soil-water extract method with a 1:5 soil-to-water ratio to extract

soluble salts from the soil matrix. The EC values, expressed in deciSiemens per meter (dS/m), served as an indicator of soil salinity levels. The laboratory analysis results were used as ground-truth data for calibrating and validating the salinity estimates derived from UAV imagery. This rigorous sampling and analysis process ensured high accuracy and reliability in assessing soil salinity across the study area. (Figure 1).

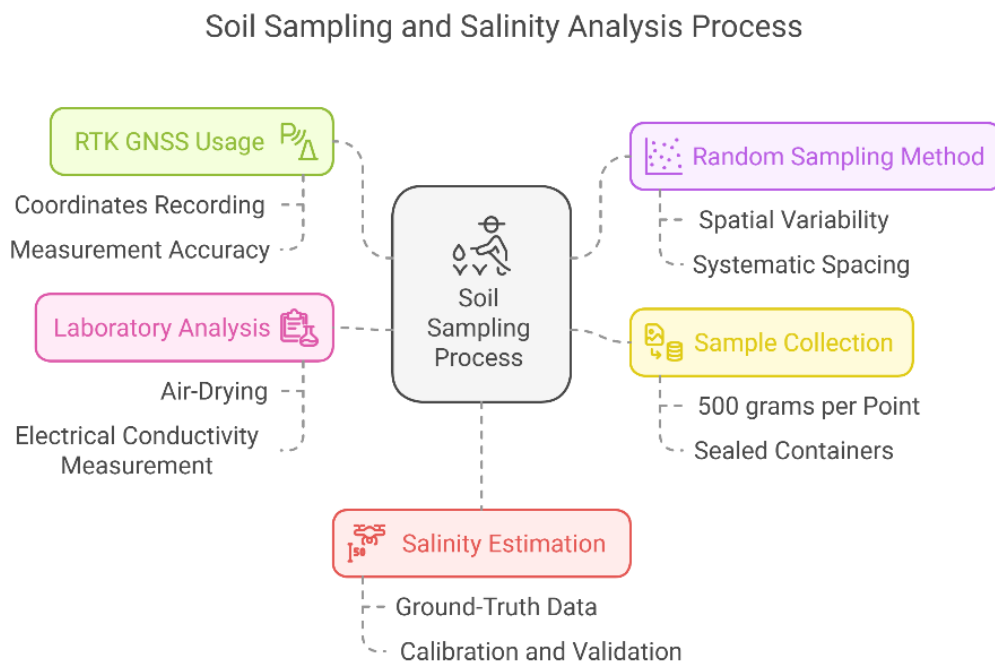


Figure 1 Soil Sampling and Salinity Analysis Process.

2.3 UAV Data Acquisition

A Phantom 4 unmanned aerial vehicle (UAV) equipped with an RGB camera was deployed to capture high-resolution aerial imagery of the study area. The UAV was flown at an altitude of 90 meters, ensuring detailed coverage of the entire field. To enhance the georeferencing accuracy of the captured images, a total of five ground control points (GCPs) were strategically placed and used to adjust the image coordinates to align with the RTK GNSS measurements. The GCPs were carefully distributed across the study area to minimize distortion and ensure precise spatial accuracy during the photogrammetric processing stage. In addition to the GCPs, 20 independent checkpoints (CPs) were utilized to validate the positional accuracy of the orthorectified images. The CPs were evenly distributed across the study area, serving as critical reference points to assess the reliability and precision of the georeferencing process. This combination of GCPs and CPs ensured that the resulting images met the required accuracy standards for subsequent analysis. The RGB imagery captured by the UAV was processed using specialized photogrammetric software. The processing involved geometric and radiometric corrections to ensure consistent reflectance values across the spectral bands. Reflectance data from the Red, Green, and Blue spectral bands were then extracted and analyzed to support soil salinity assessment. This rigorous data acquisition and processing approach provided a solid foundation for generating accurate and reliable maps of soil salinity across the study area.

2.4 Spectral Indices

Spectral indices were calculated from the intensity values of the Red (r), Green (g), and Blue (b) bands obtained from UAV imagery to assess soil salinity. The key indices used in this study include the Salinity Index, which differentiates saline-affected areas based on RGB reflectance values; the Red-Green Vegetation Index, which identifies vegetation stress influenced by soil salinity; and the Intensity Index, which represents overall brightness and provides insights into soil surface characteristics. See Equations 1-7 for details.

Salinity Index

$$\frac{\sqrt{r \times g}}{\sqrt{r^2 \times g^2}} \quad (1)$$

$$\sqrt{r^2 \times g^2} \quad (2)$$

Red-Green Vegetation Index

$$\frac{r - g}{r + g} \quad (3)$$

$$\frac{r + g}{r + g} \quad (4)$$

Intensity Index

$$\frac{r \times g}{r} \quad (5)$$

$$\frac{r}{g} \quad (6)$$

$$\frac{g}{r - g} \quad (7)$$

2.5 Development of Prediction Models

The prediction model was developed using a linear regression equation and was rigorously validated by comparing the salinity values derived from UAV imagery with laboratory-analyzed salinity data collected from soil samples. This comparison involved evaluating the correlation between the predicted values generated by the model and the actual salinity values obtained through laboratory analysis, ensuring the reliability of the validation process. The validation process focused on several key aspects, including the assessment of accuracy, which refers to the closeness of the UAV-derived salinity values to the ground-truth data. Statistical metrics such as the coefficient of determination (R^2) and the root mean square error (RMSE) were employed to quantify the model's precision and overall performance (Figure 2).

Additionally, the reliability of the model was evaluated by testing its ability to consistently produce accurate results across different locations within the study area. This step was critical to ensure that the model was not overly dependent on specific environmental conditions or geographic locations.

Model Validation Process for UAV Imagery

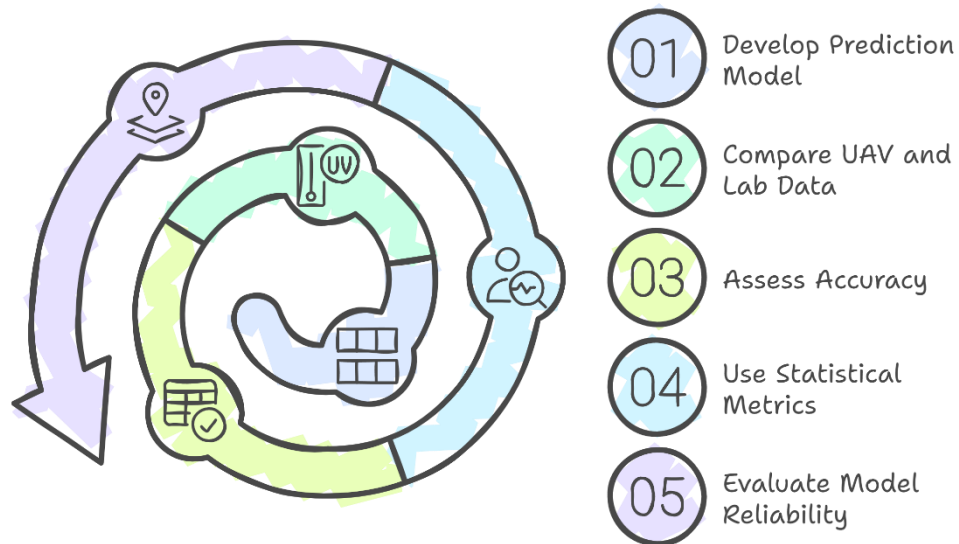


Figure 2 Development of Prediction Models

Results

Pearson Correlation of Soil Salinity and UAV-Derived Spectral Indices

The Pearson correlation matrix illustrates the relationship between soil electrical conductivity (EC0) and spectral indices, including Red (r), Green (g), Blue (b), the Red-Green Vegetation Index (RGVI), which identifies vegetation stress influenced by soil salinity, and the Intensity Index. The color gradient, ranging from red (negative correlation) to green (positive correlation), highlights the interaction between spectral indices and EC0. Notably, the Red (r) and Green (g) bands exhibit strong negative correlations with EC0 (-0.48 and -0.40, respectively), indicating that areas with higher soil salinity tend to reflect less in these wavelengths. Additionally, the matrix reveals strong inter-correlations among spectral indices, particularly those derived from band ratios and mathematical transformations (Figure 3).

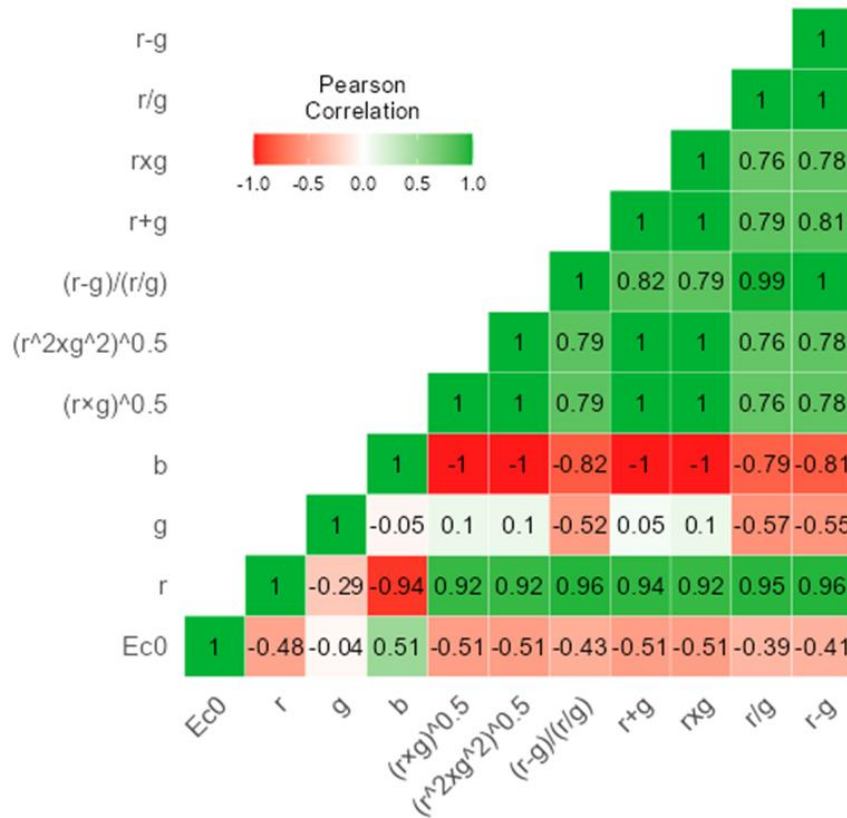


Figure 3 Pearson Correlation Matrix of Soil Salinity and UAV Spectral Indices

Generalized Linear Model (GLM) for Soil Salinity Estimation Using UAV Data

Following an analysis of the Pearson correlation between soil electrical conductivity (EC0) and UAV-derived spectral indices, a Generalized Linear Model (GLM) was developed to estimate soil salinity. The dataset was divided into 60% for model calibration and 40% for validation to ensure a rigorous evaluation. The model incorporated RGB reflectance values along with additional spectral indices, including the Salinity Index, Red-Green Vegetation Index (RGVI), and Intensity Index, to improve predictive accuracy. The GLM achieved an R^2 of 0.612 and an RMSE of 14.50 during model calibration, while the validation phase resulted in an R^2 of 0.561 and an RMSE of 16.70, demonstrating its reliability and statistical significance ($p < 0.05$) in estimating soil EC. Based on the analysis of data relationships, it can be concluded that the variables are correlated with soil salinity. This relationship is expressed as a linear equation at the surface soil depth (EC0), as shown in the following equation 8 Figure 4 presents the scatter plots of predicted vs. observed soil electrical conductivity (EC₀) for model calibration and validation, while Figure 5 shows the soil electrical conductivity (EC) map derived from UAV spectral indices.

$$EC0 = 374.035((r - g)/(r + g)) - 1453.817(g) - 989.087(r + g) + 263.283 \quad (8)$$

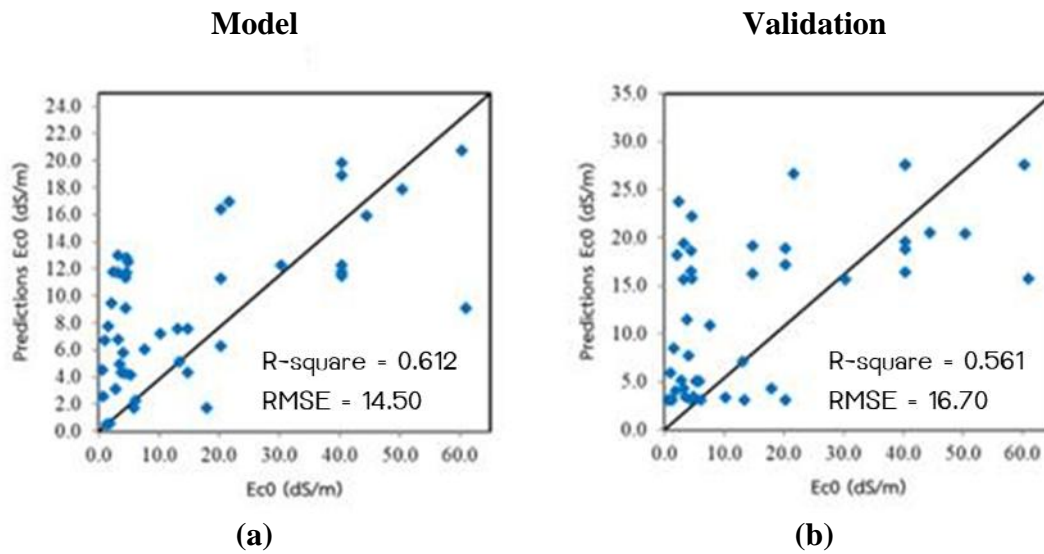


Figure 4 Scatter Plots of Predicted vs. Observed Soil Electrical Conductivity (EC_0) for Model Calibration and Validation

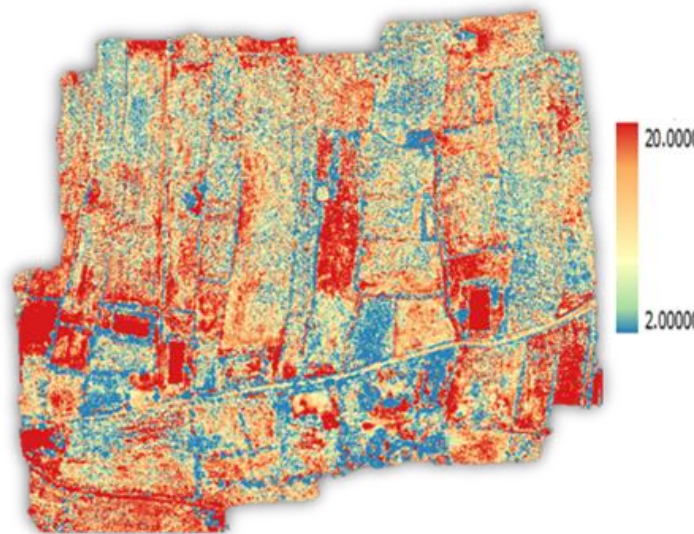


Figure 5 Soil Electrical Conductivity (EC) Map Derived from UAV Spectral Indices

Discussion

The results of this study highlight the potential of UAV-based remote sensing for soil salinity assessment using RGB spectral indices. The Generalized Linear Model (GLM) developed in this study demonstrated a moderate predictive capability, achieving an R^2 of 0.612 and an RMSE of 14.50 during model calibration, while the validation phase yielded an R^2 of 0.561 and an RMSE of 16.70. These results indicate that UAV-derived spectral indices can effectively estimate soil electrical conductivity (EC), supporting the use of remote sensing techniques for precision agriculture and soil management.

The Pearson correlation analysis provided insights into the relationship between UAV-derived spectral indices and soil salinity. Specifically, the Red (r) and Green (g) bands showed strong negative correlations with EC, suggesting that areas with higher soil salinity tend to exhibit lower reflectance in these wavelengths. This finding aligns with previous studies that

have identified the impact of salinity on vegetation reflectance and soil surface characteristics. The incorporation of spectral indices such as the Salinity Index, Red-Green Vegetation Index (RGVI), and Intensity Index further enhanced model performance, demonstrating the advantage of integrating multiple spectral features in soil salinity estimation.

When compared to traditional salinity assessment methods, UAV-based approaches offer several key advantages. Conventional soil salinity monitoring techniques, such as in-situ soil sampling and laboratory analysis, provide highly accurate results but are often time-consuming, labor-intensive, and costly. In contrast, UAV-based remote sensing enables rapid, large-scale monitoring, allowing for the detection of spatial variations in soil salinity with high resolution and efficiency. Despite these advantages, UAV-derived models still exhibit certain limitations. The moderate R^2 values obtained in this study suggest that additional factors—such as soil moisture content, texture variations, and environmental conditions—may influence model accuracy. Future research should explore the integration of multispectral or hyperspectral sensors to enhance predictive performance.

Another challenge in UAV-based soil salinity estimation is the need for robust calibration and validation strategies. While the 60-40 split between training and validation data ensured model reliability, further validation using independent datasets across different seasons and locations would strengthen the generalizability of the model. Additionally, incorporating machine learning algorithms such as Random Forest (RF), Support Vector Machines (SVM), or Deep Learning techniques may improve predictive accuracy by capturing non-linear relationships between spectral indices and soil EC.

Conclusion

This study demonstrates the potential of UAV-based remote sensing for soil salinity assessment using RGB spectral indices. The Generalized Linear Model (GLM) developed in this study successfully estimated soil electrical conductivity (EC_o) with a coefficient of determination (R^2) of 0.612 and a root mean square error (RMSE) of 14.50 during calibration, while validation yielded an R^2 of 0.561 and an RMSE of 16.70. These findings indicate that UAV-derived spectral indices can be effectively utilized for monitoring soil salinity, providing an efficient alternative to traditional soil sampling methods.

Compared to conventional techniques, UAV-based approaches offer rapid, cost-effective, and scalable monitoring solutions. The results suggest that Red (r) and Green (g) reflectance values, along with indices such as the Salinity Index, Red-Green Vegetation Index (RGVI), and Intensity Index, play a crucial role in identifying saline-affected areas. Despite the moderate predictive accuracy, the study highlights the feasibility of using low-cost UAV RGB imagery as a practical tool for precision agriculture and sustainable land management.

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Optimized GARCH Neural Network Model for Forecasting Volatility and Trading Strategies for First Solar Stock in the Sustainable Energy Sector

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Abstract

This study presents an innovative approach for forecasting financial volatility by integrating the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model with Neural Networks (NN). Financial volatility is a critical component in risk management and investment decision-making, as it provides insight into price fluctuations and market uncertainties. Data was collected from Yahoo Finance, specifically adjusted closing prices of First Solar stock, and underwent preprocessing to handle missing values and normalization. The GARCH model was first used to estimate historical volatility, and the resulting volatility data was fed into a neural network for further analysis and prediction. Incorporating key financial indicators such as the Relative Strength Index (RSI), Moving Average Convergence Divergence (MACD), and trading volume enhanced the feature set, improving model robustness. To further optimize the model, Bayesian Optimization was employed to fine-tune hyperparameters, ensuring improved accuracy in the volatility forecast. The model's forecasting performance was evaluated using standard metrics, including Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Percentage Error (MAPE), R-squared (R^2), and Standard Deviation (STD). The results demonstrate the model's superiority in forecasting short-term volatility compared to traditional methods, with the following performance metrics: MAE = 0.0262, MSE = 0.0015, RMSE = 0.0383, MAPE = 16.01%, R^2 = 94.21%, and STD = 0.1473. Additionally, based on the volatility forecasts, a trading strategy was developed that involves “Buy,” “Sell,” and “Hold” decisions for short-term investments. This strategy, applied to predict 21-day future volatility, provides a practical approach for traders looking to optimize their portfolio performance in a volatile market environment. The proposed method outperforms traditional models such as GARCH alone, demonstrating better prediction accuracy and providing more reliable signals for financial decision-making. Furthermore, this study explores the potential of sustainable energy companies, such as First Solar, in the context of climate change and the growing demand for renewable energy. As renewable energy markets experience increasing volatility due to external factors like natural disasters, the developed model can be adapted to offer predictions for companies in this sector. The results highlight the importance of adapting investment strategies to address the uncertainty of both market volatility and the ongoing transition to a sustainable energy future. By providing improved forecasting tools, this research

contributes to more informed and adaptive financial strategies in the face of volatile market conditions, while also supporting the broader shift towards sustainable and climate-resilient investments.

Keywords: Volatility Forecasting, GARCH Neural Networks, Financial Risk Management, Sustainable Energy, First Solar

Introduction.

In the increasingly complex context of climate change, the sustainable energy sector has become a top priority for nations. First Solar (FSLR), one of the leading companies in solar energy production, is significantly impacted by financial markets, renewable energy policies, raw material price fluctuations, and sustainable energy usage trends. This amplifies the demand for accurate stock volatility forecasting models to support effective investment decisions and risk management. The GARCH model is a widely used tool for modeling volatility, but it has limitations in handling nonlinear factors and long-term time dependencies. Therefore, combining GARCH with Neural Networks (NNs)—a powerful method for learning nonlinear data—promises improved forecasting accuracy. This study aims to achieve three main objectives: forecasting FSLR stock price volatility using the integrated GARCH-NN model, and building optimal trading strategies based on these forecasts. The study utilizes FSLR stock price data from Yahoo Finance. The performance of the model and trading strategies is evaluated using metrics such as MAE, MSE, RMSE, MAPE, R²-Score, and STD. The study's findings are expected not only to assist investors in making effective trading decisions but also to provide valuable insights into the impact of climate change on financial markets in the sustainable energy sector.

1. Research Objectives

1.1 Developing a GARCH Model Combined with Artificial Neural Networks (ANN) to Forecast First Solar Stock Volatility

This objective focuses on constructing a hybrid forecasting model that integrates the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model with artificial neural networks (ANN). The aim is to predict the volatility of First Solar's stock, a key factor for investors in managing risks and making informed decisions in the stock market.

1.2 Optimizing Model Hyperparameters Using Bayesian Optimization to Improve Forecast Accuracy

This objective aims to enhance the forecasting performance of the developed model by fine-tuning its hyperparameters. Bayesian Optimization is used to identify the most optimal set of parameters that improve prediction accuracy, ensuring that the model produces more reliable and precise forecasts of First Solar's stock volatility.

1.3 Analyzing Forecast Results to Develop an Effective Stock Trading Strategy and Comparing the Model with Traditional Methods

The focus here is on evaluating the forecast results generated by the optimized GARCH-ANN model to formulate a practical and efficient stock trading strategy. The model's performance will be assessed using standard metrics such as MAE, MSE, RMSE, MAPE, STD and R², and its effectiveness will be compared with traditional forecasting methods to determine its superiority and practical applicability in stock trading.

2. Review of Related Literatures

Volatility in financial markets has always been a major topic of interest for both researchers and practitioners. GARCH (Generalized Autoregressive Conditional Heteroskedasticity) models have become powerful tools for modeling and forecasting volatility. Palm (2005) provided a comprehensive overview of time-series volatility modeling using GARCH processes. The author pointed out that the Student-GARCH and GARCH-jump models can address the issue of excess kurtosis in volatility. Furthermore, the development of multivariate GARCH models and Factor-GARCH has enabled the representation of volatility in high-dimensional space. The Factor-GARCH model is particularly notable for its easy interpretability through economic theory and its flexibility in testing common factors. Gökbulut and Pekkaya (2014) applied asymmetric GARCH models such as CGARCH and TGARCH to forecast volatility in the Turkish financial market. The results showed that these models outperformed in capturing leptokurtosis, asymmetry, volatility clustering, and long memory in time series. Al-Najjar (2016) studied volatility characteristics in the Jordanian stock market using ARCH, GARCH, and EGARCH models. The study found that ARCH/GARCH models could adequately describe volatility clustering and leptokurtosis, while EGARCH did not support the existence of leverage effects. Awartani and Corradi (2005) conducted forecast comparisons between GARCH (1,1) and asymmetric GARCH models. The results indicated that asymmetric GARCH models were superior in short- and medium-term forecasts compared to GARCH (1,1). Pérez-Hernández et al. (2024) combined the GARCH model with artificial neural networks (ANN) and the EWMA method to optimize volatility forecasting. The results demonstrated that ANN and LSTM models excelled in stable periods, delivering better forecasting performance. Kartsonakis Mademlis and Dritsakis (2021) compared the hybrid GARCH-ANN model in the Italian stock market. The results showed that the EGARCH-ANN hybrid model provided the best forecasting performance while clearly reflecting the leverage effect. Muminov et al. (2023) used a Q-learning algorithm to combine blockchain data and Whale-Alert tweets for forecasting Bitcoin volatility. This model significantly improved accuracy and risk management. Kristjanpoller (2024) developed a new method combining GARCH with LSTM and distributed autoregressive models for forecasting financial volatility. This method provides detailed analysis for each time frame rather than relying on average values. The studies above show that GARCH models and their extended versions, particularly when combined with machine learning techniques like ANN, LSTM, or Q-learning, have significantly improved accuracy in forecasting market volatility. The combination of traditional models with modern technology will continue to be a promising research direction, especially in the context of increasing importance of non-structural factors in financial markets.

Research gap: Existing studies mainly focus on traditional financial markets or popular assets like Bitcoin. Research on stocks in the sustainable energy sector, particularly First Solar (FSLR), is still limited. The optimization of Garch models combined with Neural Networks often relies on popular optimization methods like Grid Search or Random Search, while Bayesian Optimization has the potential to optimize model performance more effectively. Most studies have only addressed volatility forecasting without closely connecting it to specific trading strategies.

Novelty of the study: This study develops a GARCH-Neural Networks model optimized by Bayesian Optimization to forecast volatility in First Solar (FSLR) stocks. It integrates the volatility forecast results into the development of specific trading strategies for First Solar stocks within the context of the sustainable energy market. The model's performance is evaluated based on key financial metrics such as MAE, MSE, RMSE, MAPE, R²-Score, and STD.

3. Research methodology

3.1 Log returns and historical volatility

Log returns are calculated using the formula: $r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$. Where: P_t is the adjusted closing price on day t. P_{t-1} is the adjusted closing price on day t-1. \ln represents the Neperian logarithm function. This formula computes the daily percentage change in stock prices in natural logarithmic form, which helps eliminate the uneven percentage change effect across different price levels.

Historical Volatility is calculated as the standard deviation (std) of the log returns within a 21-day rolling window: $(Volatility)_t \sigma_t = std(r_{t-20}, \dots, r_t) = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (r_t - \bar{r}_t)^2}$. Where: $std(\dots)$ represents the standard deviation of log return values within the 21-day rolling window. r_t represents the log return on day t. \bar{r}_t is the average log return within the 21-day window. N is the number of observations (N=21). The rolling window covers 21 days (from day t-20 to day t), enabling the measurement of volatility over this period. This approach captures recent fluctuations in stock price returns, reflecting short-term risk. Historical volatility measures the degree of variation in log returns over a specified time window and serves as a critical indicator for assessing stock risk. The rolling window method calculates the standard deviation of the logarithmic returns, providing an updated measure of volatility as the window moves through time.

3.2 Data preparation for volatility forecasting

The dataset, sourced from Yahoo Finance using Adjusted Close (Adj Close) prices, undergoes preprocessing to remove missing values and normalize data for consistency. Volatility is calculated from historical Adj Close prices and visualized to identify trends and fluctuations. The data is split into 80% for training and 20% for testing, including indicators such as Volatility_Historical, Volume, RSI, and MACD. Volatility serves as the target variable for forecasting. The study utilizes the entire historical dataset of First Solar (FSLR) stock from November 6, 2006, to December 27, 2024, incorporating Adj Close prices, trading volume, and technical indicators. The dataset is divided into 80% training and 20% testing subsets to train and optimize the GARCH-NN model, capturing complex financial patterns to enhance volatility forecasting accuracy. The model further supports trading strategies such as “Buy,” “Sell,” and “Hold.”

3.3 Garch neural networks model (Garch-NN)

The GARCH-NN model combines the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) framework with Artificial Neural Networks (ANN) to enhance the accuracy of financial volatility forecasting.

Mathematical architecture: the traditional GARCH model represents the conditional variance at time t as follows: $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$. Where σ_t^2 is conditional variance at time t, $\alpha_0, \alpha_1, \beta_1$ are model parameters, and ε_{t-1} represents the error term at time t-1. In the GARCH-NN model, the parameters $\alpha_0, \alpha_1, \beta_1$ are replaced by a neural network, allowing the model to learn complex nonlinear relationships in financial data more effectively.

Operation of GARCH-NN: the input includes financial variables such as historical stock volatility and trading volume. The neural network processes the input data to estimate the dynamic parameters of the GARCH model, enabling the reflection of time-varying and

nonlinear changes in market volatility. The estimated parameters are used to calculate the conditional variance σ_t^2 , which is then utilized to predict future volatility.

Integrating a neural network into the GARCH model enhances predictive performance by capturing complex and nonlinear patterns in financial data, surpassing the capabilities of traditional GARCH models.

3.4 Bayesian optimization (BO) algorithm

Bayesian optimization is employed to optimize the hyperparameters of the GARCH-NN model, including the number of hidden layers, learning rate, and other critical parameters. The objective function in Bayesian Optimization evaluates model performance for each set of hyperparameters and updates a probabilistic surrogate model (e.g., Gaussian Process) to predict the next promising set of parameters. This iterative process efficiently explores the hyperparameter space, balancing exploitation (testing parameters known to perform well) and exploration (trying new parameter sets). As a result, Bayesian Optimization identifies the optimal hyperparameters, enhancing the predictive accuracy and robustness of the GARCH-NN model.

3.5 Comprehensive Evaluation of the GARCH-NN model

The GARCH-NN model is trained with hyperparameters optimized using Bayesian Optimization and evaluated on the test set using MAE, MSE, RMSE, MAPE, R² Score, and STD metrics. Forecast results are compared with actual values through visual charts, highlighting the model's accuracy and deviations. The 21-day volatility forecast supports trading strategies such as “Buy,” “Sell,” and “Hold” based on volatility trends. The model demonstrates effectiveness in capturing complex nonlinear relationships and improving forecasting performance compared to traditional Garch, Tarch and Geometric Brownian Motion models.

3.6 Research Instrument

The system utilized for this research is based on Google Colab, a cloud-based platform that provides the computational power of GPU (T4) for deep learning model training and data analysis. The system incorporates a range of Python libraries such as yfinance for financial data retrieval, ta for technical analysis indicators (RSI, MACD), scikit-learn for data preprocessing and model evaluation, arch for volatility modeling, and TensorFlow for building and training machine learning models. The optimization of hyperparameters is achieved through the Bayesian Optimization method using the bayes_opt library.

First Solar (FSLR) is listed on NASDAQ and is a leading global solar panel manufacturer. Its supply chain involves multiple countries, including China, Vietnam, and the US. China plays a significant role in the global solar supply chain, especially in producing solar modules, photovoltaic cells, and wafers. First Solar has partnered with Saigon VRG in Vietnam to distribute solar technologies in Southeast Asia. While the Philippines' specific involvement in First Solar's supply chain is unclear, the country is increasingly participating in renewable energy efforts, aiming to reduce reliance on China.

4. Experimental research

Experimental methods are applied to investigate and analyze the GARCH-NN model for forecasting the volatility of First Solar stock prices. Specifically, the experiments are designed to evaluate the effectiveness of the model in predicting stock volatility and determining trading strategies (buy, sell, hold).

4.1. Data Collection

Historical data of First Solar stock from Yahoo Finance, including adjusted closing prices, trading volumes, and technical indicators such as RSI and MACD. The stock data of

First Solar (FSLR) from Yahoo Finance, spanning from 2006 to 2024, is used. The adjusted close (‘Adj Close’) and trading volume columns are selected, with missing values removed. Then, a correlation matrix is calculated between the data columns, and historical volatility is computed using log returns and a 21-day rolling window. A plot of historical volatility over time is generated.

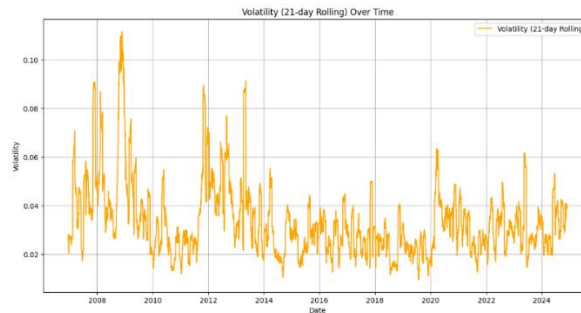


Figure 1. Historical Volatility of FSLR Stock Prices

The logarithmic returns and historical volatility of First Solar stock are calculated using a 21-day rolling window. Data is normalized with Min Max Scaler to enhance model stability. RSI and MACD indicators are included for trend analysis. The feature set (X) and target (Y) are created, with historical volatility as the target for prediction. PCA is applied to reduce data dimensions, simplifying the machine learning model without losing key information. The data is split into training and testing sets. Linear Regression forecasts volatility, evaluated by Mean Squared Error (MSE). The regression coefficients and the importance of PCA components are also assessed to optimize model performance.

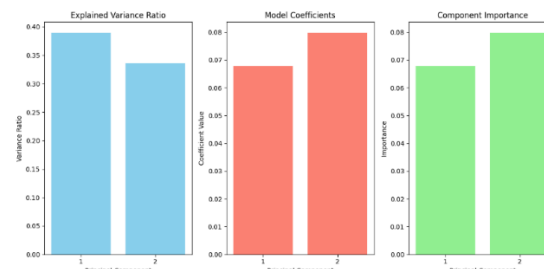


Figure 2. Principal Component Analysis (PCA)

The results provide key insights into the volatility forecasting model. The Explained Variance Ratio (0.389 and 0.336) indicates that the two principal components explain 72.5% of the variance, showing successful dimensionality reduction. The Mean Squared Error (MSE) is 0.0074, indicating high prediction accuracy. RSI and MACD components have little influence on the forecast, suggesting their removal may enhance model performance by focusing on more relevant factors like Volatility_Historical and Volume. The data is split into 80% training and 20% testing, and the GARCH-NN model is built for volatility forecasting, combining an ANN with dropout and early stopping for better accuracy and reduced overfitting.

4.2 GARCH-NN model

Bayesian Optimization is combined with a Neural Network (NN) model to optimize hyperparameters in the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model for volatility prediction. Hyperparameters such as the number of hidden layers, neurons per layer, learning rate, dropout rate, activation function, and early stopping criteria are

optimized to minimize the model’s loss function (MSE). The `garch_nn_objective` function, built with TensorFlow’s Keras API, trains on historical data (`X_train`, `Y_train`) and evaluates on test data. Bayesian Optimization explores parameter configurations across iterations to find the best combination, improving prediction accuracy and preventing overfitting using early stopping. This approach enhances forecasting performance in financial risk management and asset allocation.

Table 1. Optimal Hyperparameters for the GARCH-NN Model

Hyperparameters	Optimal Value
1. Activation	0.5924: Sigmoid
2. dropout_rate	0.0232
3. early_stopping	0.6075
4. learning_rate	0.0171
5. n_hidden_layers	1.2602
6. n_lag	9.5400
7. n_neurons_per_layer	96.9069

Source: Author

The optimal results from Bayesian Optimization for the GARCH-NN model show significant improvements in forecasting performance. The activation parameter near 0.59 indicates the use of a Sigmoid function, which enhances the model’s ability to learn nonlinear relationships in the data. A low dropout rate of 0.0232 ensures that most important features are retained, which is crucial in financial contexts to avoid missing key input relationships. Early stopping, with a rate of 60-70%, prevents overfitting by halting training when no significant improvement is observed, enhancing generalization. The small learning rate of 0.0171 allows for steady learning, minimizing the risk of overlooking important factors and maintaining model stability. Using a single hidden layer with about 97 neurons helps reduce model complexity while ensuring effective feature learning, avoiding overfitting. The 9lag parameter indicates that the model uses 9 historical values to predict future ones, suitable for financial problems that depend on past data. In summary, these optimal parameters lead to a GARCH-NN model with accurate, stable predictions, avoiding overfitting, and improving performance in volatile financial tasks.

After cleaning and transforming the parameters, they will initialize the optimal GARCH-NN model. The optimal parameters, including hidden layers, neurons per layer, dropout rate, and learning rate, will be applied for accurate forecasting. The model will be trained on `X_train`, `Y_train` for 50 epochs, with early stopping to avoid overfitting.

4. 3 The results of training and evaluation

The optimal hyperparameters, including the number of hidden layers, neurons per layer, dropout rate, and learning rate, are cleaned and transformed to build an effective GARCH-NN model. The model is trained on (`X_train`, `Y_train`) and tested on (`X_test`, `Y_test`) over 50 epochs with a batch size of 32. Early stopping is applied to halt training when errors show no improvement, mitigating overfitting. The model’s performance is evaluated using metrics such as MAE, MSE, RMSE, MAPE, R^2 , and STD, offering a comprehensive view of accuracy and stability. A comparison chart between actual (`Y_test`) and predicted values (`Y_pred`) is plotted using `plt.plot()`, providing a visual assessment of forecasting accuracy.

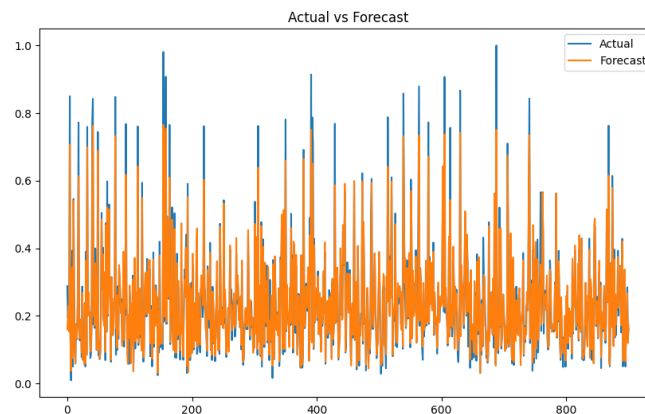


Figure 3. Actual vs Forecasted Volatility

The model evaluation results demonstrate impressive forecasting performance. MAE: 0.0263 indicates a very low average deviation between actual and predicted values, reflecting high accuracy. MSE: 0.0015 suggests minimal large errors, with predictions closely aligning with actual values. RMSE: 0.0382 quantifies prediction error compared to actual data, and its small value indicates precise forecasting. MAPE: 16.01% is considered acceptable in financial applications. The R^2 Score: 0.9422 confirms the model's ability to explain most of the variance in the data, while STD: 0.1474 indicates forecast stability with low standard deviation. These results highlight the GARCH-NN model's effectiveness in time series forecasting tasks, particularly in financial applications, where accuracy and reliability are crucial.

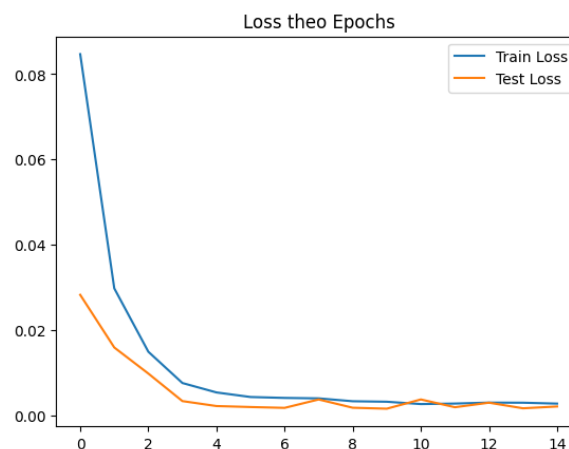


Figure 4. Convergence of Loss Function

The loss curve shows changes in Train Loss and Test Loss across epochs, enabling performance comparison on both datasets. The Train Loss curve indicates how well the model learns from training data, while Test Loss reflects its generalization ability on unseen data. The plot helps monitor convergence, assess stability, and detect overfitting if Test Loss increases while Train Loss decreases.

The GARCH-NN model forecasts 21-day price volatility using `best_model.predict(X_test[-21:])`, estimating risk or profit trends. A flexible trading strategy is established: if volatility increases, a “Buy” signal is triggered; if it decreases, a “Sell” signal appears; and if unchanged, a “Hold” signal applies. This strategy dynamically adapts to market conditions based on volatility forecasts.

Table 2. Forecast Results for Volatility Over the Next 21 Days

Day	Prediction	Strategies
2024-12-28	0.179441	Hold
2024-12-29	0.259876	Buy
2024-12-30	0.231030	Sell
2024-12-31	0.383106	Buy
2025-01-01	0.235559	Sell
2025-01-02	0.305263	Buy
2025-01-03	0.302149	Sell
2025-01-04	0.360524	Buy
2025-01-05	0.185329	Sell
2025-01-06	0.271912	Buy
2025-01-07	0.437810	Buy
2025-01-08	0.078678	Sell
2025-01-09	0.078679	Buy
2025-01-10	0.263947	Buy
2025-01-11	0.351221	Buy
2025-01-12	0.089821	Sell
2025-01-13	0.162510	Buy
2025-01-14	0.173480	Buy
2025-01-15	0.290843	Buy
2025-01-16	0.122933	Sell

Source: Author

The forecast of FSLR stock price volatility over the next 21 days reveals significant fluctuations, with the lowest volatility value recorded at 0.078678 on 2025-01-08 and the highest at 0.437810 on 2025-01-07. High-volatility days, such as 2024-12-31 and 2025-01-07, may reflect significant events or exogenous factors strongly impacting the market. Conversely, low-volatility days indicate relative market stability or cautious investor sentiment.

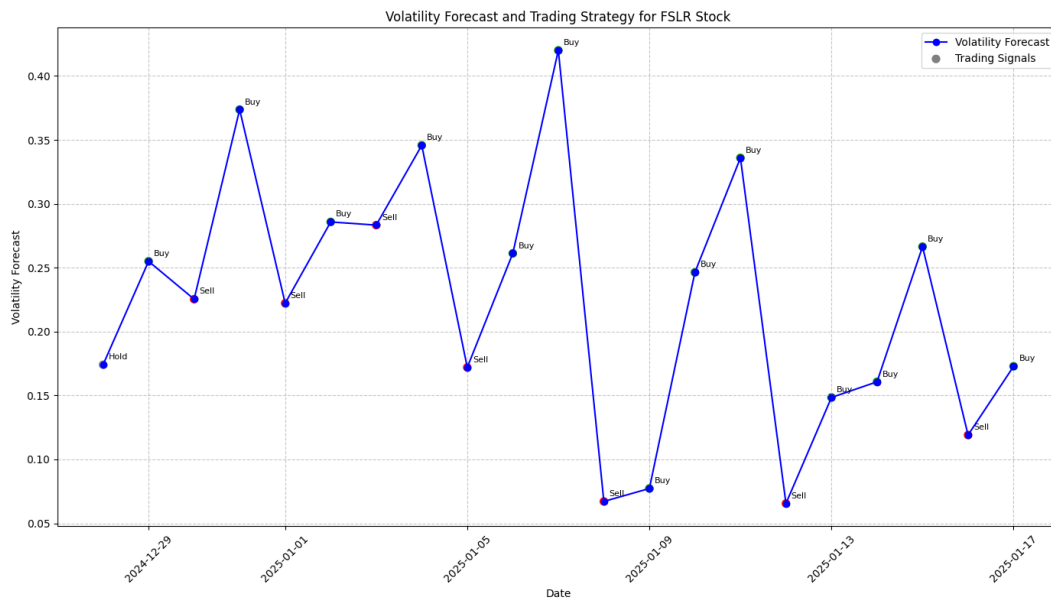


Figure 5 Volatility Prediction and Trading Strategies

The trading strategy is constructed based on these volatility trends. A “Buy” signal emerges during periods of increased volatility, reflecting potential profit expectations. Dates such as 2024-12-29, 2025-01-07, and 2025-01-11 present attractive investment opportunities. A “Sell” signal occurs when volatility decreases, helping investors mitigate potential risks, as observed on 2024-12-30, 2025-01-05, and 2025-01-12. A single “Hold” signal appears on 2024-12-28, indicating temporary market stability. The alternation between these signals demonstrates a flexible trading strategy, capable of adapting swiftly to short-term market shifts. Additionally, climate change and extreme weather events such as hurricanes and floods can significantly influence stock price volatility. Countries including the United States, Vietnam, China, and the Philippines are frequently impacted by these events, which disrupt supply chains and cause market uncertainty. The forecast results and the corresponding trading strategy offer a comprehensive perspective on FSLR stock volatility trends, assisting investors in making informed decisions, optimizing profits, and minimizing short-term risks.

Natural disasters, such as storms and climate change, can increase risks and cause "Buy" or "Sell" signals to change rapidly. Investors need flexible trading strategies to cope with uncertainty and market fluctuations. Overall, the quick changes caused by these factors not only impact the economy but also require investors to adjust their decisions to buy, sell, or hold in order to minimize risks and optimize profits.

Discussion

The forecast results for the next 21 days show a distinct fluctuation in volatility, with values ranging from 0.078678 (on 2025-01-08) to 0.437810 (on 2025-01-07). These significant changes may reflect external factors such as natural disasters, particularly in areas highly vulnerable to such events like the US, Vietnam, China, and the Philippines, which could increase market volatility. Flexible trading strategies, with “Buy” signals when volatility rises and “Sell” signals when it decreases, help investors adjust in time. External factors like natural disasters can strongly impact trading strategies and the volatility of stocks for companies like First Solar, which are involved in renewable energy.

Table 3. Comparison of GARCH-NN with Traditional Models

Metrics	Garch-NN	Garch	Tarch	GBMotion
MAE	0.0263	2.0545	1.2063	0.7301
MSE	0.0015	6.7621	1.8700	1.0214
RMSE	0.0383	2.6004	1.3675	1.0107
MAPE	16.01%	50.99%	4.8794	105.80%
R ²	94.22%	-165.46%	-67.10%	-0.18%
STD	0.1474	1.5960	1.0585	1.0105

Source: Author

The performance of different models in forecasting financial volatility. The GARCH-NN model outperforms others with MAE=0.0263, MSE=0.0015, RMSE=0.0383, MAPE=16.01%, STD=0.1474 and R²=94.22%, demonstrating its accuracy and stability. In contrast, the GARCH model performs the worst, with MAE=2.0545, MSE=6.7621, and R²_Score=-165.46%, indicating poor fit with the data. Other models like Tarch and GB-Motion show some improvement but still do not reach the performance level of GARCH-NN.

The GARCH-NN model performs well but has limitations. MAPE of 16.01% may be higher than desired in finance. To improve, parameter optimization is needed, learning from extreme fluctuations, and incorporating macroeconomic factors or market news to enhance accuracy and responsiveness.

Conclusion

The study developed a GARCH model combined with Artificial Neural Networks (ANN) to forecast the volatility of First Solar stock, aiming to provide accurate and stable predictions. Hyperparameter optimization using Bayesian Optimization improved forecast accuracy, with performance metrics such as MAE = 0.0263, MSE = 0.0015, RMSE = 0.0382, MAPE=16.01%, STD=0.1474 and R² = 94.22%, outperforming traditional methods.

The forecasting results indicate that the model can quickly respond to market volatility and support the development of flexible trading strategies that adjust to market changes. This is crucial for making effective short-term trading decisions, especially in the face of unpredictable volatility. The optimized GARCH-NN model can be adjusted to track trends in the renewable energy sector, helping investors identify long-term opportunities in the shift towards sustainable energy. For First Solar, a leader in the renewable energy industry, this model can support long-term investment strategies and contribute to the goal of mitigating the impacts of climate change.

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Session 2: Health Sciences and Technology

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Study of molecular docking binding affinity against transcriptional activation activity on estrogen receptor beta using SwissDock AC 2.0 web service**Prasan Tangyuenyongwatana^{1*} Jitti Vimtrimate¹ Chairat Angsukaset¹ and Jirapat Pasavaravech¹**¹Department of Manufacturing Pharmacy, Faculty of Pharmacy, Eastern Asia University, Pathumthani, 12110, Thailand

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Abstract

SwissDock is a web-based molecular docking server that has been launched with the new Attracting Cavities 2.0 (AC 2.0) algorithm which incorporates the CHARMM forcefield and the fast analytical continuum treatment of solvation (FACTS) model. It demonstrated a significant impact on the docking process. With its user-friendly graphic interface and little technical expertise, SwissDock stands out as a promising web-based docking platform for exploration. This study aimed to explore the SwissDock AC 2.0 web-based docking platform and evaluate the capabilities of this new algorithm by using estrogenic compounds from *Curcuma comosa* Roxb. rhizomes with estrogen receptor (2JYD and 1ERE) retrieved from Protein Data Bank. The docking experiment commenced by selecting AC 2.0 from the SwissDock interface. Next, upload the target enzymes, which are estrogen receptors, and then send the ligands in SMILES form. Then, specify the coordinates for each enzyme's active site and set the docking box size to 20 Å. The sampling exhaustivity and cavity prioritization were set to their default values and initiated the docking process. Upon completion, the docking results was downloaded as zip files. The data was extracted for analysis and charted the binding affinities (AC Score) against the relative transcription activation activity to ascertain their correlation (r^2). The PyRx 0.8 was utilized as the reference docking program. The results of the experiment indicated that the estrogen receptors 2JYD and 1ERE enzymes exhibited redocking RMSD within the range of 0.096 to 0.912, which means this docking algorithm has good accuracy. The AC 2.0 docking yielded good docking AC scores for 2YJD, ranging from -29.14 to -5.91 kcal/mol, and for 1ERE, the results ranged from -29.71 to -7.82 kcal/mol. The correlation coefficients (r^2) between AC dock scores and the relative transcription activation activities of 2JYD and 1ERE were 0.7748 and 0.6805, respectively. The correlation coefficient values above 0.7 is often considered indicative of a good predictive model. All experiments demonstrated a significant impact on the docking process, especially with estrogen receptors, achieving both excellent AC scores and a favorable correlation coefficient. The docking results were also referenced with the PyRx 0.8 program, which also gave the same trend. In conclusion, this platform requires minimal technical knowledge, no software installation, and no need to register with the website. It may serve as an educational or research tool for molecular docking, drug design, and drug development.

Keywords: Web-based molecular docking, SwissDock, Estrogen receptor beta, Curcuma comosa

Introduction

In the present, molecular docking is a pivotal computational technique in drug design that predicts the interaction between small molecules (ligands) and target proteins. This approach is essential for understanding how drugs bind to their targets, which is critical in the development of new therapeutics. Molecular docking aims to predict the preferred orientation of a ligand when it binds to a protein, allowing researchers to estimate the binding affinity and stability of the resulting complex. This information is crucial for rational drug design, as it helps identify potential drug candidates and optimize their structures for better efficacy and reduced side effects (Tripathi & Misra, 2017). About two decades ago, web-based servers emerged as online platforms that facilitated the computational modeling of interactions between small molecules (ligands) and larger biological molecules (typically proteins). These servers provide user-friendly interfaces that allow researchers, including those without extensive computational expertise, to perform docking simulations and analyze the results efficiently (Kochnev et al, 2024). There are notable web servers available for molecular docking such as MolModa, SwissDock, Webina, SeamDock, and ReverseDock (Krause et al, 2023).

SwissDock is a web-based server designed for protein-small molecule docking simulations, facilitating the study of molecular interactions crucial in drug design and development. SwissDock aims to provide a user-friendly platform for researchers to perform docking simulations without requiring extensive computational resources. It is freely accessible and does not require user registration, making it widely available to the scientific community (Grosdidier, 2011). At first, the server utilizes the EADock DSS docking engine, which allows for efficient docking calculations. The latest version of SwissDock AC 2.0 includes options for both fast and precise docking algorithms, along with enhanced search capabilities for ligands and targets. It also supports covalent ligand docking through command-line access, providing flexibility for advanced users (Bugnon et al, 2024).

In this study, we investigate the accuracy and binding affinity of the SwissDock AC 2.0 program by docking to two estrogen receptors. These receptors have a multistage downstream process that leads to various biological effects. We then evaluate the docking AC score in comparison with activity by plot the ligand's binding affinity to the relative transcription activation activity of the estrogen receptors (ER).

1. Research Objectives

1.1 To test the molecular docking accuracy of the SwissDock web service by redock experiments.

1.2 To perform estrogenic ligand docking to the β -estrogen receptors with the attractive cavity 2.0 algorithm in SwissDock web server and evaluate the correlation with relative transcription activation activity compared to AutoDock Vina docking program.

2. Review of Related Literatures

2.1 Molecular docking and scoring functions

The most widely used computational method is molecular docking, especially in structure-based drug design and discovery. Molecular docking replicates the process of recognition, where a small molecule, known as a ligand, moves, rotates, and twists extensively

within the active site of a macromolecule, typically a protein, finding the most favorable binding mode measured by a scoring function of the binding interactions (Yan & Wang, 2016). In the early days of molecular docking, the most accurate structure-based ways to rank how well a certain group of ligands binds to a target protein were those that used first-principle methods to figure out their free binding energy, like free energy perturbations (FEP) or thermodynamic integration (TI) (Foloppe & Hubbard, 2006). However, these procedures are labor-intensive and necessitate considerable work for system preparation and optimization to facilitate high-throughput use. Consequently, in molecular docking, molecules are typically prioritized using more straightforward and expedited scoring systems, which can be broadly categorized into force field-based, empirical, or knowledge-based methodologies (Costanzi et al., 2009). Even when the calculations are based on geometrically precise complexes, some scoring functions can produce scores that show poor association with experimental affinities. Nonetheless, they have demonstrated the ability to accurately differentiate between active and inactive molecules (Vilar & Costanzi, 2013).

2.2 SwissDock web-based server

SwissDock is a web-based molecular docking server (<https://www.swissdock.ch/>) that was launched in 2011 as part of the SwissDrugDesign project, aimed at facilitating drug discovery by predicting interactions between small molecules and target proteins. Initially based on the EADock DSS algorithm, SwissDock has evolved significantly over the years, incorporating advanced features to enhance user experience and docking accuracy. The latest version, SwissDock 2024, introduced two state-of-the-art docking methods: Attracting Cavities 2.0 (AC 2.0), a new and sophisticated molecular docking algorithm intended to improve the precision and effectiveness of small-molecule docking to target proteins. AC 2.0 employs a force-field-based scoring function that combines CHARMM force field energy with solvation energy terms (FACTS), allowing for more reliable predictions of ligand-receptor interactions (Bugnon et al., 2024). Users can define flexible regions within the receptor, enhancing the algorithm's ability to adapt to various docking scenarios. The other dock engine service on the web site is AutoDock Vina, which is a popular and well-known docking engine, making it accessible even to those without computational expertise (Röhrig et al., 2023).

2.3 Binding affinity and scoring functions

Binding affinity and scoring functions are critical components in the field of molecular docking, especially in drug design. They help assess how strongly a ligand interacts with its target protein, which is essential for predicting the efficacy of potential drugs. Binding affinity refers to the strength of the interaction between a ligand (such as a drug molecule) and its target receptor (typically a protein). It is quantitatively expressed through the equilibrium dissociation constant, which indicates how readily the ligand binds to the receptor (Pantsar & Poso, 2018). A scoring function is a mathematical model used in molecular docking to estimate the binding affinity of a ligand-receptor complex. It evaluates various factors that contribute to the stability and strength of the interaction based on calculated energy values. There are three main types of scoring functions: forcefield-based, empirical, and knowledge-based.(McNutt et al, 2021).

Research Methodology

1. The Research Procedure Includes 4 Steps which are:

1.1 To set up with graphic user interface of SwissDock

To set up a docking experiment with an enzyme and ligand using SwissDock AC 2.0 (<https://www.swissdock.ch/>), follow these steps: First, choose the docking algorithm by selecting Attracting Cavities 2.0 on the SwissDock interface. Next, submit a ligand by uploading a file in either SMILES or Mol2 format. Then, submit the target enzyme by

entering its PDB ID or uploading a PDB file. After that, define the search space by specifying the coordinates for the active site and the size of the docking box. The other parameters can also be selected, such as sampling exhaustivity and cavity prioritization. Finally, check all parameters for validity, enter the sample file name for results notification, and click "Start Docking" to initiate the process. Once completed, the docking results can be visualized and analyzed directly on the platform. For this study, Discovery Studio visualizer (Dassault Systèmes, France), and UCSF Chimera (<https://www.cgl.ucsf.edu/chimera/>) were used for structural conformation analysis. A redock similarity analysis was conducted by using the VEGA ZZ program (<https://www.ddl.unimi.it/>).

The details of protein and ligand preparation were described below. The PyRx 0.8 virtual screening tool (<https://pyrx.sourceforge.io/downloads/>) was used as a standard program to perform docking along with the AC 2.0 web server to confirm the docking experiments.

1.2 To prepare protein (estrogen receptors) and selected ligands

1.2.1 Protein preparation: Proteins (2JYD and 1ERE) were subjected to Swiss PDB Viewer to analyze and visualize protein structures, including their surfaces and electrostatic properties and then save as CHARMM format. SwissDock AC 2.0 requires CHARMM format for protein structures because the docking calculations are performed using the CHARMM36 force field, which is essential for accurately modeling molecular interactions. The CHARMM format allows for the inclusion of detailed information such as protein structure files (PSF), coordinate files (CRD), and additional topology (RTF) and parameter files (PAR) if necessary. This format ensures that the docking process can leverage the specific energy calculations and solvation models associated with CHARMM, providing a robust framework for simulating how ligands interact with target proteins.

1.2.2 Submit protein: The target protein file was selected, prepared it in CHARMM format, saved it as pdb, and uploaded it to the website. The prepare target button will turn red; click on it and wait for the correct signal to appear. This concludes the section.

1.3 Ligand setting: In this experiment, ChemSketch (<https://www.acdlabs.com/>) was used to draw the ligands as 2D structures (Figure 1). Once finished drawing the structure, the tool button in ChemSketch was pressed, then selected generate, and the menu appeared as a sidebar. The SMILES notation was selected, which encapsulated the compound's structure in SMILES form beneath the 2D structure. Next, the SMILES name was copied and pasted into the SwissDock ligand load space on the web panel. The prepare ligand button will turn red; click on it and wait for the correct signal to appear. This concludes the section.

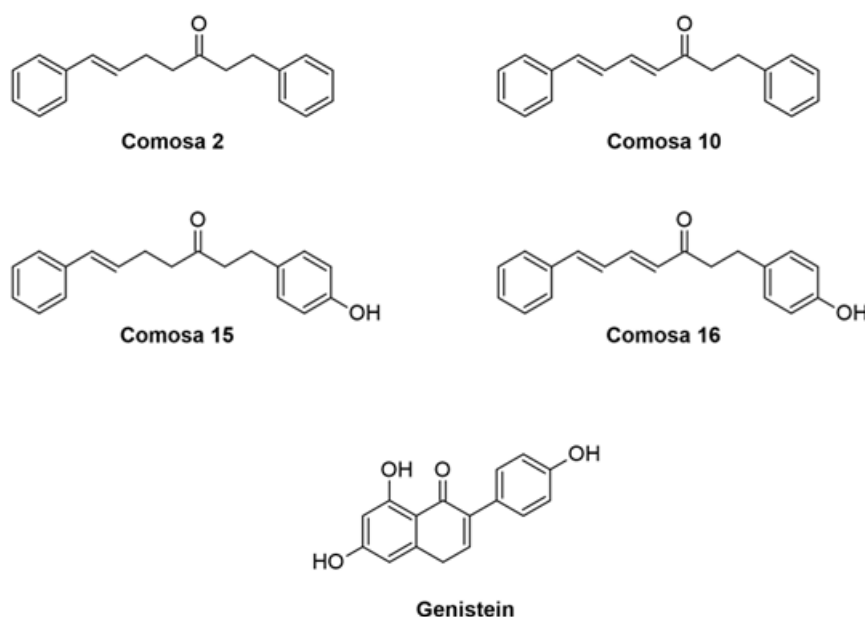


Figure 1. Structure of estrogenic compounds from *Curcuma comosa* Roxb. rhizomes.

1.3.1 Identifying binding pockets. For the coordinates of the target enzymes, the PyRx 0.8 program was used to identify the binding pocket. After obtaining the coordinates of each enzyme which were 2YJD (X = -14.16, Y = -18.79, Z = 2.96), 1ERE (X = 9.30, Y = 46.50, Z = 130.86), the coordinates of the enzyme was filled into the SwissDock AC 2.0 panel. The box size was set as $20 \times 20 \times 20$ Å. For PyRx 0.8 with AutoDock Vina as the docking engine, the center of the enzyme coordinates was the same as above except for the box size, for which the PyRx used the default value ($20 \times 20 \times 20$ Å).

1.4 To Select parameter. In SwissDock AC 2.0, RIC stands for Random Initial Conditions. This parameter allows users to define the number of random initial conditions to be generated during the docking process, which enhances the robustness and flexibility of the sampling. The default value for RIC is set to 1, but it can be adjusted to generate multiple random orientations of the ligand, thereby improving the chances of finding optimal binding poses. RIC comprises eight levels; advancing to a higher level results in a longer docking time. In this experiment, the RIC was set at level 1.

1.4.1 Sampling Exhaustivity: This parameter defines the thoroughness of the sampling process and can be set to low, medium (default), or high, corresponding to different angular sampling ranges (180° , 90° , and 60° , respectively). In this experiment, the sampling exhaustivity was set at medium (default), which is 90° , because this angle has highly success in docking on this platform.

1.4.2 Cavity Prioritization: Users can prioritize cavities as buried (default), medium, or shallow, which influences how the docking algorithm targets specific regions of the receptor. In this experiment, the cavity prioritization was set at medium (default).

1.4.3 Scoring Function: Two scoring functions are available: (a) AC Docking Score: Combines CHARMM36 force field energy with FACTS solvation energy terms. (b) SwissParam Score: Estimates binding free energy as a weighted sum of polar and nonpolar terms. This experiment only focused on the AC Docking Score.

1.4.4 Timing for docking: The SwissDock AC 2.0 web server shows the approximate time for each task. Normal small molecules with default parameter values can take approximately 7–12 minutes to finish the dock; for larger molecules (300–400 amu), it may take 15–23 minutes to finish the task. This docking time can vary depending on various factors, such as size and complexity of ligand, setting parameters, peak hours, server speed, and internet connection speed.

1.5 Start docking. The first step was to set all the parameters and do the redock experiment. This involved docking the x-ray ligands of each receptor (2JYD and 1ERE) again. The VEGA ZZ program evaluated the redocking results to determine the root mean square deviation (RMSD). The next step involved docking the sample compound, which involved loading the test compound to the panel, pressing "check parameters", and waiting for the correct signal to appear. After that, the name of the docking job was assigned, and upon pressing the "start docking" button, the web page transitions to a new page that displays all assigned parameters and the estimated duration of the job. Once the docking process is complete, the result web page will display the binding energy and an image of the enzyme-ligand, which can be freely rotated at any angle using the mouse. The 3D structure of ligand poses with parameters was compressed into a ZIP file for download. After unzipping the result file, the DOCK4 file was selected and opened within the UCSF Chimera program to obtain docking information with each pose's structure. The binding affinities (AC Score) were plotted against the relative transcription activation activity to determine their correlation.

2. Research Instruments

2.1 HP Notebook CPU: AMD Ryzen™ 5 processor · Windows 11 Home, 16 GB LPDDR5 RAM · 512 GB SSD Hard drive · 16 inch WUXGA IPS · AMD Radeon™ Graphics Ram 16 GB.

2.2 Avogadro program (<https://avogadro.cc/news/avogadro-1-1-1-released/>), and GraphPad Prism 10 (GraphPad, USA).

3. Target Group

3.1 Estrogen receptors (2JYD and 1ERE) were obtained from Protein Data Bank

3.2 Relative transcription activation activity was obtained from Suksamran et al.'s research. (Suksamran et al., 2008)

4. Statistics for Data Analysis: We used the statistics package in GraphPad Prism 10 to analyze the data using linear regression and Pearson's correlation with 95% confidence.

Results

1. The results of the molecular docking accuracy test of the SwissDock web service by redock experiments.

Redocking allows researchers to validate the accuracy of the docking algorithm by comparing the predicted binding pose with the experimentally determined pose from X-ray crystallography. A successful redock indicates that the method can reliably reproduce known interactions, which is essential for its application in predicting new ligand behaviors (Hevener et al, 2009). Table 1 displays the RMSD of each enzyme's redocking ligands. All target enzymes showed redocking RMSD in the range of 0.096 to 0.912 Å (Figure 2).

Table 1. The redock RMSD of the enzymes in the experiment.

Enzyme	RMSD (Å)
1ERE	0.096
2YJD	0.912

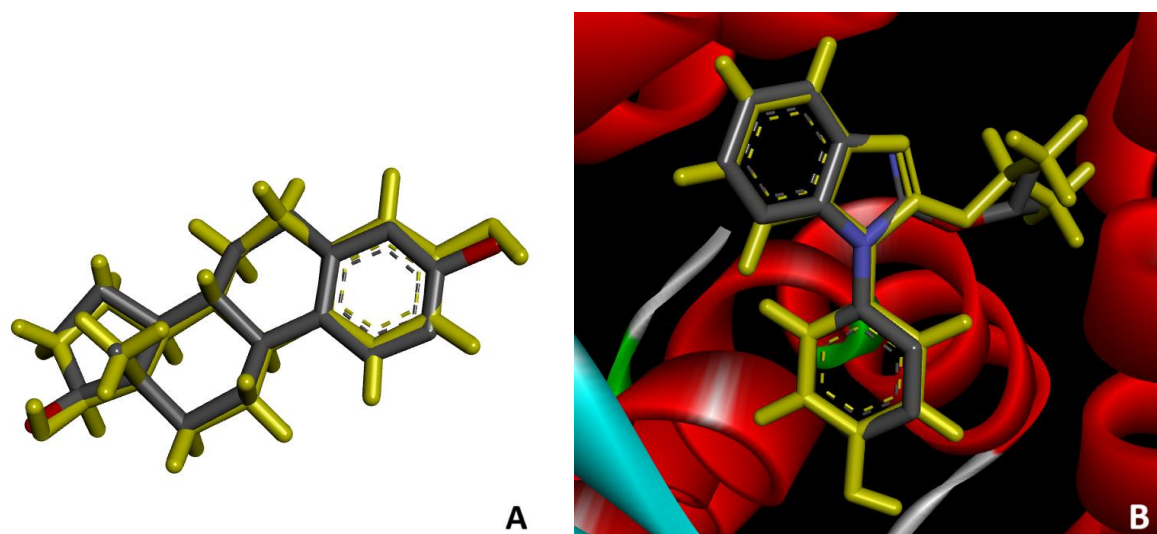


Figure 2. Redock x-ray ligand (yellow color) results of SwissDock AC 2.0 (A) x-ray ligand of 1ERE estrogen receptor with RMSD = 0.096, (B) x-ray ligand of 2YJD estrogen receptor with RMSD = 0.912

2. To perform estrogenic ligand docking to the β -estrogen receptors with the attractive cavity 2.0 algorithm in SwissDock web server and evaluate the correlation with relative transcription activation activity compared to AutoDock Vina.

The set of tests sample employed phytoestrogens from *Curcuma comosa* Roxb. rhizomes to evaluate the effectiveness of the AC 2.0 on the β -estrogen receptor (2YJD and 1ERE). The docking AC scores are shown in Table 2.

Table 2. SwissDock AC docking scores of 2YJD, 1ERE (β -estrogen receptor) compared with PyRx docking.

Compound	2YJD AC Docking scores (kcal/mol)	1ERE AC Docking scores (kcal/mol)	2YJD PyRx Docking scores (kcal/mol)	1ERE PyRx Docking scores (kcal/mol)	% activity*
Genistein	-18.22	-15.60	-8.8	-8.5	75.51
Comosa-2	-17.37	-19.79	-8.3	-8.9	85.42
Comosa-10	-5.91	-7.82	-5.8	-7.2	33.72

Comosa-15	-29.14	-29.41	-8.2	-8.2	90.56
Comosa-16	-18.22	-17.27	-7.5	-8.5	87.75
r^2	0.7748	0.6805	0.6759	0.7577	

*Data obtained from Suksamran et al, 2008

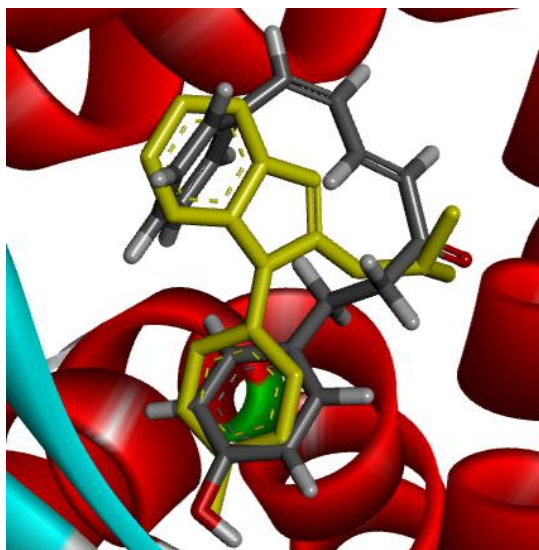


Figure 3 Docking results of SwissDock AC 2.0 comosa16 ligand in 2YJD estrogen receptor (x-ray ligand, yellow color).

Figure 3 shows an example of how the comosa 16 overlay with the 2YJD ligand fits together. The graph in Figure 4 displays the linear regression and correlation coefficient when the AC score is plotted against the percentage of estrogen activity. The correlation coefficient from 2YJD was 0.7448 and higher than the correlation coefficient ($r^2 = 0.6759$) from the PyRx 0.8 program. For 1ERE receptor, the AC score correlation coefficient equaling to 0.6805 while the correlation coefficient from the PyRx 0.8 was 0.7577. Figure 5 illustrates the interactions between the enzyme and ligand at the binding site in both 3D and 2D maps, which are utilized to assess the pose of each docking result.

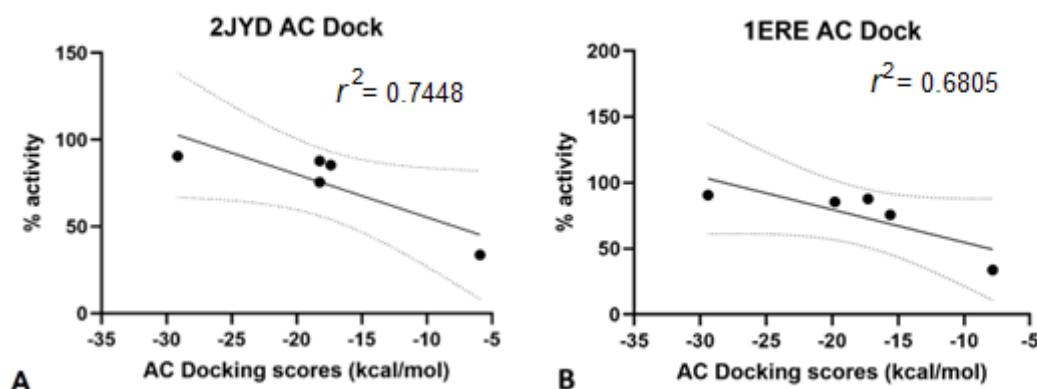


Figure 4. Linear regression and correlation coefficients of (A) 2YJD AC docking ($r^2 = 0.7448$) (B) 1ERE AC docking ($r^2 = 0.6805$)

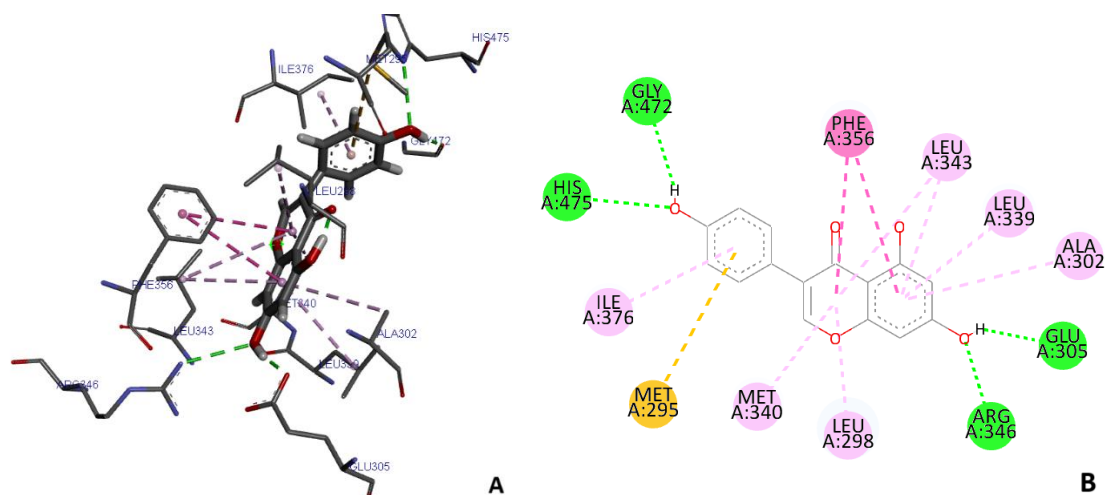


Figure 5. A and B illustrate genistein's 3D and 2D map non-bonding interactions with amino acids in the β -estrogen receptor binding pocket.

Discussion

Based on the experimental results, we first redocked the x-ray ligands of two estrogen receptors using the SwissDock AC 2.0, obtaining RMSD values within the range of 0.096 to 0.912, all of which were below 2.0. Picture A and B in Figure 1 show the redock of the x-ray ligand result placed on top of the x-ray ligand in the estrogen receptor (1ERE) and (2YJD). That means this docking algorithm has good accuracy. The binding pose of the ligand is close to the structure that was found through X-ray crystallography. This level of agreement is often considered indicative of a successful docking procedure, as it reflects that the AC 2.0 docking algorithm can reliably reproduce known interactions. The AC 2.0 docking process involves identifying and mapping the binding cavities on the target macromolecule. After identifying these cavities, the algorithm positions various "attractive points" within them. These points represent regions where ligands are likely to interact favorably with the protein. There are two types of these points, with the electrostatic cloud points being among the most attractive. The algorithm places them based on the net charge of nearby residues, which helps account for electrostatic interactions. The second type is placement cloud points; these are specifically designed to avoid clashes with the protein surface, ensuring that ligands can be docked without steric hindrance (Röhrig et al, 2023).

In the next trial, the study found that estrogen receptor docking experiments with 2YJD and 1ERE receptors with phytoestrogen compounds give good correlation coefficient of docking results. The docking results using SwissDock AC 2.0 for 2YJD and 1ERE were in agreement, and the paired t-test revealed no significant difference ($p = 0.0073$). For PyRx 0.8, docking results for both receptors also showed no significant difference ($p < 0.001$). A higher correlation coefficient of 2YJD ($r^2 = 0.7448$) suggests that the docking scores reliably predict biological activity. In molecular docking studies, the correlation coefficient helps assess the reliability of docking protocols. A strong positive correlation between docking scores and experimental data suggests that the docking method accurately predicts how well a ligand will bind to a target protein. For instance, a correlation coefficient of r^2 values above 0.7 is often considered indicative of a good predictive model in this context (Boittier et al, 2020). A coefficient greater than 0.7 is generally accepted as indicative of a reliable docking protocol, while values around 0.5 may still provide useful insights but warrant caution and further validation (Abdulfatai et al, 2017). In molecular docking, comparing the structural poses of

ligands that interact with amino acid residues involves several criteria to identify the best pose in relation to the X-ray ligand structure. Evaluate how well the ligand interacts with critical amino acid residues in the binding site, including hydrogen bonds, ionic interactions, and hydrophobic contacts. Every testing ligand in this experiment has some key hydrogen bonding with either GLU305, ARG346, GLY472, or HIS475, and all of them superimpose with the x-ray ligand; especially, genistein has all of the hydrogen bonding contacts. In the SwissDock web-based panel, we can identify the hydrogen bonds, ionic interactions, and hydrophobic contacts directly. The mouse-controlled cursor moves to an amino acid interacting with the ligand, and the viewer panel's corner displays the name of the amino acid residue. Additionally, the program features a button that allows users to view both ionic and hydrophobic interactions. The experiment also evaluated the docking result by comparing the docking process with the standard program, the PyRx 0.8 virtual screening tool, which has AutoDock Vina as the docking engine.

From the experimental docking results, the relationship between ligand binding to the estrogen receptor (ER) and subsequent transcriptional activation is complex and influenced by multiple factors. The binding energy, often represented as AC scores in docking studies, reflects how strongly a ligand interacts with the ER. Generally, lower binding energy (more negative value) indicates stronger binding affinity. However, this does not always translate linearly into transcriptional activity due to the intricate signaling pathways involved (Beekma et al., 1993; Grande et al., 2018). Ligand binding induces conformational changes in the ER's ligand-binding domain (LBD), which are crucial for activating transcription. These changes allow the receptor to interact effectively with DNA and other coactivators, thereby facilitating gene expression (Ruff et al., 2000). The estrogen response element (ERE) is a primary target for ER-mediated transcription activation. However, the pathway from ligand binding to ERE activation involves several intermediary steps and components, including coactivators and other transcription factors, which can modulate the final expression levels (Alonso, et al., 2023).

Conclusion

The study examined the performance of the SwissDock AC 2.0 web server platform to determine its ability to perform enzyme-ligand docking. The docking web-based program utilizes a new algorithm called Attracting Cavities 2.0, which incorporates the CHARMM forcefield and the fast analytical continuum treatment of solvation (FACTS) model. It demonstrated a significant impact on the docking process, especially with estrogen receptors, achieving both excellent AC scores and a good correlation coefficient. As this is our first time using this web platform, we are still studying the program's parameters with other enzymes. In conclusion, the platform requires minimal technical knowledge and may serve as an educational or research tool for molecular docking, drug design, and drug development. This platform is modern and innovative and can be used anywhere from a web panel, with no software installation and no need to register with the website. This is a new paradigm in the molecular docking arena.

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222086

Production of Recombinant Human Papilloma Virus (HPV) L1 Protein Type 31 in *Hansenula polymorpha*

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Abstract

Cervical cancer is the 2nd most common cancer in Thai women (ranked 4th for women worldwide). It is caused by Human papillomaviruses (HPVs) infection in the cervix which can be transmitted through sexual activity. In general, HPVs are divided into 2 types; low-risk types (HPV6 and 11) which can lead to genital warts and high-risk types (HPV16, 18, 31, 33, 35, 39, 45, 51, 56, 58, and 59) which are the cause of cervical cancer. Although a vaccine produced from an L1 major capsid protein of HPV is widely accepted and adopted for preventive measure, lower cross-protection against different subtypes has been reported. This study focused on the development of a cultivation medium for production of HPV31 L1 protein from a recombinant *Hansenula polymorpha* HPV31. Effects of maltose and non-animal derived nitrogen sources (HySoy, HyExpressII, HyExpressIV, and HyYest412) supplementation in the SYN6 medium (a defined medium previously developed for cultivation of *H. polymorpha*) on growth and recombinant protein yield were evaluated at a shake-flask scale. Except for HySoy, all nitrogen sources evaluated enhanced growth of recombinant *H. polymorpha* HPV31. SYN6 supplemented with HyExpressII and HySoy gave a significantly higher volumetric yield. Addition of maltose enhanced the growth significantly but resulted in lower volumetric L1 protein yield. SYN6 supplemented with HyExpressII or HySoy will be evaluated further in batch- and fed-batch bioreactor-scale cultivation. We anticipate that this research will enable efficient and feasible production process of HPV vaccines in Thailand, thereby increasing the accessibility of multivalent HPV vaccines for the Thai population.

Keywords: Human papillomavirus, HPV 31, L1 protein, virus-like particle, *Hansenula polymorpha*

Introduction

According to the 2022 report from the HPV Information Center, cervical cancer is the 2nd most common cancer among Thai women, with an estimated diagnosis rate of 8600 people per year and a mortality rate of 4500 people per year. The cause of cervical cancer is an infection with Human papillomaviruses (HPVs), a small, non-enveloped, and icosahedral DNA virus with a diameter of 52–55 nm, which can be transmitted through sexual intercourse. Major capsid L1 protein of HPV, which can spontaneously self-assemble into virus-like particles (VLPs), can be used effectively as a prophylactic vaccine. A methylotrophic yeast *Hansenula polymorpha* has been used to produce several recombinant proteins (e.g., enzyme and vaccine) for more than 30 years. This study aimed to develop a cultivation medium suitable for the production of recombinant HPV31 L1 protein from *H. polymorpha*. The developed medium

will be applied in scale-up cultivation to further optimize the cultivation conditions. It is hoped that an efficient and feasible production process would strengthen efforts to produce HPV vaccines locally in Thailand, thereby increasing the accessibility of a multivalent HPV vaccine for the Thai population. Clinical trials show that the quadrivalent vaccine (HPV types 6, 11, 16, and 18) and the bivalent vaccine (HPV types 16 and 18) are highly effective in preventing HPV infections. Nonetheless, a nanovalent HPV vaccine (HPV types 6, 11, 16, 18, 31, 33, 45, 52 and 58) is expected to offered broader coverage, approximately 90% of cervical cancer cases (Tobaiqy & MacLure, 2024).

1. Research Objectives

To evaluate the effects of maltose and 4 different non-animal derived nitrogen sources (HySoy, HyExpressII, HyExpressIV, and HyYest412) on growth and recombinant HPV31 L1 protein production in *Hansenula polymorpha*.

2. Review of Related Literatures

Globally, cervical cancer is the 4th most common cancer in women (Bruni L, 2023). World Health Organization (WHO) reported approximately 660,000 new cases and 350,000 mortality cases in 2022. The incidence of cervical cancer occurred in low- and middle-income countries. In Thailand, cervical cancer is the 2nd most common cancer in women and frequently occurs among women between 15 - 44 years of age. Most cervical cancer is caused by infection with a certain high-risk type of HPV.

Human papillomavirus (HPV) is the most common sexually transmitted infection (STI). There are more than 200 subtypes which can be divided into 2 groups: high-risk and low-risk types. The high-risk types include HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, and 59 which can lead to cervical cancer while the low-risk types (HPV 6 and 11) cause most genital warts. According to the ICO/IARC report (2023) on the 10 most common HPV oncogenic types associated with cervical cancer, HPV 16 and 18 were the most prevalent subtypes both in Thailand and globally. Nonetheless, HPV vaccines provide limited cross-protection against different subtypes. Therefore, the development of a multivalent prophylactic vaccine based on multiple subtypes is essential.

HPV capsid contains 2 structural proteins, major capsid protein (L1) and minor capsid protein (L2). The major capsid L1 protein of HPV can self-assemble into capsomeres, which then form virus-like particles (VLPs). These VLPs are non-infectious but highly immunogenic (Lowy, 2016) and therefore plays an important role in HPV vaccine production. VLP can be produced in a variety of platforms including bacteria, yeast, and insect cell. In this study, methylotrophic yeast *Hansenula polymorpha* is employed as a production platform for recombinant HPV31 L1 protein. *H. polymorpha* offers several benefits including available strong inducible promoters, an ability to be cultivated at a high-cell density, and an ability to produce recombinant protein at moderate temperatures (i.e., 30-40°C). *H. polymorpha* grows well in both defined and complex media. Although *H. polymorpha* has been used for recombinant protein production for over 30 years, the medium and cultivation techniques are not as well established as those of *Pichia pastoris*. Further research is needed to fully explore the potential of the system.

Research Methodology

1. Microorganism and media

Recombinant *Hansenula polymorpha* strain HPV31 used in this research was developed by (Kopitak, 2020) based on *H. polymorpha* NCYC495 (SH4330) *ura3* (*Ura*⁻) (provided by Yeast Genetic Resource Center, YGRC, Osaka University, Japan). Strain HPV31 harbors a chromosome integrated plasmid pHPV31, constructed based on a backbone of plasmid pUC57 (derivative of pUC19) (**Figure 1**). Synthetic complete medium with Uracil dropout mix (SC-Ura) and SYN6 medium (Degelmann, 2002) were employed as a selection medium and fermentation medium, respectively.

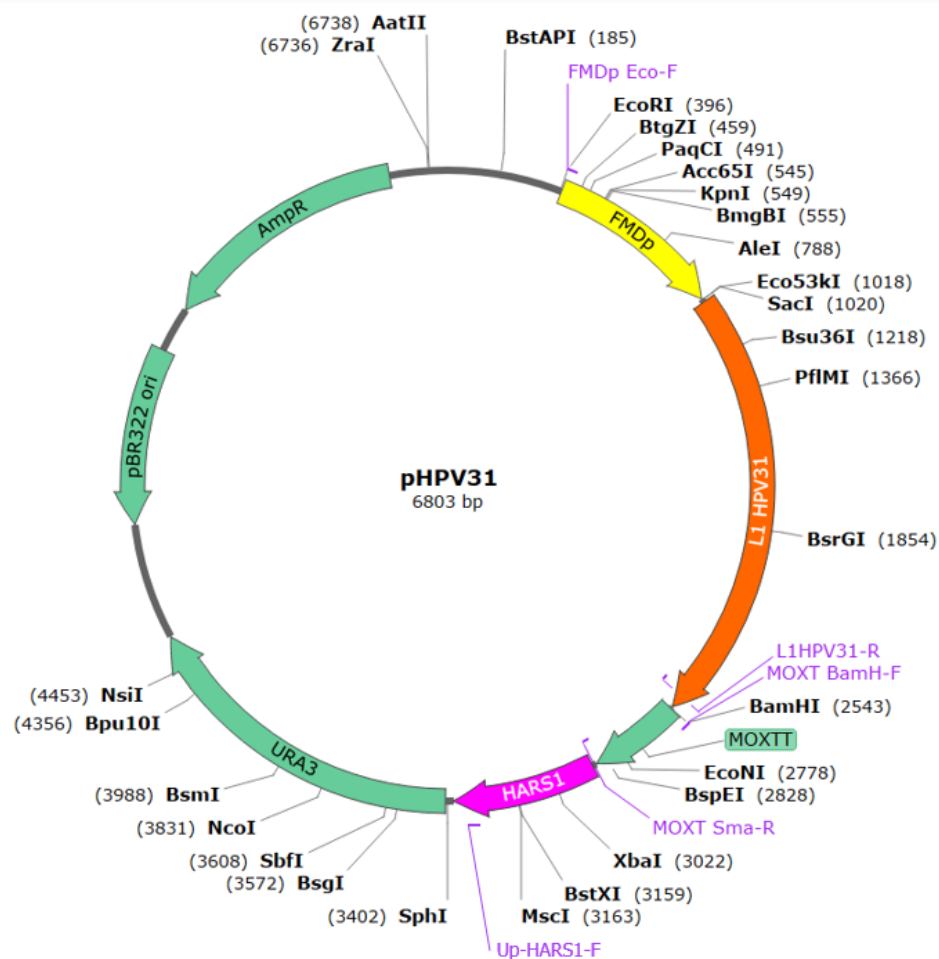


Figure 1 Recombinant plasmids pHPV31 (Kopitak, 2020).

2. Strain verification

In order to verify that the recombinant *H. polymorpha* used in this study harbored a complete expression cassette of L1 HPV 31 in the chromosome at the *HARS1* site, the genomic DNA of recombinant *H. polymorpha* was prepared following a quick and low-cost genomic DNA extraction protocol reported by (Lööke et al., 2011). PCR was performed using 3 different pairs of primers (**Table 1**).

Table 1 List of primers used in this study.

Name	Sequence (From 5' to 3')	Length (bp), GC, T _m (°C)	Purpose
FMDp Eco-F	GAGAATTCAATG TATCTAAACGCA AACTC	29, 34.5, 63.1	Verification of the recombinant plasmids pTB9 (HPV 31) and a full expression cassette of L1 HPV 31
Up-HARS1-F	GCAAACACCAAC AGATAGAACTCC TAC	27, 44.4, 62.3	Verification of an integration at <i>HARS1</i> site
MOXT BamH-F	GAGGATCCGACA TACCGCTTTTGA GAAG	28, 50.0, 70.5	Verification of an integration at <i>HARS1</i> site
MOXT Sma-R	CACCCGGGGATA TCACCACAACGT CC	26, 61.5, 74.6	Verification of the recombinant plasmids pTB9 (HPV 31) and a full expression cassette of L1 HPV 31
Os-L1H31-RV	AGCCGATCTCTT TCCGGCCTT	21, 57.1, 66.2	Verification of a full expression cassette of L1 HPV 31

Remark: NetPrimer program from PREMIERE Biosoft and PrimerQuest program were used to design primers and to predict the %GC content and T_m of primers.

3. Inoculum preparation and flask-scale cultivation

Inoculum preparation and flask-scale cultivation were performed according to the protocol described by (Phimsen et al., 2024). Briefly, SYN6 medium was supplemented with 10 g/L of specified non-animal derived nitrogen source (HySoy, HyExpressII, HyExpressIV, and HyYest 412). HyExpressII was evaluated with and without supplementation of 20 g/L maltose. The cultivation was performed at 30°C, 120 rpm for a total of 60 h. Methanol induction (1% v/v) was introduced after 36 h of cultivation.

4. Sample analysis

Sample was taken at 36 h (uninduced) and 60 h (induced), and then analyzed for OD₆₆₀, dry cell weight (DCW) and pH. Cell-free extract was prepared using bead mill according to the protocol described by (Phimsen et al., 2024). The cell-free extract was analyzed for total protein (Bradford assay) and L1 protein (Western blot and an indirect ELISA assay) following the protocol reported by (Phimsen et al., 2024).

5. Statistics for Data Analysis Statistical analysis, General Linear Model (GLM) and Dunnett's test, was performed using Minitab software (Version 21, State College, PA).

Results

1. Strain verification

Recombinant *H. polymorpha* HPV31 was verified by using 3 different primers 1) FMDp Eco-F and Os-L1 H31-RV 2) Up-HARS1-F and MOXT BamH-F 3) FMDp Eco-F and MOXT Sma-R to verify 1) the presence of the HPV 31 L1 gene, 2) the integration at *HARS1* site and 3) the full cassette for L1 protein, respectively. The result (**Figure 2**) revealed the expected sizes of PCR products 2.0, 0.9, and 2.5 kb, respectively. Therefore, the recombinant *H. polymorpha* HPV31 used in this study possessed a full expression cassette for HPV31 L1 protein integrated into its genome at HARS1 site.

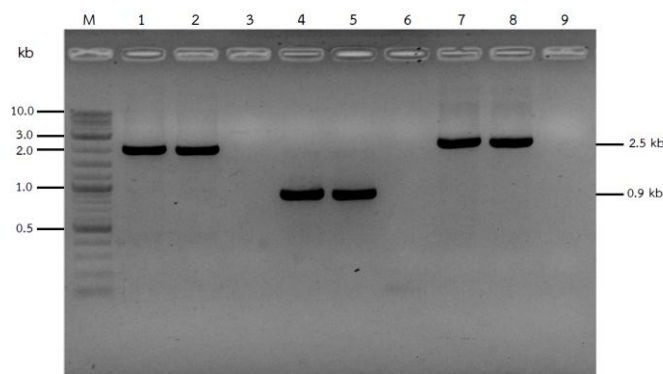


Figure 2 PCR products of plasmids pHPV31. Lane M: 2-Log DNA Ladder; Lane 1-2: PCR product from primer FMDp Eco-F and L1 HPV31-R; Lane 4-5: PCR product from primer Up-HARS1-F and MOXT BamH-F; Lane 7-8: PCR product from primer FMDp Eco-F and MOXT Sma-R; Lane 3, 6, and 9: Negative control.

2. Effects of maltose and non-animal derived nitrogen source supplementation on growth of *H. polymorpha* HPV31

SYN6 medium was supplemented with 4 different non-animal derived nitrogen sources expected to promote growth and recombinant protein production (**Table 2**). The nitrogen sources evaluated include HyExpressII, HyExpressIV, HySoy, and HyYest412. In case of HyExpressII, maltose was supplemented at 20 g/L to evaluate the effect of sugar-based carbon source on growth and recombinant protein production. It should be noted that the SYN6 medium already contains 20 g/L of glycerol as a main carbon source. A linear relationship can be observed between growth (as OD₆₆₀) and cell dry weight (**Figure 3**). OD₆₆₀ and pH after 60 h of cultivation are summarized in **Figure 4** and **5**, respectively. Except for HySoy, a significantly enhanced growth could be observed in all tested (**Figure 4**). Noted that an addition of maltose increases the growth further by 1.7-folds. A significantly higher pH of culture was observed when nitrogen source was supplemented into SYN6.

Table 2 List of SYN6-based media tested in this study.

Number	Medium
1	SYN6
2	SYN6 + HyExpressII 10 g/L
3	SYN6 + HyExpressIV 10 g/L
4	SYN6 + HySoy 10 g/L
5	SYN6 + HyYest412 10 g/L
6	SYN6 + HyExpressII 10 g/L + Maltose 20 g/L

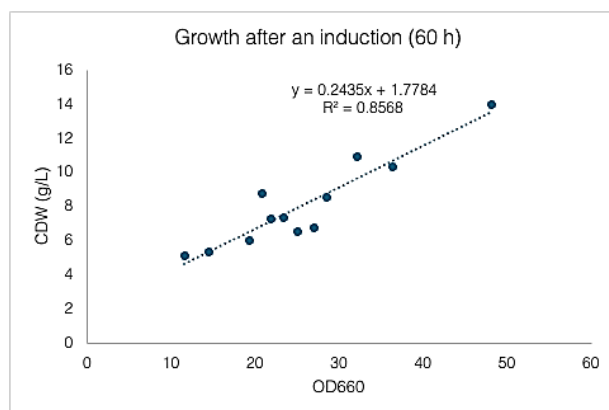


Figure 3 Relationship between CDW (g/L) and OD₆₆₀.

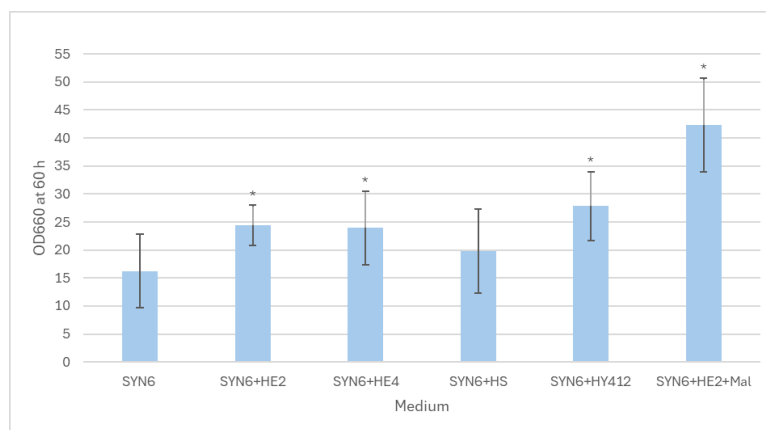


Figure 4 Growth (OD₆₆₀) of recombinant *H. polymorpha* HPV31 in SYN6 supplemented with different non-animal derived nitrogen sources. Asterisk (*) above the bar indicates a statistically significant difference between the specified medium and the control (SYN6) at $\alpha = 0.05$.

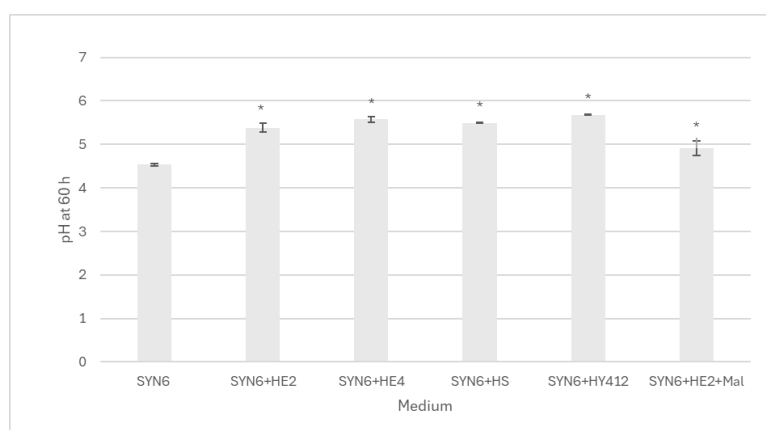
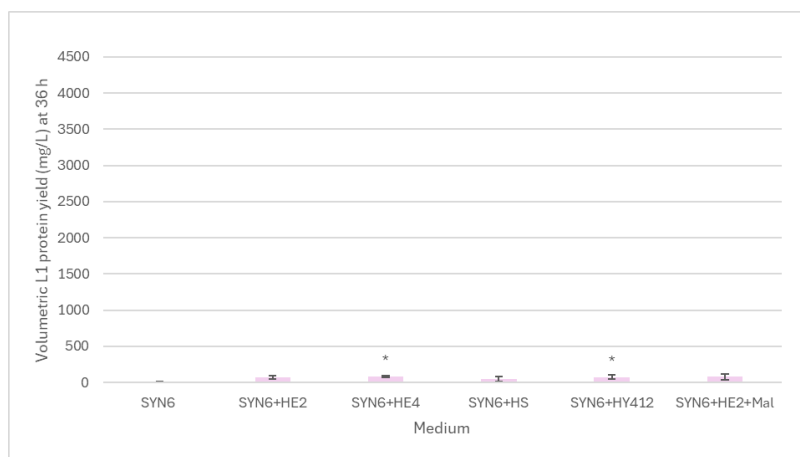


Figure 5 The pH of the recombinant *H. polymorpha* HPV31 culture when using SYN6 supplemented with different non-animal derived nitrogen sources. Asterisk (*) above the bar indicates a statistically significant difference between the specified medium and the control (SYN6) at $\alpha = 0.05$.

3. Effects of maltose and non-animal derived nitrogen source supplementation on production of recombinant L1 protein in *H. polymorpha* HPV31

Volumetric yield (g/L) of recombinant HPV 31 L1 protein was quantified by an indirect ELISA analysis. Before methanol induction, very low volumetric yield of L1 protein (less than 100 mg/L) was observed in all media tested (**Figure 6a**). Then, after 24 h of methanol induction (at 60 h of cultivation), significantly higher volumetric yield of HPV31 L1 protein were observed, emphasizing the importance of methanol induction in recombinant protein production in *H. polymorpha*. Supplementation of HyExpressII and HySoy significantly enhanced production of HPV31 L1 protein. Despite a significant positive effect on growth, the presence of an additional carbon source in a form of maltose clearly exhibited a negative effect on recombinant protein production. High growth rates can deplete cells of essential amino acids, thereby affecting recombinant protein production (Zhang et al., 2022).

a) Before a methanol induction (at 36 h of cultivation)



b) After a methanol induction (at 60 h of cultivation)

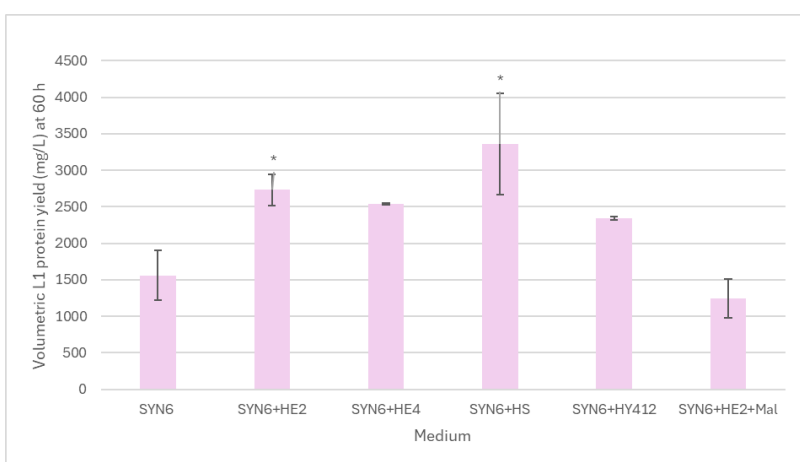
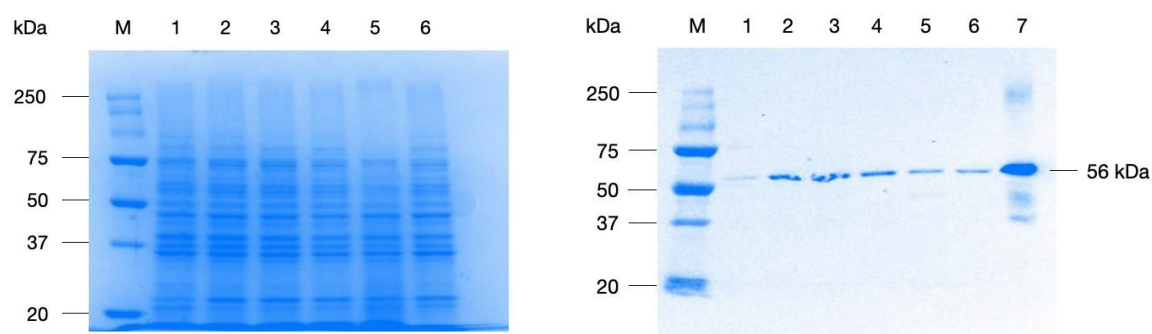


Figure 6 Volumetric yield of HPV31 L1 protein produced by recombinant *H. polymorpha* HPV31 cultivated in SYN6 supplemented with different non-animal derived nitrogen source. Asterisk (*) above the bar indicates a statistically significant difference between the specified medium with the control (SYN6) at $\alpha = 0.05$.

Results from Western blot analysis revealed that HPV31 L1 protein (56 kDa) was produced even before a methanol induction (**Figure 7a**) and a significantly higher L1 protein production was observed after 24 h of methanol induction (**Figure 7b**), supporting the results observed from an indirect ELISA assay (**Figure 6**).

Before a methanol induction (at 36 h of cultivation)



a) After a methanol induction (at 60 h of cultivation)

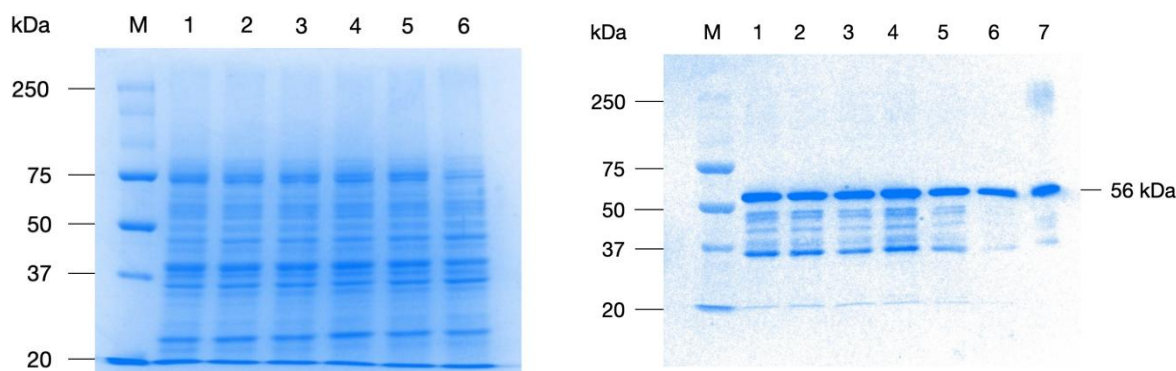


Figure 7 Western blot analysis of HPV31 L1 protein produced by recombinant *H. polymorpha* HPV31 cultivated in SYN6 supplemented with different non-animal derived nitrogen source. A 10 µg of protein was loaded on SDS-PAGE staining with Coomassie Brilliant blue (left panel) and detected by Western blot using HPV 16 (CAMVIR-1) antibody and anti-mouse IgG conjugated alkaline phosphatase as a primary and secondary antibody (right panel). Lane M: Precision Plus Protein All blue Standards Marker (Bio-Rad); Lane 1-6: cell-free extract of recombinant *H. polymorpha* HPV31 cultivated in SYN6, SYN6+HEII, SYN6+HEIV, SYN6+HySoy, SYN6+HyYest412, SYN6+HE II+Maltose, respectively. Lane 7: Positive control (a purified HPV16 L1 protein, CAMVIR-1).

Discussion

In this study, the effects of different non-animal derived nitrogen sources on growth and production of recombinant HPV31 L1 protein were evaluated. The results showed that supplementation of complex nitrogen sources (except HySoy) improved the growth of *H. polymorpha* HPV31. Additionally, the complex nitrogen sources helped stabilize pH of the culture, possibly as a result of the buffering capacity offered by peptone (Atilola et al., 2015). Among the nitrogen sources evaluated, HyExpressII and HySoy gave a significantly higher

volumetric yield of L1 protein. Peptone contains inherent catabolites which can be immediately metabolized, allowing the cells to conserve their energy in synthesizing these molecules and use available resources for recombinant protein synthesis (Kensy et al., 2009). Although the presence of an additional carbon source in a form of maltose enhanced the growth significantly, a significantly lower volumetric L1 protein yield was observed. Depletion of necessary amino acids or catabolites was suspected as a cause. In the future, this hypothesis can be verified via a fed-batch cultivation in which peptone is continuously supplied or supplemented at a higher concentration. Overall, the exceptional volumetric yield achieved in this study (3.36 g/L) validates the effectiveness of the developed cultivation medium for further scale-up.

Conclusion

To promote growth and expression of HPV31 L1 protein, SYN6 was supplemented with various non-animal derived nitrogen sources and carbon source (i.e., maltose). Supplementation of nitrogen caused a significant change in biomass density and pH of the media. Except for HySoy, all nitrogen sources evaluated enhanced growth of recombinant *H. polymorpha* HPV31. SYN6 supplemented with HyExpressII and HySoy gave a significantly higher volumetric yield. Addition of maltose enhanced the growth significantly but resulted in lower volumetric L1 protein yield. In summary, SYN6 supplemented with HyExpressII or HySoy will be evaluated further in a batch- and fed-batch bioreactor-scale cultivation. In the future, this research will directly impact the HPV vaccine provision policy in Thailand. It will affect the purchasing price and enhance the distribution of vaccines in Thailand.

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222258

Development of Model for Opisthorchiasis Prevention with Community Participation in Banphaeng Subdistrict, Banphaeng District, Nakhon Phanom Province

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Abstract

This action research aimed to develop and evaluate development of model for opisthorchiasis prevention with community participation in Banphaeng subdistrict, Banphaeng district, Nakhon Phanom province. The research was conducted from 2023, October to 2024, September. The target groups were 2 groups: 1) model development group, consisting of 2 staff members of Banphaeng hospital, community leaders of Banphaeng subdistrict, including 1 monk, 4 village headmen, 1 mayor, 2 municipal council members, 3 teachers, and 5 public health volunteers, totaling 18 people. 2) Research participants group: 200 family health leaders aged 40 and over, were found to be at risk of opisthorchiasis, using a verbal screening. The research participants were selected by purposive sampling. The research process consists of 3 stages. The research instruments were a knowledge test, participation questionnaire, and opisthorchiasis prevention behavior questionnaire. The data were analyzed using frequency, percentage, mean, standard deviation, and t-test (paired sample). The results of the research found that:

1. Context analysis results, some people still preferred to eat food cooked from uncooked or half-cooked fish.

2. The developed model consists of, 1) Village health volunteers screening family health leaders aged 40 years and over. 2) examined feces for parasite eggs, if liver fluke eggs were found, treat everyone. 3) Studied prevention of opisthorchiasis, behavior change training, and making civil society not eat uncooked fish.

3. The average knowledge score to prevention opisthorchiasis, average participation scores, average behavior score to prevention opisthorchiasis, after model development were higher than before model development, statistically significant ($p < .05$), all variables.

Keywords: Model Development, opisthorchiasis, Community Participation

Introduction

Opisthorchis viverrine (Liver Fluke) is a parasitic worm that is of significant public health concern in Thailand. The World Health Organization has classified liver fluke infection and cholangiocarcinoma (bile duct cancer) as major public health issues. Liver fluke infection is recognized as the primary cause of cholangiocarcinoma. In 2009, the nationwide prevalence

of liver fluke infection was 8.7%, with the highest prevalence in the northeastern region at 16.6%. This increase in liver fluke infection correlates with higher rates of cholangiocarcinoma and liver cancer in the affected areas (Department of Disease Control, 2009).

In 2012, deaths from cholangiocarcinoma and liver cancer reached 14,000 cases, with new cases continually rising. Of these, 63% were cholangiocarcinoma, and 18% were liver cancer. The most affected age group was 40–60 years. The increase in liver fluke infections in northeastern Thailand has been linked to the rise in cholangiocarcinoma and liver cancer in areas with the highest infection rates. The top five provinces with the highest incidence rates per 100,000 population are Sakon Nakhon (15.38), Khon Kaen (4.60), Mukdahan (0.30), Sa Kaeo (0.18), and Nakhon Phanom (0.14). Residents in northeastern Thailand suffering from liver fluke infections face an average of 7.6 daily deaths from liver cancer and cholangiocarcinoma (Pornchira Chooson, 2023). To address this issue, the Ministry of Public Health established a plan to control parasitic worm infections, aiming to reduce liver fluke and hookworm infections in all areas to less than 5% by 2017 (Ministry of Public Health and Collaborative Network, 2016).

The situation of liver fluke infection in Health Region 8, based on the 2023 summary report of the project to modify behaviors of at-risk groups for liver fluke and cholangiocarcinoma in Health Region 8, reveals concerning data. Screening for liver fluke using the OV-RDT method across seven provinces with 13,955 participants identified 3,190 positive cases, accounting for 22.86%. In Nakhon Phanom Province, 2,818 individuals were screened, with 645 testing positive (22.89%), ranking it third highest among provinces in Health Region 8 (Health Region 8 Office, 2023). This prevalence significantly exceeds the threshold set by the Ministry of Public Health. Additionally, liver cancer and cholangiocarcinoma were the leading causes of death in Nakhon Phanom from 2017 to 2019, with mortality rates of 65.33, 69.00, and 61.11 per 100,000 population, respectively. In Banphaeng District 2022, data from Banphaeng Hospital showed that among 530 individuals aged 40 years and older tested for liver fluke eggs, 116 (21.89%) were positive. In 2023, three cases of cholangiocarcinoma were reported in the district, with two fatalities (Banphaeng District Public Health Office, 2023).

The primary causes of liver and bile duct cancer are the consumption of nitrosamines accumulated from fermented foods such as pla som (fermented fish) and pla ra (fermented fish paste), or eating dishes made with raw or undercooked freshwater cyprinid fish, which may be contaminated with liver fluke larvae. Prolonged accumulation of liver flukes leads to inflammation of the bile ducts, which can eventually develop into cholangiocarcinoma (bile duct cancer).

Screening for liver fluke infection to detect early-stage infections and promoting awareness to encourage behavioral changes for disease prevention are the main strategies to address this issue. Banphaeng District has implemented the strategy "Reduce Liver Fluke, Eliminate Bile Duct Cancer," supporting participatory development across all levels individual, family, community, and society. This approach incorporates community participation, enabling residents to take ownership of the problem, collaboratively analyze solutions, and develop effective liver fluke prevention methods. Efforts to educate the public and promote accurate understanding aim to encourage appropriate and healthy behaviors, effectively reducing liver fluke infections while aligning with the community's specific context.

1. Research Objectives

1. To develop a community-based model for preventing liver fluke disease in Banphaeng subdistrict, Banphaeng District, Nakhon Phanom province.

2. To evaluate the effectiveness of the community-based model for preventing liver fluke disease in Banphaeng subdistrict, Banphaeng District, Nakhon Phanom province.

2. Review of Related Literatures

2.1 Liver Fluke Disease

2.1.1 Causes of Liver Fluke Disease

Liver fluke disease is caused by the liver fluke *Opisthorchis viverrini*. This parasite has a flat, elongated body resembling an acacia leaf, measuring 5–10 mm in length and 2–3 mm in width, with a rounded posterior end. The body is translucent with a flesh-like color. The oral sucker is located near the anterior tip, while the pharynx is small, and the esophagus is short. The intestines branch into two long lateral trunks extending to the posterior end. *O. viverrini* is hermaphroditic, with the openings of the female and male reproductive organs positioned close together. Extensive research studies have confirmed that liver flukes are the primary cause of cholangiocarcinoma (bile duct cancer).

2.1.2 Life Cycle of the Liver Fluke

Adult *O. viverrini* flukes reside in the bile ducts of definitive hosts, including humans, dogs, and cats, and may also inhabit the gallbladder or pancreas. Their eggs are excreted with bile into the small intestine and eventually expelled in feces. If the eggs reach freshwater sources, they are ingested by freshwater snails of the genus *Bithynia*, the first intermediate host. Inside the snails, the eggs hatch into miracidia, which develop into cercariae. The cercariae leave the snails and encyst in freshwater fish, the second intermediate host, such as *Cyclocheilichthys repasson* (*pla ta pien*), *Hampala dispar* (*pla soi nok kao*), *Thynnichthys thynnoides* (*pla suth*), and *Barbonymus gonionotus* (*pla ka mung*). Within the fish, the flukes develop into the infective stage, metacercariae, which are encased in cysts. Humans and animals who consume raw or undercooked fish containing metacercariae, such as in dishes like *koi pla* (a raw fish salad), ingest the fluke larvae. Once in the duodenum, the metacercariae excyst and migrate into the large bile ducts, progressing into the smaller ducts, where they mature into adult flukes. The period from ingestion of the infective larvae to the detection of eggs in feces is approximately 4–8 weeks (Wykoff et al., 1965).

2.2 Action Research

Action research (Kemmis & McTaggart, 1988) involves the following steps:

2.2.1 Planning

Planning involves setting a course of action in advance based on predictions of potential outcomes resulting from implementing the plan. This also considers past events or issues related to the topic being studied.

2.2.2 Action

Action refers to carrying out the planned activities carefully and ensuring the work proceeds according to the set plan. The plan, however, may change depending on conditions and limitations of the situation.

2.2.3 Observation

Observation involves collecting data on the processes and outcomes of the implementation. It also includes monitoring supporting factors, obstacles, and issues that arise during the execution of the plan. Proper observation requires prior planning.

2.2.4 Reflection

Reflection provides critical feedback on the actions taken based on observed data. It includes analyzing the processes, outcomes, supporting and obstructing factors, and issues encountered during the development to determine whether the objectives were met.

2.3 Related Research

The following studies are relevant to this research:

2.3.1 Bovornpipat Krasasena and Chulaporn Sota (2019) studied the development of a liver fluke prevention model in Chanuman subdistrict, Chanuman district, Amnat Charoen Province.

2.3.2 Worakorn Wichaiyo (2020) examined the development of a model community for liver fluke prevention in Kalasin Province.

2.3.3 Kittiya Kumchan, Nopparat Songsom, and Patraporn Charoenbut (2021) analyzed the effects of a community participation program to prevent bile duct cancer in Rasi Salai district, Sisaket Province.

2.3.4 Ornicha Chotikawanichkul, Panarat Pensuk, Sasirat Nachairitwong, and Benjamas Unrat (2021) explored health literacy and preventive behaviors against liver fluke disease among high school students in schools under the Secondary Education Service Area Office, Health Zone 9.

2.3.5 Akkhopol Sriakkaprom (2023) developed a community-based liver fluke prevention model in Pak Chom district, Loei Province.

Research Methodology

1. The research procedure includes

This study is action research conducted in Banphaeng subdistrict, Banphaeng district, Nakhon Phanom province. The research procedure consists of three phases as follows:

Phase 1: Analyze the situation and review related research studies, analyzing the situation and context of the area by: 1) Reviewing documents and research related to liver fluke disease. 2) Analyzing morbidity/mortality rates over the past five years to observe trends in liver fluke disease and community context. 3) Conducting meetings with research participants to review the previous model, brainstorm ideas, and plan a new model for liver fluke disease prevention

Phase 2: Develop a liver fluke disease prevention model through community participation in Banphaeng subdistrict, Banphaeng district, Nakhon Phanom province. This phase consists of four steps: 1) Planning 2) Action 3) Observation 4) Reflection

Phase 3: Evaluate the development of the liver fluke disease prevention model through community participation in Banphaeng subdistrict, Banphaeng district, Nakhon Phanom province.

1.1 Process Evaluation

1.1.1 Analysis of the situation regarding liver fluke disease prevention in Banphaeng subdistrict, Banphaeng district, Nakhon Phanom province

1.1.2 Results of the development of a liver fluke disease prevention model through community participation.

1.2 Outcome Evaluation

1.2.1 Assessment of knowledge about liver fluke disease prevention among research participants.

1.2.2 Assessment of participation in liver fluke disease prevention among research participants.

1.2.3 Assessment of behavior in liver fluke disease prevention among research participants.

2. Research Instruments

1. CCA-01 Risk Screening Form (CASCAP), Khon Kaen University (Khon Kaen University, 2023).
2. The tools used for data collection consist of four parts as follows:
 - Part 1: General information, including gender, age, marital status, education, and primary occupation (5 items).
 - Part 2: Liver fluke disease knowledge test, developed by the researcher. This section consists of 15 multiple-choice questions with a total score of 15 points.
 - Part 3: Questionnaire on participation in liver fluke disease prevention, developed by the researcher. This section uses a 4-point rating scale with 20 items.
 - Part 4: Questionnaire on behavior related to liver fluke disease prevention, developed by the researcher. This section uses a 4-point rating scale with 12 items.

3. Target Group

1. The group involved in developing the model consisted of 18 members, including two staff members from Banphaeng Hospital, key community leaders from Banphaeng subdistrict (one monk, four village heads, one municipal mayor, two municipal council members, three teachers, and five village health volunteers). They were selected using purposive sampling.
2. The research participants were family health leaders aged 40 years and older who were identified as at risk through verbal screening for liver fluke disease. A total of 200 participants were selected using purposive sampling and voluntarily participated in the project.

4. Statistics for Data Analysis

1. Qualitative data were analyzed using content analysis.
2. Levels of knowledge, participation, and behavior in preventing liver fluke disease were analyzed using frequency distribution, percentage, mean, and standard deviation.
3. The differences in the mean scores of knowledges about liver fluke disease, participation in prevention, and preventive behaviors before and after the development of the participatory prevention model were compared using paired sample t-test statistics.

Results

1. Process Results

1.1 Context Analysis Results

The geographical context of Banphaeng subdistrict is a lowland area along the Mekong River, with Nong Krue Khaw Canal running parallel to the villages. A village meeting revealed that some residents still consume raw or undercooked fish. The community addressed this issue by campaigning for health education, putting up banners discouraging the consumption of raw fish, and setting examples through government officials who refrained from eating raw fish. Community shops displayed signs reading "This shop sells boiled fermented fish and delicious som tam" at 12 locations. In addition, three primary schools included lessons on liver fluke disease prevention.

1.2 Development of the Liver Fluke Disease Prevention Model

Opinions were gathered from research participants and village health volunteers (VHVs) in the area to jointly develop a screening model called the "Banphaeng Model," consisting of three steps:

1.2.1 VHVs screened family health leaders aged 40 years and older using two questions: (1) Have you ever eaten raw or undercooked freshwater fish with scales, or raw fermented fish? (2) Have you ever had a stool test that detected liver fluke eggs? If the answer

to either question was "yes," the individual was considered at risk and included in the "Banphaeng Model."

1.2.2 Stool tests were conducted to detect liver fluke eggs. Those found to have liver fluke eggs were treated.

1.2.3 Preventive behavior studies were conducted, including training to change behaviors and agreements to abstain from eating raw fish.

1.3 Results of Implementing the "Banphaeng Model" for Liver fluke disease prevention

Family health leaders aged 40 years and older underwent stool testing, with 200 participants screened. Those who tested positive for liver fluke eggs were treated and received training to modify their behaviors for liver fluke disease prevention.

2. Outcome Results

2.1 Levels of knowledge about liver fluke disease, participation in disease prevention, and behaviors for preventing liver fluke disease before and after the development of the prevention model.

Table 1 Levels of Knowledge and Behaviors for Preventing Liver Fluke Disease Before and After the Development of the Model (n = 200)

Variable	Before the Development of the Model			After the Development of the Model		
	\bar{X}	S.D.	Level	\bar{X}	S.D.	Level
1. Knowledge about Liver Fluke Disease	10.30	1.06	Moderate	12.87	1.41	High
2. Participation in Disease Prevention	2.25	0.39	Moderate	3.28	0.23	High
3. Disease Prevention Behaviors	1.39	0.49	Moderate	2.75	0.30	High

From Table 1, prior to the model development, knowledge about Liver Fluke Disease among family health leaders was at a moderate level ($\bar{x} = 10.30$, S.D. = 1.06), Participation in Disease Prevention was at a moderate level ($\bar{x} = 2.25$, S.D. = 0.39) and Disease Prevention Behaviors were also at a moderate level ($\bar{x} = 1.39$, S.D. = 0.49). After the model development, knowledge about Liver Fluke Disease increased to a high level ($\bar{x} = 12.87$, S.D. = 1.41), Participation in Disease Prevention improved to a high level ($\bar{x} = 3.28$, S.D. = 0.23) and Disease Prevention Behaviors also advanced to a high level ($\bar{x} = 2.75$, S.D. = 0.30).

2.2 Results of comparing the mean scores of knowledge about liver fluke disease, participation in disease prevention, and disease prevention behaviors before and after the model development.

Table 2 Results of comparing knowledge, awareness, and prevention behaviors of liver fluke disease (N=200).

Variable	Before the Development of the Model		After the Development of the Model		t
	\bar{x}	S.D.	\bar{x}	S.D.	
1. Knowledge about Liver Fluke Disease	10.30	1.06	12.87	1.41	14.47*
2. Participation in Disease Prevention	2.25	0.39	3.28	0.23	12.48*
3. Disease Prevention Behaviors	1.39	0.49	2.75	0.30	13.70*

* Significant at the 0.05 level.

From Table 2, it was found that after the development of the model, the sample group had higher average scores for knowledge about liver fluke disease, participation in disease prevention, and prevention behaviors of liver fluke disease compared to the scores before the development of the model, with statistical significance ($p < 0.05$) for all variables.

Discussion

1. Process Results

The context analysis revealed that the geography of Banphaeng subdistrict is a flat area next to the Mekong River, with a long stream of Nong Khrue Kao running parallel to the villages. Through a village forum, it was found that some people still preferred to eat dishes made from raw or undercooked fish. The community addressed this issue by campaigning for health education, posting signs to prohibit the consumption of raw fish, and having government officials set an example by not eating raw fish. Additionally, 12 shops in the community displayed signs saying “This shop serves boiled fish and spicy papaya salad.” Three primary schools in the area taught about liver fluke disease prevention (Banphaeng Hospital, 2023). A liver fluke disease prevention model was developed by gathering input from the group involved in the development process. The model, called the “Banphaeng Model,” consists of three steps: 1) Community health volunteers (CHVs) screen family health leaders aged 40 and above with two questions: (1) Have you ever eaten raw freshwater fish or fermented fish? (2) Have you ever tested stool samples and found liver fluke eggs? If either condition is met, the person is considered at risk and is enrolled in the “Banphaeng Model.” 2) Stool tests are conducted to check for liver fluke eggs, and anyone testing positive is treated. 3) Liver fluke disease prevention behaviors are studied, behavioral changes are trained, and an agreement is made not to eat raw fish.

The development of the model began with a community analysis involving the community members such as the CHVs, who are trusted in the community for health care. This involvement allowed at-risk health leaders to access comprehensive and appropriate services, including stool tests for liver fluke eggs and treatment. This aligns with the research by Bawornpipat Kasetsen and Chulaphon Sotha (2009).

2. Outcome Results

The results of the liver fluke disease prevention through community participation in Banphaeng subdistrict, Banphaeng district, Nakhon Phanom province showed that, based on the comparison of knowledge about liver fluke disease, participation in disease prevention, and liver fluke disease prevention behaviors before and after the development of the model, it was found that before the development of the model, the community health leaders had moderate

knowledge of liver fluke disease ($\bar{x} = 10.30$, S.D. = 1.06), moderate participation in disease prevention ($\bar{x} = 2.25$, S.D. = 0.39), and moderate liver fluke disease prevention behaviors ($\bar{x} = 1.39$, S.D. = 0.49). After the model development, the knowledge of liver fluke disease was at a high level ($\bar{x} = 12.87$, S.D. = 1.41), participation in disease prevention was at a high level ($\bar{x} = 3.28$, S.D. = 0.23), and liver fluke disease prevention behaviors were at a high level ($\bar{x} = 2.75$, S.D. = 0.30). This shows that after the model development, the sample group had high knowledge about liver fluke disease, high participation in disease prevention, and high liver fluke disease prevention behaviors. These results align with the research by Kittiya Kamchan, Nopparat Songserm, and Phattaraporn Charoenbut (2021).

The results of the comparison of the average scores for knowledge about liver fluke disease, participation in disease prevention, and liver fluke disease prevention behaviors before and after the development of the model showed that after the model development, the sample group had higher average scores for knowledge about liver fluke disease, participation in disease prevention, and liver fluke disease prevention behaviors than before the model development, with statistically significant differences ($p < 0.01$ for all variables). After the development of the model, community health leaders had higher average scores for knowledge about liver fluke disease, participation in disease prevention, and liver fluke disease prevention behaviors compared to before the model development. This was due to the fact that after the model development, there were more diverse methods of delivering knowledge and communication, as well as a closer follow-up on behaviors by the community, leading to greater awareness and self-behavioral adjustment among the community health leaders. This is in line with the study by Suwat Siri Kaenwai (2015).

Conclusion

In summary, the developed model is suitable for the context of liver fluke disease prevention. The findings of this research can be expanded to areas with high-risk groups for liver fluke disease to reach a broader population.

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Effects of Sexual Health Media Literacy Development Program on the Prevention of Premature Sex and AIDS in Lower Secondary School Students, Banphaeng District, Nakhon Phanom Province

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Abstract

This research aimed to study and compare the effects of the sexual media literacy development program on the prevention of premature sex and AIDS in lower secondary school students, Banphaeng district, Nakhon Phanom province, before and after receiving the program. The research conducted from November 2023 to March 2024. The research method was quasi-experimental (one-group pretest and posttest design), with a sample of 34 lower secondary school students using a multi-stage random sampling, calculated the sample size by the G*Power program. The research instruments included the sexual media literacy development program and a questionnaire. The statistics used for data analysis were frequency, percentage, mean, standard deviation, and paired sample t-tests. The results indicated that:

1. The mean score of knowledge about AIDS of the sample group, after receiving the program was higher than before receiving the program, statistically significant at the 0.01 level ($t=14.88$, $p=0.00$).

2. The mean score of attitudes toward avoiding premature sex of the sample group, after receiving the program was higher than before receiving the program, statistically significant at the 0.01 level ($t=10.56$, $p=0.00$).

3. The mean score of self-efficacy in refusing premature sex of the sample group, after receiving the program was higher than before receiving the program, statistically significant at the 0.01 level ($t=6.67$, $p=0.00$).

4. The mean score of ease of communicating about sex with parents of the sample group, after receiving the program was higher than before receiving the program, statistically significant at the 0.01 level ($t=5.77$, $p=0.00$).

5. The mean score of intention to premature sexual intercourse of the sample group, after receiving the program was higher than before receiving the program, statistically significant at the 0.01 level ($t=10.83$, $p=0.00$).

This suggests that, the developed program improved understanding and knowledge of sexual health media literacy to prevent premature sexual activity and HIV/AIDS among lower secondary school students in the target area. Therefore, the program should be expanded and applied to other areas.

Keywords: Sexual Health Media Literacy, Prevention of Premature Sex, AIDS

Introduction

The problem of premature sex among adolescents is becoming more severe and complex, posing significant challenges to both individual well-being and public health. Premature sex has a direct impact on adolescents, families, society, and the country, with the main consequences being unwanted pregnancies, sexually transmitted diseases (STDs), and AIDS. According to the 2022 report on behavioral surveillance of HIV infection among students in Thailand, Thai adolescents are engaging in sexual activity at an earlier age, with the mean age of first sexual intercourse being 13 years old. Surveillance of sexually transmitted infections (STIs) over a 10-year period from 2009 to October 2019, revealed that the rate of STIs among youth aged 15–24 years had doubled, increasing from 41.6 per 100,000 population in 2007 to 169.12 per 100,000 population in 2018 (Department of Disease Control, 2024). In addition, the adolescent birth rate aged 10–14 years in Thailand was 6.8%, 6.1%, and 5.8% in 2020, 2021, and 2022, respectively (Ministry of Public Health, 2024).

Nakhon Phanom Province, a university town and tourist destination, has experienced rapid economic and social growth. From 2020 to 2023, teenage pregnancies under 15 were recorded as 14, 27, 16, and 33, respectively (Nakhon Phanom Provincial Public Health Office, 2023). In Banphaeng District, had 7 secondary schools, and opportunity expansion schools, with 1,874 lower secondary school students. The statistics of teenage pregnancies in the same period were 4, 7, 10, and 11, respectively. From the results of syphilis and HIV screening among youth aged 13–24 years in Banphaeng district, conducted between August 2023 to December 2023, using the HIV/Syphilis combo rapid test on 1,00 individuals, no cases of syphilis infection were detected, but 2 cases of HIV infection were identified, accounting for 2.00% (Banphaeng Hospital, 2024). These figures highlight the challenges and significant impacts of premature sexual behaviors among adolescents in Banphaeng district, Nakhon Phanom province, which requires immediate attention.

Health Literacy (HL) refers to intellectual and social skills that foster motivation and competence to access, understand, and use health information and services to maintain and promote well-being. It emphasizes empowering individuals to take control of their healthy lifestyle choices (World Health Organization [WHO], 2021). Health literacy affects motivation or intention to determine health behaviors that affect the implementation of that health behavior (Wagner, et al., 2009). which is the basis for making decisions about appropriate health behaviors, leading to the implementation and management of one's health both in normal conditions and during illness.

Likewise, media plays an important role in adolescents' lives as they spend over seven hours per day using online media via smartphones excluding school-related use. Sexual and romantic content is prevalent in the media. Media may serve as sex educators for adolescents; however, the messages often idealize risky sexual behaviors and unhealthy relationships while neglecting sexual health behaviors and open communication. Researchers have proposed several comprehensive programs to understand the paths in which sexual media influences adolescents' health and to provide essential sexual health education programs with medically accurate information about teen birth rates, the prevalence of sexually transmitted infection (STI), and effective sexual health communication (Scull, et al., 2021). Research on health literacy and risk behaviors highlights that health media literacy plays an important role in adolescents' lives. The development of media literacy has a positive effect on adolescents' attitudes and intentions toward drug use, smoking, and sexual risk behaviors. Media literacy skills are related to changes in attitudes and intentions to act in adolescent behaviors. Sexual media literacy positively impacts sexual health decisions by enhancing self-efficacy awareness and intentions to prevent pregnancy during sex activity (Vahedi, Sibalis, & Sutherland, 2018).

A literature review within the Thai context reveals limited studies on the development of media literacy in rural communities. According to a national survey found that 95.5 % of Thai female adolescents aged 15-21 years lack adequate sexual health knowledge, which is the main factor contributing to risk behaviors and premature pregnancy (Department of Mental Health, 2019). Consequently, the study aims to examine the effectiveness of the sexual health literacy development program in reducing risky sexual behaviors and preventing AIDS infection among lower secondary school students. These students, at the onset of adolescence, often experience curiosity and experimentation. Enhancing adolescents' media literacy regarding sexual health and disease prevention could play a vital role in mitigating risky behaviors and appropriately addressing the issue of HIV/AIDS in this demographic.

1. Research objectives

1.1 To study the effects of the sexual media literacy development program on the prevention of premature sex and AIDS in lower secondary school students, Banphaeng district, Nakhon Phanom province.

1.2 To compare knowledge about AIDS, attitudes toward avoiding premature sex, self-efficacy in refusing premature sex, ease of communicating about sex with parents, and intention to premature sexual intercourse, of the sample group, before and after receiving the sexual health media literacy development program.

2. Review of Related Literature

2.1 Health media literacy programs

The integration of media literacy into sexual health education enhances adolescents' self-efficacy, decision-making, and healthy behavior intentions (Vahedi, Sibalis, & Sutherland, 2018; Wagner et al., 2009; Scull et al., 2021). Effective interventions, such as the Thai Ministry of Public Health's V-shape model (2017), improve health literacy and reduce risks like pregnancy and STIs by developing cognitive, communication, and decision-making skills. Multimedia approaches further support engagement and real-life application, emphasizing the importance of investing in targeted media literacy programs for long-term health benefits, particularly among vulnerable groups.

2.2 Attitudes toward avoiding premature sex

Attitudes toward avoiding premature sex are influenced by personal values, family beliefs, cultural norms, and educational interventions. Comprehensive sexuality education is effective in encouraging adolescents to delay sexual activity and practice safer sex. Studies, such as Sulak et al. (2005), show that parental attitudes play a significant role in shaping adolescent sexual behaviors.

2.3 Self-efficacy in refusing premature sex

Self-efficacy in refusing premature sex refers to an individual's conscious recognition of their readiness and boundaries concerning sexual activity, enabling them to make informed decisions about delaying sexual involvement until they feel prepared. This self-awareness is crucial for adolescents, as early sexual initiation has been linked to various emotional and psychological consequences. For example, Punyanuch Salachua (2021) revealed that at the end of the immediate experiment and the four-week follow-up period, students who received the program had a statistically significant higher perception of their ability to refuse premarital sex than before ($p < .001$). Likewise, research underlines the importance of both peers and teachers in healthy sexual development among youths, especially girls, and emphasizes the need for targeted health and sexual education programs.

2.4 Ease of communicating about sex with parents

Ease of communicating about sex with parents involves open, supportive discussions that influence adolescents' sexual health decisions, including increased contraceptive use. Although mothers' involvement offers modest protective benefits, particularly for girls, discomfort and cultural taboos remain significant barriers. High-quality, open dialogue is essential for promoting healthier sexual behaviors.

2.5 Intention to premature sexual intercourse

The intention to premature sexual intercourse is shaped by personal, cultural, and social factors, including values, beliefs, and awareness of potential risks like STIs or pregnancy. It reflects a proactive commitment to delaying sexual involvement for reasons such as emotional readiness and health concerns. The study by Sulak et al. (2005) highlights the impact of educational programs in shifting attitudes and increasing knowledge about adolescent sexual activity. After attending these programs, adult participants showed significant improvements in their understanding and a stronger commitment to delaying sexual activity, with support for postponing it until after high school rising from 94% to 98%, and until marriage rising from 77% to 91.5%. This underscores the importance of education in influencing positive attitudes toward sexual delay.

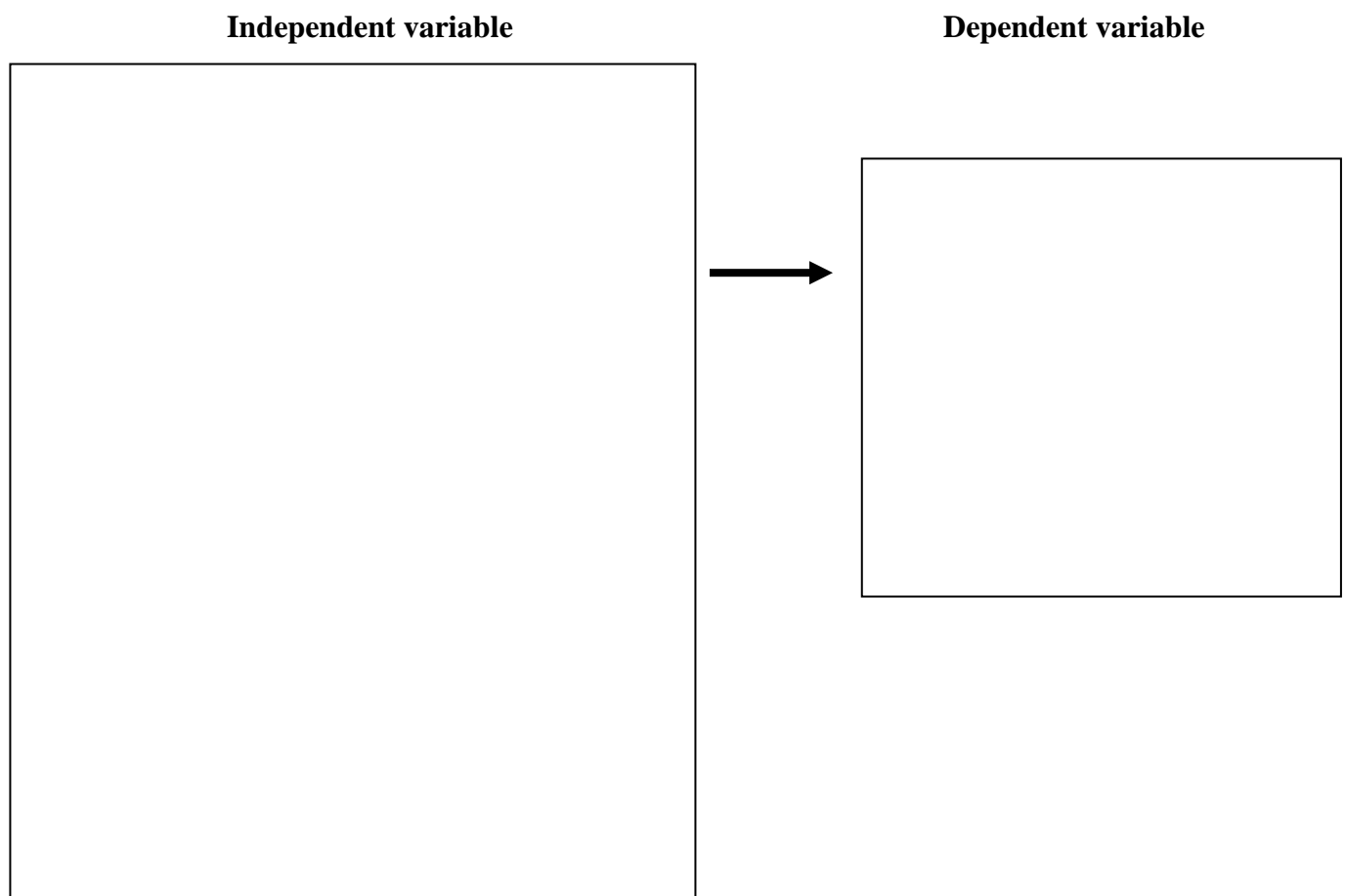


Figure 1 The conceptual framework for research

Research Methodology

The participating schools were randomized to the intervention group using quasi-experimental research with a one-group pretest and posttest design. The classroom teachers were asked to distribute the consent forms to students. The students were asked to review the forms with their parents and return the signed copies indicating their choice to participate or not. The experimental and data collection was conducted from November 2023 to March 2024. The SHML-AIDS prevention development program was organized for the experimental group six times, 40 minutes each, with six activities through lectures, video media, group discussions, demonstrations, and skills training. A conceptual framework for research on the effectiveness of the SHML-AIDS prevention development program aims to explore how enhancing students' sexual health knowledge and media literacy influences their attitudes, behaviors, and health outcomes. In this study, the independent variable is the sexual health literacy development program, which includes six skill-building activities on sexual health, risk prevention, and effective communication about sexual behavior. The dependent variables comprise knowledge about AIDS, attitudes toward avoiding premature sex, self-efficacy in refusing premature sex, ease of communicating about sex with parents, and intention to premature sexual intercourse among lower secondary school students.

1. Population and sample

1.1 The population in this study is 1,874 lower secondary school students, secondary schools, and opportunity expansion schools in Banphaeng district, Nakhon Phanom province, second semester of the academic year 2023.

1.2 The sample group in this study is lower secondary school students, Banphaeng Pittayakhom school, Banphaeng district, Nakhon Phanom province, in the second semester of the academic year 2023, using a multi-stage random sampling method. The sample size was determined using the G * Power program version 3.1.9.7 (Faul et al., 2007) to compare the difference in the mean of two values before and after the experiment. The sample group was 32 participants. However, to prevent the loss of the sample group during the experiment, the sample size was increased to 34 participants.

Inclusion and Exclusion Criteria

1) Inclusion Criteria (1) be a lower secondary school student with parental permission, able to participate in activities and answer questionnaires (2) have normal intellectual learning ability (3) willing to participate in this research study voluntarily. 2) Exclusion Criteria (1) participate in the sexual health media literacy development program, participation time less than 80% (2) transfer school during the research (3) Intend to withdraw from the research, can withdraw without notice.

2. Research instruments

The research instruments used were the sexual health media literacy development program (7 weeks) based on the V shape model with 6 components (Ministry of Public Health, 2017), consisting of 1) Access, using activities to lecture and practice skills in accessing sexual health information from reliable sources, such as information on sexually transmitted diseases and AIDS. 2) Cognitive, using activities to lecture on sexually transmitted diseases and AIDS, and practicing negotiation and refusal skills in risk situations. 3) Communication skill, using activities to practice skills in communicating sexual health information and persuading others to understand and accept the information. 4) Decision skill, using activities to develop decision-making skills through rational analysis. 5) Self-management, using activities to practice goal setting and behavioral planning, and asking, answering, and expressing opinions on events. 6)

Sharing, using activities to lecture on sharing sexual health information and sexually transmitted diseases, and practicing role-playing counseling. The data collection instrument included a set of questionnaires consisting of six sections: Section 1: General information; Section 2: AIDS knowledge test with 15 items; Section 3: Attitudes toward mature sexual intercourse, 10 items; Part 4: Self-efficacy questionnaire on refusing premature sexual intercourse, 4 items for females and 3 items for males; Part 5: Ease in communicating about sex with parents, 8 items; and Part 6: Intention to avoid premature sexual intercourse, 5 items. The quality of the research instruments can be described as follows:

2.1 The SHML-AIDS prevention development program, developed by the researcher, content validity was evaluated by 3 experts.

2.2 The 15-item AIDS knowledge test was developed by the researcher, content validity was evaluated by 3 experts with a content validity value of 0.67 - 1.00. The results of the try out at a secondary school in Na Thom District, including 30 participants, revealed that the item difficulty value ranged from 0.22 to 0.70, the item discrimination value was from 0.42 to 0.74, and the reliability value using the KR-21 formula of Kuder-Richardson was equal to 0.91.

2.3 The 10-item attitude questionnaire on premature sex, the 4-item self-efficacy questionnaire on refusing premarital sex for females, and 3-item self-efficacy questionnaire on communicating about sex with parents, the 8-item comfort questionnaire, and the 5-item intention to avoid premature sexual intercourse questionnaire were revised by the researcher. content validity was evaluated by 3 experts with a content validity value of 0.67 - 1.00. The results of the try out at a secondary school in Na Thom District, 30 people, obtained the discrimination power of each item as 0.28 - 0.88, 0.30 - 0.70, 0.32 - 0.78, 0.36 - 0.81, 0.29 - 0.79, respectively, and the reliability of the whole version using Cronbach's alpha coefficient formula as 0.86, 0.78, 0.81, 0.84, and 0.80, respectively.

3. Statistics for Data Analysis

General data of the sample group were analyzed using descriptive statistics by distributing frequency, maximum, minimum, percentage, mean, and standard deviation. Comparison of the difference in mean scores of AIDS knowledges, attitudes toward avoiding premature sexual intercourse, self-perception of ability to refuse premature sexual intercourse, ease of communicating about sex with parents, and intention to avoid premature sexual intercourse of the sample group before and after receiving the program using Paired sample t-test statistics.

Results

1. General information about the sample. Participants reported their gender, grade level, and leisure activities.

The result of General information about the sample, classifies gender, latest term GPA, and leisure activities of students showed that, the most sample group was female at 64.81%, with the latest term GPA from 2.50 to 2.99, with 58.82 %. The most leisure activities of students were browsing the internet/social media at 26.47 percent, followed by talking on the phone at 20.59 percent. As shown in table 1.

Table 1 Number and percentage of samples classified by gender, latest term GPA, and students' leisure activities (n = 34)

Item	Number (person)	Percentage
1. Gender		
1.1 Male	12	35.29
1.2 Female	22	64.71
2. Latest term GPA		
2.1 Below 2.50	1	2.94
2.2 2.50 – 2.99	20	58.82
2.3 3.00 and above	13	38.24
3. Students' leisure activities		
3.1 Browsing the internet/ social media	10	29.41
3.2 Talking on the phone	7	20.59
3.3 Helping with family work	5	14.71
3.4 Reading books, praying, meditating	5	14.71
3.5 Playing sports/ exercising	4	11.77
3.6 Playing computer games	3	8.82
(x̄ = 2.91, S.D.= .34, Max = 3.80, Min = 2.48)		

2. Comparison of all variables

2.1 Comprising a level of knowledge about AIDS, attitudes toward avoiding premature sex, perceived ability to refuse premature sex, ease of communicating about sex with parents, and intention to premature sexual intercourse of the sample group before and after receiving the program.

The mean score of AIDS knowledge in the sample group was at a moderate level before receiving the program ($\bar{x} = 10.24$) and increased to a high level after receiving the program ($\bar{x} = 13.03$). The mean score of attitudes toward avoiding premature sex of the sample group before receiving the program was positive at a moderate level ($\bar{x} = 2.82$), and at a high level after receiving the program ($\bar{x} = 3.95$). Self-efficacy in refusing premature sex of the sample group was moderate before the program ($\bar{x} = 3.01$) and increased to a high level after receiving the program ($\bar{x} = 4.07$). Comforting in communicating about sex with parents of the sample group before receiving the program was moderate ($\bar{x} = 2.49$) and increased to a high level following the program ($\bar{x} = 3.10$). Lastly, the intention to premature sexual intercourse before receiving the program was moderate ($\bar{x} = 2.63$) and significantly increased to a high level after receiving the program ($\bar{x} = 3.78$). As shown in table 2.

Table 2 Mean scores of knowledges about AIDS, positive attitudes toward avoiding premature sex, perceived ability to refuse premature sex, ease of communicating about sex with parents, and intention to premature sexual intercourse.

Variable	Before receiving program			After receiving program		
	\bar{x}	S.D.	Interpretation	\bar{x}	S.D.	Interpretation
1. Knowledge about AIDS	10.24	1.56	Medium	13.03	1.34	High
2. Attitude towards avoiding premature sex	2.82	.046	Medium	3.95	0.50	High
3. Self-efficacy in refusing premature sex	3.01	0.70	Medium	4.07	0.58	High
4. Ease of communicating about sex with parents	2.49	0.64	Medium	3.10	0.73	High
5. Intention to premature sexual intercourse	2.63	0.76	Medium	3.78	0.69	High

3. The comparison of the mean scores of knowledges about AIDS, attitudes toward avoiding having premarital sex, perceived ability to refuse having premarital sex, ease of communicating about sex with parents, and intention to premature sexual intercourse of the sample group before and after receiving the program.

The comparison results of the mean scores of knowledge about AIDS, attitudes toward avoiding premature sex, self-efficacy in refusing premature sex, ease of communicating about sex with parents, and intention to avoid premature sexual intercourse of the sample group before and after receiving the program found that after receiving the program, the sample group had a higher mean score than before receiving the program with statistical significance ($p < 0.01$) in all variables. As shown in table 3.

Table 3 The comparison of the mean scores of variables of the sample group before and after receiving the program

Variables	Before receiving program		After receiving program		t	p-value
	\bar{x}	S.D.	\bar{x}	S.D.		
1. Knowledge about AIDS	10.24	1.56	13.03	1.34	14.88	.00**
2. Attitude towards avoiding premature sex	2.82	.046	3.95	0.50	10.56	.00**
3. Self-efficacy in refusing premature sex	3.01	0.70	4.07	0.58	6.67	.00**
4. Ease of communicating about sex with parents	2.49	0.64	3.10	0.73	5.77	.00**
5. Intention to premature sexual intercourse	2.63	0.76	3.78	0.69	10.83	.00**

** Significant at the 0.01 level.

Discussion

1. The study found that lower secondary school students in Banphaeng District had a moderate level of knowledge about AIDS before participating in the SHML-AIDS prevention program. After the program, their knowledge significantly increased to a high level ($p < 0.01$). The program, based on the V-shape health literacy model (Ministry of Public Health, 2017),

developed students' skills through six 40-minute sessions emphasizing access, cognition, communication, decision-making, self-management, and sharing. Initially, students relied on unreliable sources, such as YouTube and Facebook, for health information. After engaging in systematic learning activities, their understanding of sexual health and AIDS improved significantly. These findings align with Chollada Anee et al. (2017), who found that increased health literacy across six key areas led to improved behaviors in sexual health promotion and prevention ($p < 0.05$), and was consistent with the study of Saowalak Tubsai (2024), who found that factors related to sexually transmitted disease risk behaviors of high school students in Thalang district Phuket province consists of the sexual knowledge ($P\text{-value} < 0.001$).

2. Before receiving the SHML-AIDS prevention program, students had a moderate attitude toward avoiding premature sexual intercourse ($\bar{x} = 2.82$, S.D. = 0.46). After the program, their attitude significantly improved ($\bar{x} = 3.95$, S.D. = 0.50) ($p < 0.01$). The positive change in attitudes resulted from learning through various activities based on the V-shape health literacy framework. Attitudes are shaped by knowledge (cognitive) and feelings (affective) (Webber, 2015), and can shift due to social values, environment, and exposure to sexual information through media (Pangarin Hoirattana & Pramot Wongswat, 2017; Therefore, providing accurate knowledge, fostering logical thinking, and developing positive attitudes are crucial in preventing premature sex and combating inappropriate sexual values in society and peer groups, and was consistent with the study of Punyanuch Salachua (2021), who found that, at the immediate conclusion of the experiment and at the 4-week follow-up, students who received the program had a mean score of positive attitudes toward avoiding premature sexual activity, significantly higher than the control group, ($F = 13.744$, $p < .001$).

3. Before receiving the SHML-AIDS prevention program, students had a moderate self-efficacy in refusing premature sex ($\bar{x} = 3.01$, S.D. = 0.70). After the program, their self-efficacy significantly increased ($\bar{x} = 4.07$, S.D. = 0.58) ($p < 0.01$). The program, based on the V-shape health literacy framework, involved various activities that enhanced students' ability to refuse sex and their intention to avoid it. These activities focused on both knowledge and practical application, including weekly assignments and gender dialogues. Role-playing and virtual simulations helped students engage actively, fostering critical thinking and self-efficacy. Bandura's (1977) theory suggests that training in real-life simulated situations helps students analyze, evaluate, and set safe life goals. This is consistent with the study of Punyanuch Salachua (2021), which found that, at the immediate conclusion of the experiment and at the 4-week follow-up, students who received the program had a mean score of sexual refusal self-efficacy, significantly higher than the control group, ($F = 16.463$, $p < .001$).

4. Before participating in the SHML-AIDS prevention program, students had a moderate level of ease of communicating about sex with parents ($\bar{x} = 2.49$, S.D. = 0.64). After the program, their ease of communicating level increased significantly ($\bar{x} = 3.10$, S.D. = 0.73) ($p < 0.01$). The program, based on the V-shape health literacy framework, helped increase students' comfort with discussing sex by engaging them in step-by-step activities. However, discussing topics like teenage pregnancy remains sensitive in Thai society, where sex communication is often viewed as taboo. Teens may feel embarrassed or misunderstood by their families, which can discourage open communication. This is consistent with the study of Scull et al. (2018), which found that, The students in the sample group demonstrated a statistically significant increase in their self-efficacy for communicating with their parents about sex, at the .01 level.

5. Intention to avoid premature sexual intercourse, before receiving the program, the sample group had mean score at a moderate level ($\bar{x} = 2.63$, S.D. = 0.76). After receiving the program, the mean score was at a high level ($\bar{x} = 3.78$, S.D. = 0.69). After receiving the

program, the sample group had mean score that was significantly higher than before receiving the program ($p < 0.01$). This is consistent with the study of Punyanuch Salachua (2021), which found that, at the immediate conclusion of the experiment and at the 4-week follow-up, students who received the program had a mean score of intention to sexual refusal, significantly higher than the control group, ($F = 19.441$, $p < .01$)

The experimental group of students participated in the SHML-AIDS prevention program, learning through step-by-step activities based on the V-shape health literacy framework, focusing on decision-making (Step 4), self-management (Step 5), and telling others (Step 6). These activities helped students develop confidence and decision-making skills by analyzing the pros and cons of actions. The program provided opportunities for practicing decision-making in simulated situations, such as deciding whether to engage in premarital sex, and selecting reliable sexual health information. Group activities and self-management exercises encouraged students to plan a safe lifestyle and avoid premature sex. The program led to an increased intention to premature sexual intercourse, supported by the theory of planned behavior, which suggests that intention is influenced by attitudes, reference group influences, and perceived behavioral control. The final step, sharing, allowed students to practice sharing sexual health information with peers and family members, reinforcing their ability to avoid risky behaviors. This aligns with Vahedi et al. (2018), who found that media literacy positively impacts attitudes and intentions toward health risk behaviors in adolescents.

Conclusion

The implementation of the six main components of the sexual health media literacy program is the ability of individuals to access, understand, and use information to promote and maintain good health. For literacy development to be successful, it is necessary to develop both aspects: knowledge and skills. The SHML-AIDS prevention development program resulted in the experimental group of students having higher mean scores on AIDS knowledge, positive attitudes toward avoiding early sex, self-efficacy perception, ease of communicating about sex with parents, and intentions to avoid early sex. The findings of this study suggest several key implications for SHML-AIDS prevention development programs aimed at adolescents. First, the success of the prevention development program highlights the importance of developing both knowledge and practical skills to enhance individuals' ability to access, understand, and apply information for promoting good health. The significant improvements in AIDS knowledge, attitudes toward avoiding early sex, self-efficacy, communication with parents, and intentions to delay sexual activity indicate that comprehensive, media-based educational interventions can be highly effective in shaping positive health behaviors among adolescents. These results support the growing body of literature that emphasizes the value of media literacy in reducing risky behaviors and fostering healthier decision-making. Therefore, integrating media literacy into sexual health education should be prioritized, particularly in programs targeting adolescents, to equip them with the necessary tools to make informed, responsible health choices.

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The Role of 14-3-3 Protein in Erythropoiesis: Insights into Erythropoietin-Mediated Signaling and Apoptosis Regulation

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Abstract

Erythropoiesis refers to the process of red blood cell production, originating from hematopoietic stem cells (HSCs) committed to the erythroid lineage. This process is tightly regulated and two critical factors essential for driving erythroid progenitors toward red blood cell formation are erythropoietin (Epo) and transferrin (holo-Tf). Both Epo and holo-Tf are required for erythroid survival, and their absence leads to the activation of apoptosis mechanism in erythroid progenitor. Ineffective erythropoiesis is associated with apoptosis during erythroid cell maturation. For instance, apoptosis is the major complication that observed in the hereditary blood disorder such as β -thalassemia which related to the dysregulation of anti-apoptotic proteins. Previous studies implicated the involvement of 14-3-3 protein in Epo-mediated signaling pathway that promotes erythroid survival. However, the precise mechanism of 14-3-3 protein and its connection to the cell survival remain unclear. Our result from western blot analysis demonstrated the inhibition of 14-3-3 protein function caused an increased phosphorylation activity of STAT-5, AKT, and ERK1/2 in Epo mediated signaling pathway. Further experiment in human primary erythroid cell with 14-3-3 protein inhibitor caused the reduced in cell viability and up-regulate the BAX/Bcl-2 apoptosis related pathway. Collectively, these findings revealed the essential role of 14-3-3 protein in erythropoiesis, highlighting its association in Epo-mediated signaling, together with anti-apoptosis mechanism.

Keywords: 14-3-3 protein, Apoptosis, Erythropoiesis, Red blood cell

Introduction

Red blood cells (RBCs) production, or erythropoiesis, is a tightly regulated process that occurs in the bone marrow. This process initiates from hematopoietic stem cells (HSCs) differentiates into erythroid committed progenitors to become the mature red blood cell. Erythropoiesis influenced by several key factors, including specific cytokine and microenvironment to ensure the survival of erythroid progenitor in each stage. At the molecular level, erythropoietin (Epo) and holo-transferrin (holo-Tf) are essential in erythroid differentiation and maturation (Richard & Verdier, 2020). The survival of erythroid progenitor depends on the availability of both elements since they can activate Janus kinase 2 (JAK2) which phosphorylates signal transducer and activator of transcription-5 (STAT5),

phosphatidylinositol-4,5-bisphosphate 3-kinase/protein kinase B (PI3K/AKT), and mitogen-activated protein kinase/extracellular signal-regulated kinase (MAPK/ERK) to promote cell survival (Tothova et al., 2021). Importantly, the Epo mediated signaling pathway control erythroid cell survival which promotes an anti-apoptotic factor, such as Bcl-xL (Sathyanarayana et al., 2008). All these factors enhance survival of erythroid progenitor by inhibiting apoptosis and induces terminal differentiation of these progenitors into mature red blood cell.

The 14-3-3 protein family, including various isoforms, plays critical roles in the regulation of erythropoiesis by interacting with signaling proteins and transcription factors essential for erythroid differentiation and maturation (Aghazadeh & Papadopoulos, 2016). Under physiological condition, 14-3-3 protein regulates cellular mechanism by modulating the activity of transcription factors, controlling nuclear localization, and ensuring appropriate gene expression of the targeted gene (Morrison, 2009). Previous research suggests the 14-3-3 protein tightly regulated cell stress response and apoptotic mechanism. 14-3-3 protein interact with pro-apoptotic proteins, BAD and FOXO proteins. Its function is to sequester the pro-apoptotic protein in cytoplasm to prevent the apoptotic targeted gene (Masters & Fu, 2001). Furthermore, as the various isoform of 14-3-3 protein, one study implies the specific zeta (ζ) isoform involved in the apoptotic mechanism in platelet production (Mason et al., 2007) by regulating mitochondrial function and phosphatidylserine exposure in thrombosis. While knowing the 14-3-3 protein involvement in maintaining erythropoiesis, it is important to study the relationship between 14-3-3 protein and apoptotic mechanism in erythroid cell. As the 14-3-3 protein's role in mitochondrial function and apoptotic mechanism is well characterized; however, the direct mechanism between Epo mediated signaling pathway and 14-3-3 protein remained unknown. This study aims to identify the role of 14-3-3 protein in the regulation of STAT5, AKT, and ERK1/2 pathways.

To study the molecular mechanism between 14-3-3 protein and erythroid survival pathway, UT-7/Epo erythroleukemic cell line were treated with suboptimal dose of Epo and physiological concentration of holo-Tf. The pharmacological inhibitor of 14-3-3 protein, trifluoroacetate (R18) was used to study the protein function, and the selective dose will be identified. The change in phosphorylation activity of STAT5, AKT, and ERK1/2 were analyzed using western blot analysis. Cell viability will be monitor by tryphan blue exclusion assay to observe the survival rate. The specific markers during each stage of human primary erythroid cell were detected using flow cytometry. Markers of erythroid cells, CD71 and CD235a, were observed among control and pharmacological group as the cells progress to maturation. By knowing the 14-3-3 protein's role in an apoptosis mechanism in erythroid cell, targeting this protein offers potential therapeutic strategies for enhancing erythropoiesis or preventing erythroid malignancies, such as erythroleukemia.

1. Research Objectives

- 1.1 To study the 14-3-3 protein function in the regulation of erythropoietin mediated signaling pathway in UT-7/Epo erythroleukemic cell line
- 1.2 To observe the change in erythroid maturation in human primary erythroid cell by using 14-3-3 protein pharmacological inhibitor
- 1.3 To investigate the apoptotic mechanism of the 14-3-3 protein inhibition in human primary erythroid cell

2. Review of Related Literatures

2.1 Erythropoiesis and Erythropoietin Signaling Transduction

Red blood cell production (erythropoiesis) is controlled by two major growth factors: stem cell factor (SCF) and erythropoietin (Epo). SCF plays role in a proliferation stage and Epo is important in differentiation through maturation stage of erythroid cell (Ginzburg & Rivella, 2011; Goldwasser et al., 1984). All type of blood cells originates from hematopoietic stem cells (HSCs). HSCs can develop into lymphoid progenitor cells (LPCs) and myeloid progenitor cells (MPCs). MPCs are the cell which capable of developing into red blood cell. Erythropoiesis starts with the hematopoietic stem cells in the bone marrow and undergo maturation into mature red blood cell, reticulocyte, that contains no nucleus. Then, the reticulocytes are released from the bone marrow into the bloodstream which will develop into red blood cell as an oxygen carrier within 1-2 days. The specific marker can be detected during each stage of erythropoiesis. For example, CD34 represents the hematopoietic stem and progenitor cells (HSPCs). CD36 and CD71 is expressed during erythroid precursors, late erythroid proliferation, and erythroblast. During the erythroid maturation, CD235a or glycophorin A (GPA) indicates the end stage of erythropoiesis because GPA expresses when the erythrocyte membrane when hemoglobin is formed (Schippel & Sharma, 2023).

Erythropoietin (Epo) is a hematopoietic growth factor. Epo is mainly produced by kidney (Koury et al., 1989) which will regulate the red blood cell production in bone marrow in response to hypoxia. The main function of Epo is to regulate the process of erythropoiesis. Thus, the synthesis of Epo must be correlated to the requirement of oxygen level in the body. The activation of Epo depends on the relationship of ligand and its receptor: Erythropoietin receptor (EpoR). EpoR belongs in the type I cytokine receptor which requires the homodimerization for activation. When Epo binds to EpoR, the action causes conformational changes and activates Janus tyrosine kinase 2 (JAK2). JAK2 phosphorylates tyrosine residues in the intracellular domain which acts as the signal transducers to activate Signal Transducer and Activator of Transcription-5 (STAT5) protein. STAT5 then dissociates from JAK2 and translocate to the nucleus to activate the regulatory regions of targeted DNA (Richmond et al., 2005). Also, when Epo induces the phosphorylation of JAK2, it activates Phosphatidylinositol-4,5-bisphosphate 3- kinase/Protein kinase B (PI3K/AKT) and Mitogen-activated Protein Kinase/Extracellular Signal-regulated Kinase (MAPK/ERK) downstream signaling. This process upregulates the expression of several genes responsible for differentiation, proliferation, and prevent cell death (apoptosis) of the erythroid cells. In addition to Epo, the red blood cell production also requires essential nutrients such as iron, vitamin B12, and folate. Any abnormalities arising with genetics or external factors that are essential to the process of erythropoiesis will lead to the production of less than normal red blood cells, which is the main cause of anemia (Ginzburg & Rivella, 2011).

2.2 Apoptotic mechanism in ineffective erythropoiesis

In ineffective erythropoiesis, the maturation of erythroid precursors is disrupted, leading to the premature death or incomplete differentiation. Several molecular mechanisms contribute to this process includes increased apoptotic mechanism of erythroid precursors and ineffective signaling pathways in erythropoiesis.

One of the hallmarks of ineffective erythropoiesis is the excessive apoptosis of erythroid precursors. This is particularly evident in conditions like β -thalassemia and myelodysplastic syndrome (MDS). In β -thalassemia, the imbalanced production of globin chains, specifically the excess of unpaired α -globin chains, precipitates within erythroid

precursors, generating reactive oxygen species (ROS) that damage cellular components, leading to apoptosis (Kong et al., 2004). The well-known mechanism that protects erythroid cells from oxidative stress is the Forkhead box O3 (FOXO-3) that activate oxidative stress response genes (Thanuthanakhun et al., 2017). Under normal condition, FOXO-3 activity is tightly regulated by growth factor signaling, particularly through the PI3K/AKT pathway. Also, when AKT phosphorylates, FOXO-3 is exported into cytoplasm where 14-3-3 protein is sequestered, so FOXO-3 is denatured into an inactive form (Tzivion et al., 2011). Under cell stress, FOXO-3 is dephosphorylates and translocate into nucleus to activate several gene in response of oxidative stress (Stefanetti et al., 2018). Another significant protein that protects erythroid from apoptosis is Bcl-2 protein. Bcl-2 is an anti-apoptotic protein that promotes cell survival by inhibiting the activation of pro-apoptotic proteins. Under normal condition, activation of Bcl-2 is crucial for erythroid differentiation and maturation into red blood cell. Bcl-2 helps maintain mitochondrial membrane integrity, preventing the release of pro-apoptotic factors like, cytochrome C, which initiate the apoptotic cascade (Mason et al., 2007). The downregulation of Bcl-2 in ineffective erythropoiesis is reported to the decrease ability of fighting oxidative stress and upregulate the apoptosis pathway.

Research Methodology

1. The Research Procedure Includes 3 Steps which are:

- 1.1. To study the 14-3-3 protein function in by detecting the phosphorylation activity of STAT-5, AKT, and ERK1/2 in UT-7/Epo erythroleukemic cell line
- 1.2. To investigate the 14-3-3 protein function in erythropoiesis in human primary erythroid cell by the detection of specific markers during erythroid progression
- 1.3. To confirm the 14-3-3 protein function in apoptotic mechanism in human primary erythroid cell

2. Research Instruments

- 2.1. UT-7/Epo erythroleukemic cell line maintenance.
- 2.2. Hematopoietic stem and progenitor cells (HSCs) and human primary erythroid cell culture.
- 2.3. Immunoblotting analysis.
- 2.4. Flow cytometry analysis.

3. Target Group / Populations and Samples

- 3.1. UT-7/Epo erythroleukemic cell line were presented in an individual biological culture system.
- 3.2. Human primary erythroid cells were collected from the healthy donor and approved by the Human Research Ethics Committee, Faculty of Medicine Ramathibodi Hospital, Mahidol University to Application of Hematopoietic Stem Cells from Leftover Specimen for Development of Hematological Disorder Treatment (MURA2023/305).

4. Statistics for Data Analysis

Data were analyzed from at least three independent biological experiments. The statistical differences among group were analyzed by using unpaired student's t-test or one-way analysis of variance (ANOVA) test with Tukey's multiple comparison. All quantification bar graph were plotted as mean \pm SEMs. Statistically significant differences were considered at P-values of less than 0.05, 0.01, 0.001, and 0.0001 (*P < 0.05, **P < 0.01, ***P < 0.001, and ****P < 0.0001).

Results/Research

1. The results of the study of 14-3-3 protein function in the regulation of erythropoiesis by observing the cell's viability and phosphorylation activity in UT-7/Epo erythroleukemic cell line

We developed the system of treatment in UT-7/Epo erythroleukemic cell line to observed 14-3-3 protein function. UT-7/Epo erythroleukemic cells were culture in minimal essential medium alpha modification (α -MEM) with 1% penicillin/streptomycin and supplemented with 10% fetal bovine serum (FBS). To observe the molecular mechanism of the Epo mediated signaling pathway, cells were starved with 0.8% BSA for 18 hours and treated with physiological dose of Epo (0.1 U/mL) and 0.2 mg/mL holo-transferrin (holo-Tf) for 10 minutes. Also, the pharmacological inhibitor of 14-3-3 protein, trifluoroacetate (R18) at the respective concentration was added 48 hours prior to the treatment. After the treatment, UT-7/Epo cells were collected and lysed in the lysis buffer. The western blot analysis of phospho-STAT-5, phospho-AKT, and phospho-ERK1/2 showed the elevation of signaling pathway when increase the concentration of 14-3-3 protein inhibitor. In this case, we observed that at 10 μ g/mL R18 phosphorylation of AKT and ERK1/2 showed the significant change in promoting signaling pathway (**Figure 1**); therefore, 10 μ g/mL was selected as the potential affecting dose of 14-3-3 protein inhibitor. After the dose determination, cell viability was observed to confirm that the change in cellular mechanism does not affect the survival of the cells. For the cell viability experiment, UT-7/Epo cells were treated with 0.1 U/mL Epo and 0.2 mg/mL holo-Tf to mimic the normal physiological concentration. Along the cell culture, 10 μ g/mL of R18 was maintain throughout the respective date. Cumulative cells were monitored starting from day 0 to day 6 by trypan blue extrusion assay. UT-7/Epo cells were counted every two days, and we observed the significant increasing in total cell at day 4; however, cells were then displayed the similar pattern at day 6 (**Figure 2**). From these results, at dose 10 μ g/mL of 14-3-3 protein inhibitor affects the phosphorylation of Epo mediated signaling pathway directly which does not interfere with the morphological change of the cells.

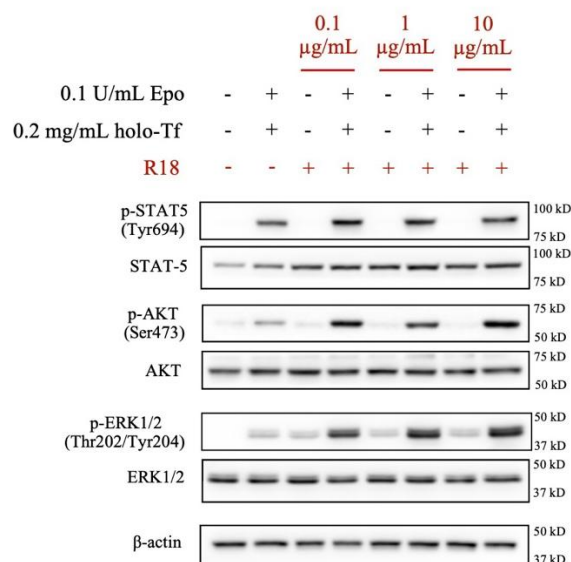


Figure 1 Pharmacological inhibitor of 14-3-3 protein, trifluoroacetate (R18), caused the over-activation of Epo mediated signaling pathway.

Western blot analysis of UT-7/Epo erythroleukemic cells showed the elevation of phospho-STAT-5, phospho-AKT, and phospho-ERK1/2 corresponded to 0, 0.1, 1, and 10 μg/mL of R18 inhibitor.

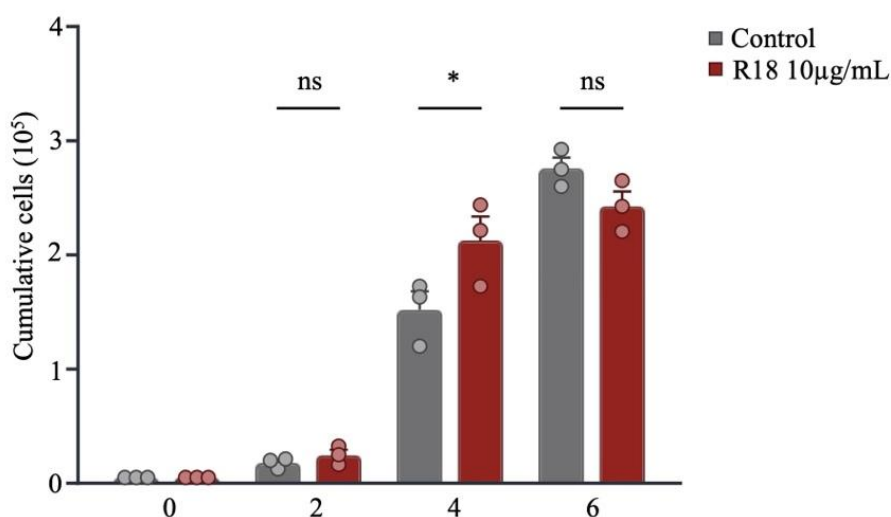


Figure 2 Trifluoroacetate (R18) does not interfere with the cell viability of UT-7/Epo erythroleukemic cells.

Cell viability of UT-7/Epo erythroleukemic cell line of control and 10 μg/mL of R18 were monitored during day 0, 2, 4, and 6 of culture. Cumulative cells were analyzed by trypan blue extrusion assay. Graph of cumulative cells was plotted by mean ± S.E.M; *P < 0.05 (n = 3).

2. The investigation of 14-3-3 protein's role in erythroid progression by the detection of erythroid specific markers during terminal maturation

The researcher has developed the method to detect the erythroid cells during each stage of progression. Isolated hematopoietic stem cells (HSCs) from three healthy donor were cultured in two phases medium system. From day 0 to day 7, HSCs were cultured in Isocove Modified Dulbecco Modified Media (IMDM) supplemented with 1% Glutamax, 1% PS, 15% BIT 9500 serum substitutes (bovine serum albumin, recombinant human insulin, human transferrin), 100 ng/mL stem cell factor (SCF), 10 ng/mL interleukin-3 (IL-3), and 100 ng/mL interleukin-6 (IL-6) for inducing HSCs into erythroid lineage. Cells were differentiated into erythroid progenitor and cultured in the erythropoietin (Epo) dependent by switching IL-6 to 1 U/mL Epo. In this phase, cells were identified as an erythroid during differentiation stage into the mature red blood cells. Since the CD71 is only expressed during erythroid differentiation and CD235a only expresses at the maturation stage, these two markers can represent the progression of erythroid cell from differentiation to maturation of red blood cell. In this case, human primary erythroid cells were culture with 10 µg/mL of R18 and showed the decreasing in the CD71⁺/CD235a⁺ starting from day 14 to day 16 (**Figure 3**). This implies the decreasing in the erythroid maturation rate when inhibiting 14-3-3 protein as observed in R18 treatment group. Also, since the developmental anomaly is observed in R18 group, the inhibition of 14-3-3 protein caused the delayed in erythroid progression.

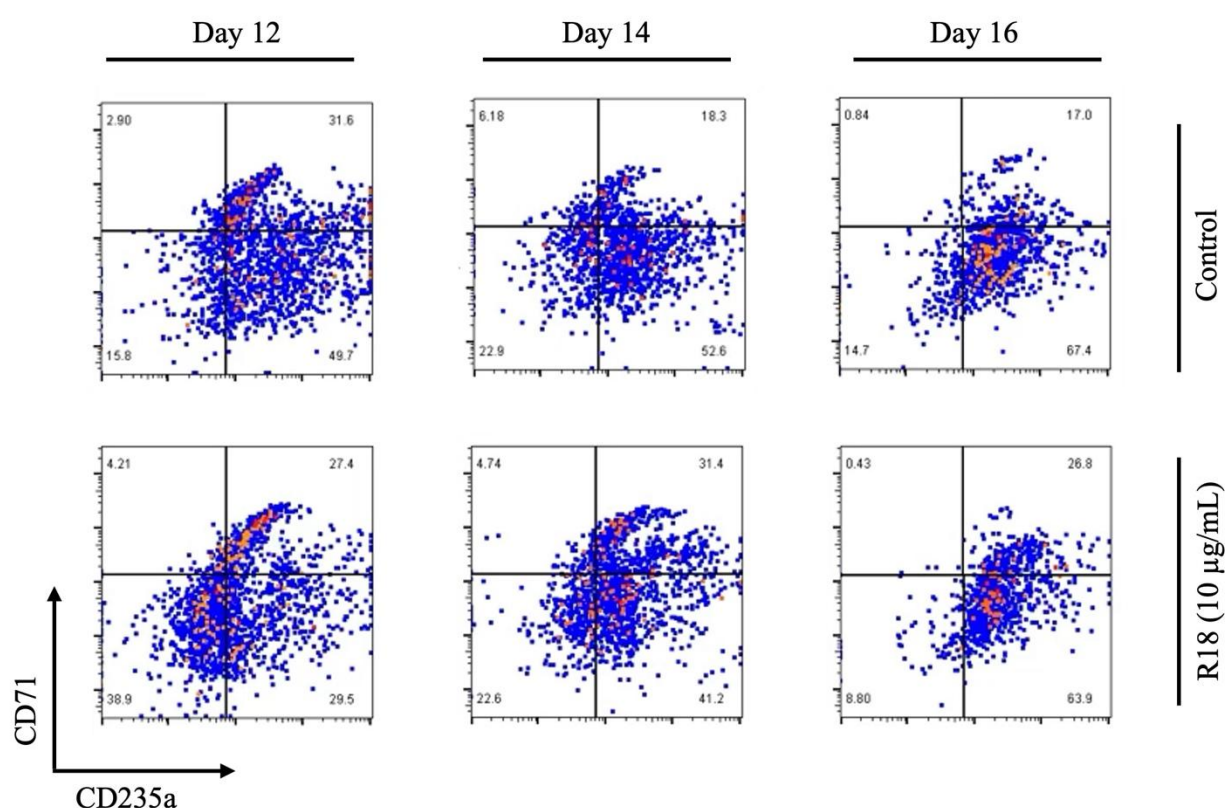


Figure 3 Inhibition of 14-3-3 protein function affects erythroid during differentiation to terminal maturation.

Flow cytometry analysis of erythroid cells with normal culture and treatment with 10 µg/mL of 14-3-3 protein inhibitor (R18) during day 12 to day 16 were identified by CD71 and

CD235a markers. Treatment of 10 $\mu\text{g/mL}$ R18 showed the decreasing in terminal maturation markers (CD71⁺/CD235a⁺).

3. The identification of the apoptotic mechanism caused by the inhibition of 14-3-3 protein underlying the decreasing of terminal differentiation

To investigate the cause of decreasing in terminal maturation, cell viability during day 12, 14, and 16 was monitored by trypan blue exclusion assay. The decreasing in cell number was observed starting from day 14 and significantly decrease on day 16 (**Figure 4A**) when comparing with the normal culture and 10 $\mu\text{g/mL}$ R18 culture. This suggest that the inhibition of 14-3-3 protein caused the dysregulation of survival pathway of erythroid cells during differentiation stage; therefore, the apoptotic mechanism during day 16 was further investigate. To investigate the apoptotic mechanism, western blot analysis of anti-apoptotic protein, Bcl-2, and pro-apoptotic protein, BAX, was investigated (**Figure 4B**). The protein expression of Bcl-2 showed the decreasing in its activity. In contrast, the BAX protein which induced by the program cell death of the cells was elevated. The quantification of western blot analysis's intensity was analyzed by ImageJ software, and the BAX/Bcl-2 ratio showed the significantly increased at day 16 of culture. Taken together, the inhibition of 14-3-3 protein caused the dysregulation of anti-apoptotic pathway which is lethal to the survival of erythroid cells.

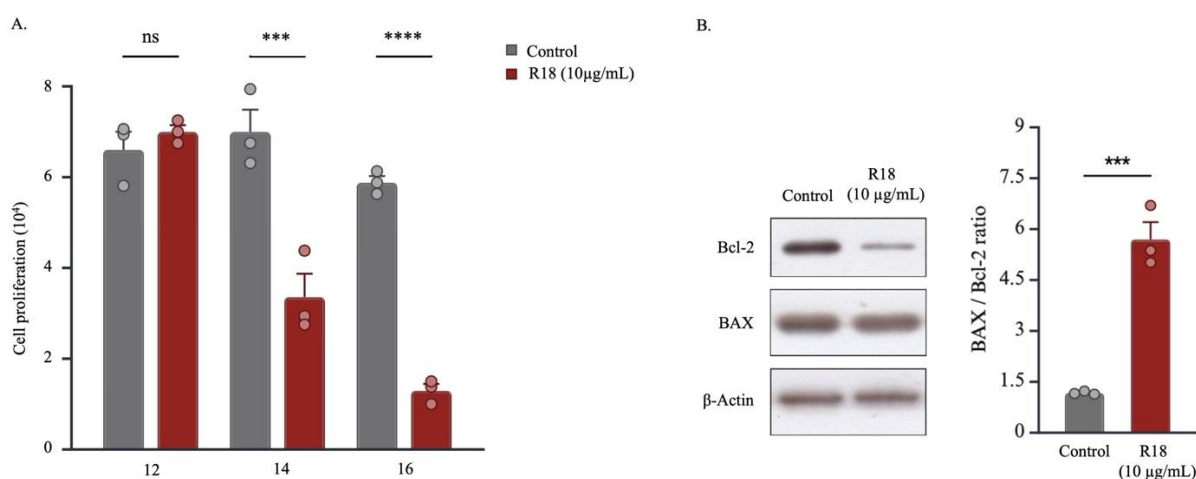


Figure 4 The inhibition of 14-3-3 protein affects the survival of erythroid cell which mediated by apoptotic mechanism pathway. (A) Cell proliferation of erythroid cells was monitored by trypan blue exclusion assay. Graph was represented by the cell number and plotted by means \pm S.E.M; *** $P < 0.001$, **** $P < 0.0001$ ($n=3$). (B) Western blot analysis of anti- and pro-apoptotic pathway using anti-Bcl-2 and anti-BAX was analyzed (left). The BAX/Bcl-2 ratio was quantified and normalized by housekeeping protein β -actin. Quantified intensity was represented by means \pm S.E.M; *** $P < 0.001$ ($n=3$).

Discussion

The goal of erythropoiesis or red blood cell production is to regulate the balance between cell proliferation, differentiation, maturation to ensure the need under the physiological condition. To comply with this condition, the apoptosis mechanism must be maintained in order to ensure the survival of the erythroid cells. However, many studies in hematological disease indicate that apoptosis is the major concern that mediated the ineffective

erythropoiesis. One of the significant proteins in the regulation of cell survival is the 14-3-3 protein. The 14-3-3 protein is the highly conserved molecule that function as molecular chaperones, binding to phosphorylated serine/threonine residues in targeted protein (Mukherjee et al., 2024). The role of 14-3-3 protein in apoptosis largely depends on its ability to sequester pro-apoptotic factors, thereby modulating mitochondrial outer membrane permeability and cytochrome c release which the key regulator in the intrinsic apoptosis at the cellular level (Liau et al., 2020). This study identified the 14-3-3 protein as the regulator that modulating Epo signaling pathway and regulating the apoptosis mechanism. Our result from the 14-3-3 protein pharmacological inhibitor (R18) caused the over-activation of AKT and ERK1/2 pathway in UT-7/Epo erythroleukemic cell line. This suggests the dysregulation in the oxidative response mechanism since the AKT and ERK1/2 deal with the clearance of oxidative stress and maintaining survival of erythroid cells (Tzivion et al., 2011). Additionally, 10 µg/mL is the suitable dose for the R18 inhibitor throughout the human primary erythroid cell culture since this concentration affected signaling pathway specifically but does not cross with the cell survival; therefore, we confirm that 14-3-3 protein affects the Epo signaling directly.

Furthermore, the delay in maturation that leads to the upregulation of apoptotic pathway was observed in human primary erythroid cells treating with R18. As the decreasing in CD71⁺/CD235a⁺ was observed in R18 treatment, it is plausible that 14-3-3 protein can regulate the differentiation stage of erythroid cells. Also, the 14-3-3 protein inhibition caused the decreasing of anti-apoptotic protein, Bcl-2 which complies with the decreasing in cumulative cell. From this research, we identify the novel role of 14-3-3 protein in the regulation of erythroid progression along with the survival of the red blood cell. Through its integration into Epo-mediated survival pathways, 14-3-3 protein ensures the production of red blood cells while preventing apoptotic mechanism in erythroid progenitor. Also, the dysregulation of this mechanism contributes can contribute to hematological disorder, which making the 14-3-3 protein as a promising target for therapeutic approach. Future studies focusing on the molecular intricacies of 14-3-3 protein interaction may provide deeper insight into its role in erythropoiesis that important in many of hematological diseases.

Conclusion

The production of red blood cells is critically dependent on the Epo-mediated signaling pathway, which regulates their proliferation, differentiation, and maturation. Dysregulation of this pathway can lead to ineffective erythropoiesis and increase cell death, particularly during differentiation stage. Our study highlights the 14-3-3 protein as a key regulator of the Epo signaling pathway, essential for promoting red blood cell differentiation and survival. Inhibition of the 14-3-3 protein interfere the phosphorylation of STAT-5, AKT, and ERK1/2; thereby, impairing antioxidant mechanisms in erythroid cells and activating apoptosis pathway, resulting in defective red blood cell maturation. Identifying proteins that regulate this critical stage is a fundamental to advancing our understanding of erythropoiesis in various conditions. This research provides valuable insights into the mechanisms underlying blood diseases and represents a significant step toward developing innovate therapeutic strategies.

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Relationship between Water Source, Ice Cube Type, and Seller Behavior with the Existence of Fecal Coliform Bacteria in Iced Tea: Case Study in Pekalongan

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Abstract

Drink contamination can occur if the raw materials of the drink do not meet health requirements. Coliform bacteria contamination in drinking water can cause various infectious diseases such as diarrhea that caused by *E. coli*. The presence of fecal coliform bacteria in water is one indicator of water pollution by pathogenic bacteria originating from human waste. The purpose of this study was to determine the relationship between raw water sources, types of ice cubes, and seller behavior with the presence of fecal coliform bacteria in iced tea. The research design used in this study was cross-sectional. In taking samples using the purposive sampling technique with a sample size of 23 respondents of iced tea sellers in Kesesi District, Pekalongan Regency. The results of the study were analyzed using Chi-Square and Fisher Exact Test, with the variables studied including water sources, types of ice cubes, seller behavior, and the presence of fecal coliform bacteria. The results of laboratory sample tests of iced tea showed that 74% of iced tea did not meet the requirements because they contained fecal coliform bacteria. The results of the analysis showed no relationship between water sources and Seller Behavior with the presence of fecal coliform bacteria in iced tea with p-value = 0.131 and 0.539 respectively. There was a relationship between the type of ice cube and the presence of fecal coliform bacteria in iced tea with a p-value = 0.035 with a Continuity Coefficient value of 0.475 which means having a close relationship. The conclusion of the study showed that most iced tea samples did not meet the requirements, and it was known that there was a relationship between the type of ice cube and the presence of fecal coliform bacteria in the iced tea. The selection of ice cubes types can reduce fecal coliform bacteria contamination in iced tea.

Keywords: Colifecal, Ice Cubes, Iced Tea, Seller behavior

Introduction

Coliform is a group of bacteria that is used as an indicator of pollution in water. *Escherichia coli* is included in the coliform bacteria group and can cause digestive tract infections. From the SKAMRT 2020 results, the microbiological parameter aspect of *E. coli* for the household proportion of Drinking Water Facilities (SAM) nationally, only 31.3% of SAMs have zero *E. coli* test results, meanwhile in rural and urban areas, each has 27.1% and

35% results respectively (Direktorat Jenderal Pencegahan dan Pengendalian Penyakit, 2023). Certain types of *Escherichia coli* can cause diarrhea outbreaks (Khan et al., 2022; Patil et al., 2019; Zhou et al., 2021). Data from the Pekalongan Regency Health Service reported that there were 10,954 cases of diarrhea in Pekalongan Regency in 2022, and in 2023 there was a decrease in cases of 8,954 cases (Dinas Kesehatan Kabupaten Pekalongan, 2022, 2023).

The presence of *E. coli* in drinking water should not be tolerated according to the Indonesian Minister of Health Regulation Number 492/PERMENKES/PER/IV/2010 Regarding Drinking Water Quality Monitoring, which stipulates that the APM Coliform is 0/100 mL and *E. coli* is 0 colonies/mL. Bacterial contamination in drinks or food is not only caused by contaminated raw materials but can also be influenced by the behavior of the seller. The results of the study showed that there was a relationship between *E. coli* bacterial contamination in food/drink products and the hygiene and behavior of handlers (Khan et al., 2022)(Asril et al., 2023; Ghosh, 2023; Herawati et al., 2023).

The cold beverage industry in Indonesia, including iced tea, has experienced significant growth along with the increasing middle class and rapid urbanization (Naibobo et al., 2023). Iced tea is a popular drink because it is affordable and can be used as a side dish. Iced tea is made using water and ice, which are sources of coliform bacteria contamination (Sitorus et al., 2024). Water is a good medium for bacterial growth, so contamination can easily occur if hygiene and sanitation are not properly considered.

The raw materials for making ice cubes can be raw water, refill water, or the filtration process in large-scale ice factories is susceptible to contamination by pathogenic bacteria. The water used in crystal ice cubes comes from raw water, and its processing is only through a filtration process that is put into the ice tube machine (Nurmalasari et al., 2019). The presence of bacteria in ice cubes has been reported in several studies, including the discovery of 100% *E. coli* bacterial contamination from ice cube samples in Karangasem Regency, Bali, and the presence of ice cube contamination in Langsa City, Aceh (Nurmalasari et al., 2019; Sitorus et al., 2024; Wiguna et al., 2022).

Refill water is also widely reported to be contaminated with bacteria (Aeni et al., 2023; Guhad, 2022). The results of the study showed coliform contamination in 63% of bottled drinking water samples (Nurmalasari et al., 2019). In addition, research conducted on refill water depots in Bekasi showed that there were 3 samples contaminated with *E. coli* and 5 samples contaminated with *Pseudomonas* (Rahmawati & Lumbantobing, 2023). Based on the background description, the researcher is interested in knowing the relationship between water sources, types of ice cubes, and Seller Behavior with the presence of coliform bacteria in iced tea.

1. Research Objectives

- 1.1 To identify the presence of fecal coliform bacteria in iced tea sold in Kesesi District, Pekalongan Regency
- 1.2 To examine the relationship between water sources and fecal coliform contamination in iced tea.
- 1.3 To determine the relationship between ice cubes types and fecal coliform presence in iced tea
- 1.4 To analyze the relationship of Seller Behavior on fecal coliform contamination in iced tea.

2. Review of Related Literatures

Coliform bacteria contamination cannot be found in drinking water. Although the presence of coliform bacteria does not always cause disease, its presence in drinking water indicates that the water is contaminated with disease-causing pathogens. Fecal coliform contamination of drinking water sources can cause outbreaks of waterborne diseases (Talpur et al., 2023). Fecal coliform bacteria have the characteristics of rod cells, are Gram-negative, do not have spores, and can ferment lactose to produce acid and gas at a temperature of 37 degrees Celsius (Kurahman et al., 2022). The fecal coliform bacteria group is a group of bacteria that comes from human waste. Some species that are included in fecal coliform are *E. coli*, *Shigella*, *Salmonella*, *Vibrio*, streptococci, *Clostridium perfringens*, and *Klebsiella* (Some et al., 2021).

Tea is a traditional brewed drink that contains antioxidants and anti-inflammatories (Ding et al., 2022; Lind et al., 2023; Truong & Jeong, 2022). Tea drinking is the favorite drinking water in the world. There are more than 3 billion tea drinkers in 160 countries. Therefore, tea can boost global economic growth worth nearly 200 billion US dollars in 2020 and is expected to increase to more than 318 billion US dollars by 2025. There are 3 billion people who like to drink tea in the world, and more than two billion cups of tea are consumed every day around the world (Pan et al., 2022).

Fecal coliform contamination in iced tea can come from the raw materials used, that is, water and ice cubes, and also from Seller Behavior. One of the materials to make iced tea is drinking water. Refill drinking water is a ready-to-drink that can be obtained from refilled drinking water depots that are processed into drinking water and sold directly to consumers (Azteria & Rosya, 2023). Refill drinking water depots continue to grow along with the community's need for good quality water that is safe for consumption. Based on data from the Central Statistics Agency, the need for clean water in the social needs group is 97.9 million/m³, special needs are 163.6 million/m³, commercial and industrial needs are 456.3 million/m³, non-commercial needs are 2,917.7 million/m³, and other needs are 715.2 million/m³ (Direktorat Statistik Industri, 2021). The high demand for clean water is the reason for the large number of refill drinking water depots throughout the region. However, the quality of refill drinking water often does not meet standards with the discovery of coliform bacteria contamination in samples (Azteria & Rosya, 2023; Guhad, 2022; Rahmawati & Lumbantobing, 2023; Toalu et al., 2023).

A worker who handles food during its preparation, processing, storage, transportation, and serving is known as a handler. The quality of the food given is influenced by the handler's actions, knowledge, and attitude. Handlers with diarrhea, fever, or the flu shouldn't work in the food processing industry. In the event of a wound, the handler is required to cover the wound with a waterproof barrier, such as plastic gloves or plaster (Siregar et al., 2024). A person's actions to improve their health are referred to as behavioral elements. Disease prevention, personal cleanliness, food sanitation, and meal presentation are all included in this. The Decree of the Minister of Health of the Republic of Indonesia No. 1096 regulates the standards for the cleanliness and hygienic conduct of those who handle food and beverages (KEPUTUSAN MENTERI KESEHATAN REPUBLIK INDONESIA NOMOR 1098/MENKES/SK/VII/2003, 2003).

The results of the study by Asril et al. showed that the results of a survey on 50 Thai tea products in Lampung showed that 100% of samples were contaminated with coliform bacteria and *Pseudomonas* sp. The results of the study also showed that the quality of Thai tea was poor due to unhygienic raw materials and seller habits. (Asril et al., 2023). The others research about The Maros City Culinary Center's investigation on handler behavior and the prevalence of MPN coliform bacteria in fruit juice drinks revealed a correlation between handler conduct and

drink coliform bacteria. The results of Fisher's test revealed a strong correlation between handlers' attitudes and their level of knowledge regarding the presence of coliform bacteria in beverages (Rostina S, Khiki Purnawati Kasim, 2022).

Research Methodology

1. The Research Procedure

The type of research used is observational research with a cross-sectional design. This research examines the relationship between water sources, types of ice cubes, and the Seller Behavior with the presence of fecal coliform bacteria in iced tea. The dependent variable of this research is presence of fecal coliform bacteria in iced tea and the independent variable are water sources, types of ice cubes, and the Seller Behavior.

2. Research Instrument

The instruments used in this study were laboratory test equipment with Lactosa Broth (LB) and Brilliant Green Lactosa Bile Broth (BGLB) media with Most Probably Number method to determine the fecal coliform contamination in iced tea and used observation sheets to find out about the water source and ice cubes that are the raw materials for iced tea in their stalls and Seller Behavior. Identification of fecal coliform contamination with the MPN method includes a presumptive test and a confirmation test. Positive results are seen from the presence of gas trapped in the Durham tube in the media that incubated at a temperature of 44 degrees Celsius.

3. Populations and Samples

The population in this study were food stalls representing 23 villages in Kesesi District at Pekalongan Regency. The sample in this study was iced tea sold in 23 food stalls from 23 villages in Kesesi District with the inclusion and exclusion criteria set to reduce research bias. The inclusion criteria for this study were that respondents were iced tea sellers at stalls that were settled and sold other foods on the roadside and non-permanent stalls. Sampling was carried out aseptically with a sterile bottle and, on the same day, was immediately taken to the laboratory to test for the presence of fecal coliform bacteria. The number of respondents taken only 1 from each village in Kesesi District (23 respondents) is a limitation of the study. This takes into account the costs required for this study. This research has obtained ethical approval from the Health Research Ethics Commission with number 122/B.02.01/KEPK/VII/2022.

4. Statistics for Data Analysis

Univariate analysis was conducted to describe each variable, both independent variables (water, ice cubes, and Seller Behavior) and dependent variables (fecal coliform bacteria in iced tea). While bivariate analysis was conducted using chi-square and Fisher exact statistical tests to determine the significant relationship between each independent variable and the dependent variable. The use of the Fisher Exact Test in the bivariate test between water sources and seller habits with the presence of fecal coliform bacteria takes into account the sample size, which is too small and does not meet the requirements for the Chi-square test.

Results

1. Identification of Fecal Coliform Contamination in Iced Tea

A sample of 23 iced tea sellers is representative of each of the 23 villages in the Kesesi District. The selected samples had stalls with non-permanent buildings in their residential

environment with non-permanent building conditions such as walls, floors, and roofs that did not meet the standards of a healthy stall. Most of the stalls used as samples in the study were located near highways that sold food and other food needs.

The results of the study showed that the characteristics of respondents of iced tea sellers were dominated by women, as much as 70%, with ages above 30 years as many as 20 people and the highest level of education of iced tea sellers was dominated by elementary school graduates 74%. The results of observations of water sources used as raw water for making iced tea at 23 food stalls selling iced tea in Kesesi District, Pekalongan Regency, showed that the 23 iced tea sellers in Kesesi District, mostly use well water as 15 stalls (65%), and PAM water as many as 8 stalls (35%).

Table 1. Fecal Coliform Contamination in Iced Tea

Count of contamination in iced tea	Jumlah	Presentase
Qualified	6	26%
Unqualified	17	74%
Count	23	100%

The results of laboratory tests using the MPN method showed that 74% of iced tea sold did not meet health requirements because fecal coliform bacteria were found in the samples and 6 samples (26%) did not present fecal coliform bacteria (Table 1). The results of observations of the types of ice cubes used as a mixture for making iced tea at 23 food stalls selling iced tea in the Kesesi District, showed that 57% of the types of ice cubes used were block ice cubes, 4% were crystal ice cubes, and 39% were homemade ice cubes. The results of the research about Seller Behavior showed that 3 sellers (13%) have poor personal hygiene behavior, and 20 sellers (87%) have good trader behavior or personal hygiene.

2. Relationship between Water Source and the Presence of Fecal Coliform Bacteria in Iced Tea

In the bivariate analysis, the independent variable (water source) is associated with the dependent variable (the presence of fecal coliform bacteria in iced tea), which is tested using the Chi-Square test. The results of the cross-test between the independent and dependent variables can be seen in Table 2. The analysis results show that respondents who had fecal coliform bacteria numbers $>0/100$ ml (do not meet the requirements) were 13 stalls (57%) using well water and 4 stalls (17%) using PAM water as raw water for making iced tea (Table 2).

Table 2. Table of Relationship of Water Source with Fecal Coliform Contamination in Iced Tea

Water resource	Count of Fecal Coliform Bacteria						P value	CC
	Qualified		Unqualified		Total			
	N	%	N	%	N	%		
Well water	2	9%	13	57%	15	66%	0.131	0.370
PDAM	4	17%	4	17%	8	34%		
Count	6	26%	17	74%	23	100%		

The results of the study showed that more iced tea sellers used water sources to make water soaking using well water rather than using PDAM water. The results of the Chi-square test with the Fisher Exact test showed that that was no relationship between air sources and the presence of fecal coliform bacteria in iced tea with a p-value of 0.131 greater than $\alpha = > 0.05$ with a continuity coefficient value of 0.370 that mean no relationship between water source and the present of fecal coliform bacteria.

3. Relationship between Ice Cubes Types with the Presence of Fecal Coliform Bacteria in Iced Tea

Observation of the type of ice cubes used was carried out through direct observation and interviews. The type of ice cubes used was dominated by block ice cubes (57%). The results of the bivariate analysis test with the Chi-square test are presented in Table 3.

Table 3. Table of Relationship between Ice Cube Types with Contamination of Fecal Coliform

Ice Cubes Types	Count of Fecal Coliform Bacteria						P value	CC
	Qualified		Unqualified		Total			
	N	%	N	%	N	%		
Block ice cubes	1	4%	12	53%	13	57%	0.035	0.475
Crystal Ice cubes	1	4%	0	0%	1	4%		
Homemade ice cubes	4	17%	5	75%	9	39%		
Count	6	25%	17	75%	23	100%		

According to Table 3, it is known that the samples that did not meet the quality standards were 12 samples (53%) using block ice cubes and 5 samples (22%) using homemade ice cubes. These results indicate that the proportion of fecal coliform bacteria was greater in iced tea stalls that used block ice cubes. The results of the Chi-Square test of the relationship between the type of ice cube and the presence of fecal coliform bacteria in iced tea showed that the p -value = 0.035 or less than $\alpha = 0.05$ with a contingency coefficient value of 0.475. So it can be concluded that there is a close relationship between ice cubes types and the presence of fecal coliform bacteria in iced tea.

4. Relationship between Seller Behaviour with the Presence of Fecal Coliform Bacteria in Iced Tea

Seller Behavior aspects relate to a person's actions in improving health. The Seller Behavior questionnaire consists of 10 questions referring to the Decree of the Minister of Health of the Republic of Indonesia No. 1096 regulates the standards for the cleanliness and hygienic conduct of those who handle food and beverages with questions about the use of water, the seller's health condition, handwashing habits, sneezing and coughing etiquette, washing cooking utensils, use of soap in washing utensils, habits of throwing away garbage, smoking habits, and cleanliness of clothing. The results of the bivariate analysis test with the Chi-square test are presented in Table 4.

Table 3. Table of Relationship between Seller Behavior with Contamination of Fecal Coliform in Iced Tea

Count of Fecal Coliform Bacteria								
Seller Behavior	Qualified		Unqualified		Total		P value	CC
	N	%	N	%	N	%		
Not Good	0	0%	3	13%	3	13%	0.539	0.224
Good	6	26%	14	61%	20	87%		
Count	6	25%	17	75%	23	100%		

According to Table 3, it can be seen that there are only 3 sellers who do not have good habits out of 23 respondents. In 3 respondents with bad behavior, fecal coliform bacteria contamination was found. Fecal coliform bacteria contamination was also found in sellers who already have good behavior in as many as 14 stalls (61%). The results of the Chi-Square test with the Fisher Exact test of the relationship between Seller Behavior and the presence of coliform bacteria in iced tea showed that the p -value = 0.539 is more than $\alpha = 0.05$ with a contingency coefficient value of 0.224. So it can be concluded that there is no relationship between Seller Behavior and the presence of fecal coliform bacteria in iced tea.

Discussion

Contamination of iced tea in 74% of samples indicates that the quality of iced tea mostly does not meet drinking water standards with various contamination numbers ranging from 3/100 mL to >2400/100 mL. Positive result at sample is an indicator of contamination of fecal bacteria in iced tea. Fecal coliform bacteria such as *E. coli* often cause health problems in the outbreak of waterborne diseases like diarrhea (Aminian et al., 2023; de Lira et al., 2021; Robert et al., 2021; Zhou et al., 2021).

Observations made on iced tea sellers in Kesesi District, Pekalongan Regency, mostly use well water because it is easier and does not cost much. The traders boil the water first until it boils because the raw water used to make tea infusions must be hot so that the tea water can turn reddish. Boiling water can reduce the number of bacteria in the water (Elvina Sophia Ranti et al., 2024; Ghaudenson et al., 2021). Even though the water has been boiled, using a container that is not sterile can also cause contamination.

The results of the research showed that most iced tea seller prefer to use block ice because it is easier and more economical. Iced tea sellers get block ice from ice depots in the market. The price of block ice is cheaper, but the manufacturing process uses raw water. The use of block ice is not actually for consumption but as a preservative for fresh food such as fish. The process of transporting block ice, which only uses carts and is only lined with sacks, is one of the triggers for contamination of block ice cubes. Several studies have shown that the quality of block ice does not meet standards because there is contamination of coliform bacteria (Aditya et al., 2022; Nurmalasari et al., 2019; Rizka et al., 2024).

Fecal coliform bacteria contamination was also found in iced tea sellers who used homemade ice cubes. This is thought to be caused by homemade ice cube sellers not necessarily using boiled water to make ice cubes. They often use refilled water, which often contains bacterial contamination due to poor sterilization processes (Aeni et al., 2023; Azteria & Rosya, 2023; Toalu et al., 2023). One of the interfering variables that was not tested in this study was the ice cube container. However, if we refer to the results of the interview about the seller's behavior, it shows good results, where most sellers have practiced washing the container with soap and running water.

Coliform bacteria contamination in crystal ice was also found in previous studies that found 100% of samples contaminated with coliform bacteria in Langsa City, Aceh (Sitorus et al., 2024). Research in Central Mexico also found contamination of coliform bacteria, fecal coliform, and nontuberculous mycobacteria from packaged ice cube samples (Castro-Morales et al., 2024). The results of the study on 3 types of ice cubes (ice blocks, crystal ice cubes, and plastic packaging ice cubes) sold at Peterongan Market in Semarang City showed that all samples contained coliform bacteria contamination and did not meet the National Standardization Agency No. SNI 7388:2009 concerning the limit of microbial and food contamination of <3/gram of MPN index (Sofyanita, 2023).

Iced tea sellers in Kesesi District, Pekalongan Regency, already have good behavior in personal hygiene, such as wearing clean clothes, washing hands, and washing equipment using soap. This can reduce the risk factor of bacterial contamination in drinks or food sold. However, the results of the bivariate test showed that this behavior was not related to bacterial contamination in iced tea. The cleanliness and sanitation of traders can be influenced by their knowledge or awareness (Suryani et al., 2021). Although the seller's behavior was good, fecal coliform bacterial contamination was still found in the iced tea they sold. As many as 14 sellers of the 17 samples contaminated with fecal coliform bacteria had good personal hygiene behavior. This is thought to be because the source of contamination comes from the ice cubes

used. The results of this study indicate that bacterial contamination is not only caused by the behavior of the seller but also by the raw materials used.

The results of this study are not in line with the existing theory. This is thought to be due to research bias and the number of samples being too small. Another factor that allows results that are not in line with the theory is that during the interview, sellers tend to answer with good answers, but researchers cannot directly observe whether these good practices have actually been implemented or not.

Conclusion

Based on the results and discussion, it can be concluded that 74% of iced tea sold in Kesesi District is contaminated with fecal coliform bacteria. These results indicate that the safety of drinks does not meet health standards. There is no relationship between water sources and seller behavior with the presence of fecal coliform bacteria in iced tea, and there is a close relationship between ice cube types with fecal coliform contamination in iced tea. Referring to the research results, the government should issue a standard policy for good iced tea sales procedures and conduct regular inspections and for further research, the number of samples should be increased and more focused on frenchise iced tea sellers, which are currently found in abundance along the road.

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Comparative Study of Antibacterial Activity of *Rhizophora apiculata* Stem Extract and Ciprofloxacin Against *Vibrio parahaemolyticus*

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Abstract

Rhizophora apiculata, a type of mangrove tree with a hard wood structure, contains bioactive compounds such as alkaloids, saponins, flavonoids, and tannins that exhibit antibacterial potential. Previous studies demonstrated the ability of mangrove root bark extracts to inhibit the growth of pathogenic bacteria, including *Streptococcus sp.* and *Vibrio harveyi*. This study evaluates the antibacterial activity of *Rhizophora apiculata* stem extract against bacterial growth using three different concentrations (5%, 10%, and 15%), compared to Ciprofloxacin (5 µg/mL) as a positive control and DMSO (10%) as a negative control. The antibacterial effectiveness was measured by observing the inhibition zone. Results showed that Ciprofloxacin exhibited the largest inhibition zone, followed by mangrove stem extract at 15%, 10%, and 5% concentrations. As expected, DMSO showed no antibacterial activity. Statistical analysis revealed significant differences among all treatments ($p < 0.05$). The *Rhizophora apiculata* stem extract demonstrated significant antibacterial potential, with the highest effectiveness at a 15% concentration. This study reinforces the prospects of mangrove plants as a natural source of antibacterial agents and supports further exploration for pharmaceutical applications.

Keywords: disk diffusion method, stem maceration, Ciprofloxacin, inhibition zone, Gram-negative bacteria

Introduction

Indonesia is home to various species of mangrove plants, one of which is *Rhizophora apiculata*, commonly known as oil mangrove. This plant possesses antibacterial properties. Several previous studies have examined the chemical compounds found in *Rhizophora apiculata* and their potential applications. According to research conducted by Derlian et al. (2011), crude extracts from the root bark of *Rhizophora apiculata* contain various secondary metabolite compounds, including flavonoids, saponins, terpenoids, alkaloids, steroids, and tannins.

Rhizophora apiculata has significant potential in the field of phytopharmaceuticals, particularly in its stem. Research by Rahim et al. (2008) revealed that the plant's stem contains tannins, which act as antimicrobial agents. The ability of *Rhizophora apiculata* stem extracts to inhibit bacterial growth is attributed to the presence of active compounds within the plant. One of the bacteria that can be inhibited by the antibacterial compounds in *Rhizophora apiculata* is *Vibrio parahaemolyticus*, a Gram-negative bacterium that naturally inhabits

aquatic environments (Xie et al., 2005). This bacterium is commonly found in estuaries and coastal areas but does not thrive in deep-sea environments. *Vibrio parahaemolyticus* is widely present in East Asian waters and exhibits optimal growth at a salt (NaCl) concentration of 3%, within a temperature range of 5–43°C, and at a pH level between 4.8 and 11. The bacterium grows most rapidly at 37°C, with a generation time of approximately 9–10 minutes (Charles-Hernandez et al., 2006).

Vibrio parahaemolyticus is a major causative agent of gastrointestinal infections (acute diarrhea), accounting for approximately 20–30% of cases in Asian countries, including Japan, Hong Kong, Thailand, and Indonesia. This bacterium can enter the human digestive system through the consumption of contaminated seafood containing harmful microorganisms. One of the primary sources of seafood contamination, including shellfish, shrimp, and other marine products, that can lead to gastrointestinal food poisoning is *Vibrio parahaemolyticus* (Maria, 2008).

1. Research Objectives

- 1.1 Extract of *Rhizophora apiculata* mangrove stem
- 1.2 To determine the effect of *Rhizophora apiculata* mangrove stem extract concentration on the inhibition of *Vibrio parahaemolyticus* bacteria.
- 1.3 To study Identification of *Rhizophora apiculata* mangrove plant.

2. Review of Related Literatures

Based on research conducted by Darlian et al. (2011), it was found that the crude extract from the root bark of *Rhizophora apiculata* mangrove contains various secondary metabolite compounds, such as flavonoids, saponins, terpenoids, alkaloids, steroids, and tannins. This extract also has the ability to inhibit the growth of *Streptococcus sp.* bacterial colonies. Meanwhile, research by Jampil et al. (2012) showed that the bark extract of *Rhizophora sp.* at a concentration of 1000 ppm was able to inhibit the growth of *Aeromonas salmonicida* bacteria with an inhibition zone of 7.9 mm and contained secondary metabolite compounds such as tannins, flavonoids, saponins, and steroids. Furthermore, research by Rahim et al. (2008) revealed that the bark of *Rhizophora apiculata* produces tannins that can be used as antimicrobial agents.

Previous studies have proven that *Rhizophora apiculata* mangrove has antibacterial potential. Darlian et al. (2011) found that root bark extract of *Rhizophora apiculata* using polar, semi-polar, and non-polar solvents was able to inhibit the growth of *Streptococcus sp.* colonies. Additionally, previous research has shown that the crude extract of *Rhizophora apiculata* root bark using methanol solvent can inhibit the growth of *Vibrio harveyi* bacteria (Widjajanti et al., 2015).

The Minimum Inhibitory Concentration (MIC) refers to the lowest concentration of an antibiotic that is still capable of inhibiting the growth of a specific microorganism. This test aims to determine the effective antibiotic concentration for preventing pathogen growth and serves as a reference for the appropriate dosage in treating infections in patients (Harmita and Radji, 2008).

Research Methodology

1. The Research Procedure Includes 5 Steps which are:

- 1.1 An experimental study aimed at determining the inhibitory effect of *Rhizophora apiculata* mangrove stem extract on *Vibrio parahaemolyticus* bacteria..

1.2 Independent Variable: Ethanol extract concentrations of 5%, 10%, 15%, and Ciprofloxacin. **Dependent Variable:** The antibacterial inhibition activity, measured by the diameter of the inhibition zone against *Vibrio parahaemolyticus* growth. **Controlled Variable:** Variables that can be controlled, such as time, temperature, autoclave, incubator, agar media, humidity, and bacteria.

1.3 The antibacterial activity test was conducted using the disk diffusion method. The testing process began with sterilization, which was performed to eliminate any living microorganisms and prevent microbial contamination. Bacterial rejuvenation was carried out to obtain active bacteria and prevent bacterial degradation. The rejuvenation process involved taking the *Vibrio parahaemolyticus* bacterial culture using a needle and inoculating it into solidified NA (Nutrient Agar) media.

1.4 Identification of mangrove plants and phytochemical screening of mangrove stems were conducted. The extraction of mangrove stem was performed using the maceration method. The antibacterial activity of the stem extract was tested using positive control (Ciprofloxacin) and negative control (10% DMSO). Next, 0.1 mL of the prepared bacterial suspension was introduced into a previously sterilized Petri dish, followed by the addition of 10 mL of molten NA (Nutrient Agar) media. The mixture was homogenized and left to solidify. Then, a paper disk soaked in the active compound solution was placed into the Petri dish containing the bacterial culture. The plates were then incubated at 37°C for 24 hours.

2. Research Instrument (s)

2.1 The tools for collecting mangrove samples include sample bags, knives, while the tools used in the laboratory are blenders, magnetic stirrers, measuring glasses (Pyrex), Laminar Air Flow (LAF), autoclave (model 25 x Electric 380°C), analytical balance, sieves, refrigerators, water bath, micropipettes, stirring rods (Pyrex), test tubes (Pyrex), Erlenmeyer flasks, beaker glasses, Petri dishes (Pyrex), pipettes, inoculating needles, Bunsen burners, vials (Pyrex), and calipers.

2.2 The research materials include mangrove stem samples of *Rhizophora apiculata*, 96% ethanol solvent, Nutrient Agar (NA), bacterial isolate *Vibrio parahaemolyticus*, 10% DMSO, 0.9% NaCl, Ciprofloxacin (PT. Alisiphen), MHA, aquadest, alcohol, spirit, cotton, aluminum foil, tissue, and label paper.

3. Samples

Sampel yang digunakan adalah ekstrak batang bakau *Rhizophora apiculata* yang diperoleh dari pantai daerah Pekalongan

4. Statistics for Data Analysis

The data obtained is then analyzed using the SPSS software. The analysis is used to determine whether there is a significant difference between each treatment using the One Way ANOVA (Analysis of Variance) statistical test, with a confidence level of 95%.

Results

1. Phytochemical Identification

The phytochemical identification of mangrove stems showed that the stems contain tannins, which are indicated by a brown color.

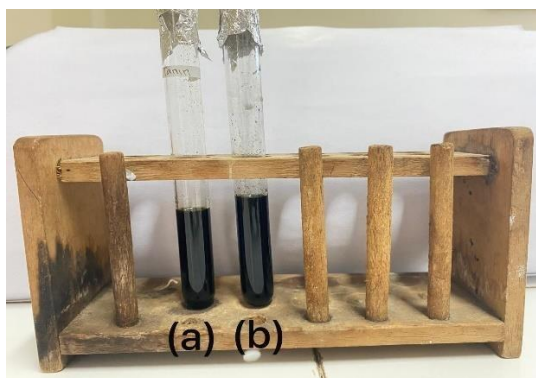


Figure 1. Phytochemical Identification Results of Tannin.
(a) mangrove stem sample results, (b) tannin reference standard.

Phytochemical Screening is a test to determine the chemical compounds present in a substance. This screening is conducted to provide an overview of the classes of compounds contained in the mangrove stem extract using 1% FeCl₃. This is supported by Harborne (1987), who states that the classical method for detecting simple phenolic compounds is to add the extract to a 1% FeCl₃ solution in water, which produces a strong green, red, purple, blue, or black color. In this study, a positive tannin result is indicated by a dark green color. The reference standard used in this study is tannin with a dark green solution color. This aligns with the research conducted by Tika Meliyati (2020), which found that mangrove stems contain tannin compounds that react with FeCl₃, resulting in a black color.

2. Antibacterial Activity Test of *Vibrio parahaemolyticus*

The method used to measure antibacterial activity is the disc diffusion method, as the extract from the mangrove stem is in liquid (suspension) form. This method facilitates the even distribution of the extract onto the disc, allowing the active compounds to diffuse through the agar medium. Additionally, *V. parahaemolyticus* is a pathogenic bacterium that grows optimally in both liquid and solid environments, making this method suitable for ensuring direct contact between the bacterium and the active compounds through diffusion, thus enabling the evaluation of the extract's effectiveness against the bacteria (Jawetz, et al. 2008).

Table 1. Results of Antibacterial Activity Test of Mangrove Stem.

Concentration	R1	R2	R3	Mean±SD	Interpretation
Ciprofoksasin(+)	16,35	18,4	20,8	18,51±1,81	Strong
5%	8,75	11,6	10,95	10,43±1,21	Medium
10%	9,5	13,15	12,5	11,71±1,58	Strong
15%	10,9	13,6	15,6	13,36±1,92	Strong
DMSO(-)	0	0	0	0	

Explanation: R1: Replication 1, R2: Replication 2, R3: Replication 3.

This is consistent with the statement by Surjowardojo et al. (2015), which states that if

the inhibition zone diameter is less than 5 mm, it is categorized as weak; 6-10 mm as moderate; 11-20 mm as strong; and more than 20 mm as very strong.

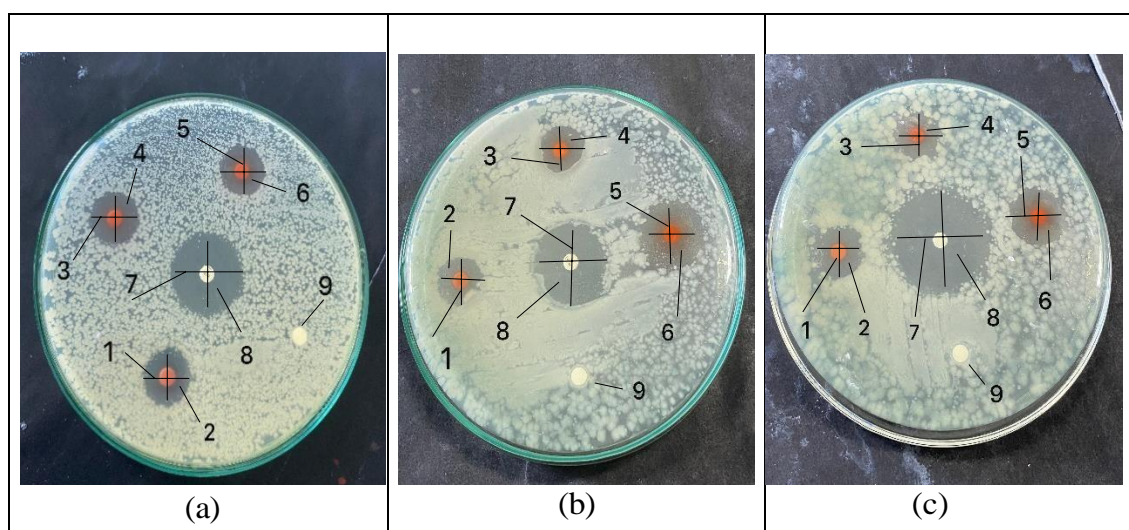


Figure 2. Results of antibacterial activity test of 96% ethanol extract of mangrove stem at concentrations of 5%, 10%, 15%, and Ciprofloxacin and DMSO 10%.

(a) Replication 1, (b) Replication 2, (c) Replication 3

Figure 2 shows that the ethanol extract of mangrove stems has antibacterial activity against *Vibrio parahaemolyticus* bacteria. Compounds known to play a role in inhibiting bacterial growth include tannin compounds, which act as antibacterial agents by inhibiting the enzymes reverse transcriptase and DNA topoisomerase, preventing bacterial cell formation, disrupting protein transport, inactivating cell adhesion, and deactivating enzymes inside bacterial cells (Agustin, et al. 2018).

3. DATA ANALYSIS

Antibacterial analysis helps assess the effectiveness of treatments statistically, providing a more objective evaluation of the differences in effectiveness between various statistical methods or concentrations in combating bacteria. In a one-way ANOVA analysis, several factors must be considered: the data must be normally distributed, the data must be homogeneously distributed, and the variance of each data group must be uniform or homogeneous. Homogeneity of variance means that the data distribution within each treatment group is similar. If this assumption is violated, the differences between groups may be due to data variability rather than the treatment itself.

The results of the homogeneity and normality tests were analyzed using Levene's Test for homogeneity and the Shapiro-Wilk Test for normality. The homogeneity test (Levene's Test) produced a significance value (sig.) of 0.922. Since this value is greater than 0.05, it can be concluded that the data meets the assumption of homogeneity (the variance between groups is considered equal). The normality test resulted in a p-value greater than 0.05, indicating that the data is normally distributed. The one-way ANOVA analysis resulted in a p-value of 0.006 ($p < 0.05$), indicating a significant difference between the group means. This means that at least one group differs significantly from the others.

Table 2. Post Hoc Tukey Test

Concentratio n	5%	10%	15%	K(+)	K(-)
5%	0,000	0,865	0,354	0,005	0,000
10%	0,865	0,000	0,757	0,015	0,000
15%	0,354	0,75	0,000	0,058	0,000
K(+)	0,005	0,015	0,058	0,000	0,000
K(-)	0,000	0,000	0,000	0,000	0,000

Table 2 compares the differences in the mean values of the "Inhibition Zone Diameter" among various treatment groups. The purpose of this test is to identify whether there are statistically significant differences in the inhibition zone between each pair of treatments. The significance value (Sig.) in the table is crucial for determining whether the differences are statistically significant at the 0.05 level. A significance value (p-value) of less than 0.05 indicates a significant difference between groups.

- **Positive Control and 5%:** The mean difference is 808.33 with a p-value of 0.005, indicating a significant difference. The 95% confidence interval (CI) ranges from 276.55 to 1340.12.
- **Positive Control and 10%:** The mean difference is 680.00 with a p-value of 0.015, indicating a significant difference. The CI ranges from 148.21 to 1211.79.

Discussion

The **best inhibition zone of the antibiotic ciprofloxacin against *Vibrio parahaemolyticus*** varies depending on the study and testing method. In general, ciprofloxacin is known to be effective in inhibiting *Vibrio parahaemolyticus*, with an inhibition zone diameter that can exceed 20 mm in bacterial sensitivity tests (using the disc diffusion method).

One study that examined the effectiveness of ciprofloxacin against *Vibrio parahaemolyticus* was conducted by Jeya Sekaran et al. (2006), which demonstrated that ciprofloxacin is an antibiotic with excellent activity in inhibiting the bacteria. In this study, the inhibition zone of ciprofloxacin was found to be 18.51 mm. The variation in results can be attributed to several factors, such as differences in the ciprofloxacin concentration used, variations in bacterial strains, and differences in environmental or media conditions, including pH and media composition.

Conclusion

The **96% ethanol extract of mangrove stems**, tested using the disc diffusion method, exhibits antibacterial activity against *Vibrio parahaemolyticus*. The inhibition zone of the mangrove stem extract at a **5% concentration** against *Vibrio parahaemolyticus* was **10.43 mm**, categorized as **moderate**.

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222402

Serum Vitamin D Level and Degree of Aging Signs Measuring Age Spots and Wrinkles

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Abstract

Background: Vitamin D has well known antioxidant and anti-inflammatory activities which can prevent the aging signs by fighting against free radicals. Wrinkles and age spots are the prominent aging signs commonly seen in elderly people. Since vitamin D fight against the reactive oxygen species, aging spots and wrinkles are more likely to be seen in the individuals with lower serum vitamin D level.

Objective: To study the correlation between Vitamin D level and degree of aging signs (age spots and wrinkles) in Thai Bangkokian.

Methods: Total 19 volunteers, aged 40-60 years old male and female who meet all inclusion and exclusion criteria are selected to participate in cross sectional descriptive study. The blood collection was done for detection of serum vitamin D level (25 OH vitamin D). Then, the degree of aging spots and wrinkles are tested by VISIA system and Glogau Scale respectively.

Result: There is no significant correlation between serum vitamin D level and degree of age spots. However, the serum vitamin D level is significantly negatively correlated with degree of wrinkles measured by Glogau Scale.

Conclusion: In this study, level of serum vitamin D is correlated with aging parameters including age spots and wrinkles. The results demonstrated that there is no significant correlation between serum vitamin D levels and aging parameter for age spots and wrinkles measured by VISIA scan. However, serum vitamin D levels and degree of facial wrinkles are significantly negatively correlated measured by Glogau scale.

Keywords: Vitamin D, Free Radicals, Wrinkles, Age Spots, Reactive Oxygen Species

Introduction

Aging is a process of progressive changes in physiological functions in the organisms that lead to senescence, or irreversible decline in biological function to adapt the metabolic stress (Bocheva, 2021). Skin, like any other organs, undergoes aging with gradual decline in morphological and physiological features (Zhang, 2018). Skin aging process is characterized by structural and functional alterations in extracellular matrix components such as collagens and elastin.

Aging of skin is a complex process and both genetic (intrinsic) and environmental (extrinsic) factors play an important role in it (Bocheva, 2021). The epidermis becomes more fragile and age spots appears on the skin as melanocytes number and their function are altered in older age. Dynamic changes such as loss of volume in the dermis, decreased collagen and loss of fat, together with gravity and muscle pull, leads to wrinkles and the formation of dynamic lines in loss of elasticity (Kahn, 2010). Vitamin D is an essential nutrient for skin and

is also a natural antioxidant which is very important for the health of the skin. The active metabolites of vitamin D₃ shows an antiaging and photoprotective effects on the (Bocheva, 2021). They exhibit these effects through anti-inflammatory action and antioxidant action (Bocheva, 2021). They also prevent premature skin aging by preventing DNA damage and promoting the DNA repair mechanisms (Bocheva, 2021). So, they can be used as prevention and treatment of premature skin aging.

25-hydroxy vitamin D₃ [25(OH)D₃] is a major circulating metabolite of vitamin D and it reflects the level of vitamin D status in the body (Bocheva, 2021). Vitamin D deficiency in general population has been a global problem (Bocheva, 2021).

The level is contributed by physiological factors such as age, skin type, BMI (body mass index), pregnancy and exclusive breastfeeding. And the environmental factors may also influence the level of vitamin D such as sun exposure, winter season and high latitude location. Vitamin D deficiency is very common in older people and this problem can deteriorate the skin morphology as well as the skin function (Bocheva, 2021).

One more function of vitamin D is that it involves in telomeres biology and cellular aging (Zarei, 2021). Telomeres are specific DNA-protein structures present at the end of the chromosomes (Shammas, 2011). A small portion of the telomeric DNA is lost and the length of telomere become shorter progressively every time the cells divide (Shammas, 2011). Shorter telomeres increase the chance of cellular senescence and release the inflammatory molecules (Weintraub, 2017). When the levels of telomerase activity declines, the length of the telomere become shorter resulting in cell senescence and apoptosis (Zarei, 2021). Increasing numbers of senescent cells may lead to acceleration of cellular aging.

Vitamin D decrease the rate of telomere shortening through anti-inflammatory and anti-cell proliferation mechanisms (Zarei, 2021). In the study of US radiology technologists, vitamin D deficiency was associated with shorter length of the telomere in whites but not blacks (Liu, 2016). One study also suggest that higher vitamin D concentration is associated with longer telomere length, which have the potentially beneficial effects of vitamin D on aging (Zarei, 2021).

Nowadays anti-aging is so much popular because people concern about their aging looks a lot. There are so many anti-aging treatments which can make people looks younger than their actual age. However, aging comes from inside of our body and this process is irreversible. The burden of lifelong inflammation and oxidative stress may induce shorter telomere and advanced aging. In view of the fact that prevention is always better than cure, maintenance of the physiology is the best way for anti-aging. The conditions inside the body must be known in order to maintain the physiological function of it. For skin, there are so many factors influencing the health of the skin including nutrition, exercise, sun exposure and skincare. As vitamin D has huge role in the maintenance of the skin aging, there may have relationship between the serum vitamin D status and level of skin aging which includes age spots and wrinkles. The purpose of this study is to reveal that the low serum vitamin D level is associated with higher prevalence of appearing aging spots and wrinkles in elderly people.

1. Research Objectives

1.1 To study the correlation between Vitamin D level and degree of aging spots in elderly people

1.2 To study the correlation between Vitamin D level and degree of facial wrinkles in elderly people

2. Materials And Methods

2.1 Research Design: Cross-sectional descriptive study

2.2. Study area: Bangkok, Thailand

2.3 Study Population: Volunteers with age spots and wrinkles, both male and female, ages 40-60 years, who matched with all inclusion criteria.

2.4 Sample: Volunteers with age spots and wrinkles, both male and female, ages 40-60 years, who matched with all inclusion criteria.

2.5 Sample Size Determination: The study of association between vitamin D level and aging signs such as age spots and wrinkles has never been established before, so the researcher chose to calculate the sample size with the following formula (Hulley SB, 2013).

set $r = 0.6$,

Type I error, α (two-tailed) = 0.05

Type II error, $\beta = 0.20$

$Z_{\alpha/2} = 1.96$

$Z_{\beta} = 0.84$

$C = 0.5 * \ln[(1+r)/(1-r)]$, if $r = 0.6$

Total sample size = $n = [(Z_{\alpha/2} + Z_{\beta})/C]^2 + 3$

Total sample size = $n = [(1.96 + 0.84)/0.6931]^2 + 3 = 19$

n = Minimal required sample size

Z_{α} = Standard normal deviate for $\alpha = 1.96$ for 95 % CI

Z_{β} = Standard normal deviate for $\beta = 0.84$ for power of the test 80%

r = expected correlation coefficient = 0.6 (assumption)

2.6 Inclusion Criteria

1. Healthy volunteers with age spots and wrinkles, both male and female, ages 40-60 years, who live in Bangkok
2. Healthy volunteers with wrinkles (Glogau wrinkle scale Type 2 and above), both male and female, ages 40-60 years, who live in Bangkok
3. Healthy volunteers with visible age spots, both male and female, ages 40-60 years, who live in Bangkok
4. All volunteers are required to sign an informed consent form of benefits and risks of the procedure and documentation and publication of photographs.

2.7 Exclusion Criteria

1. Microdermabrasion
2. Lasers both ablative and non-ablative
3. Intense pulse light
4. Chemical peeling
5. Botox injection
6. Skin needling
7. Facial whitening agent
8. Exposure to heavy sunlight daily
9. Use of hormones, supplements or drugs that affect melanogenesis

These criteria are excluded from the duration of 6 months before the procedure.

Results And Discussion

1. Results

1.1 General Characteristics (Demographic data)

Table 1 Baseline characteristics of sample (Demographic Data)

Variable	n = 19
Gender, n	
Male	7
Female	12
Age (years), mean±SD (Min-Max)	50.84±7.14 (40-60)
Occupation, n	
Employee	8
Housewife/retired	7
Offsite work	4
Sunlight exposure 1-2 hours/day,	2
Treatments within 6 months, n	1

According to the baseline characteristics presented in table 4.1 of 19 healthy volunteers with age spots and wrinkles, there were 12 females and 7 males, with a mean age of 50.84±7.14 years. The majority of them worked as employees were 8, while 7 were housewives/retired, and 4 were offsite work. Two participants were exposed to sunlight, and only one had received treatment within the past 6 months.

1.2 Clinical Evaluation

1.2.1 Clinical evaluation of Aging sign parameters and degree of wrinkles

Table 2 Statistical Analysis of Aging sign parameters (visible spots, UV spots, brown spots) and degree of Wrinkles

Variable	n = 19
Visible spots (%), mean±SD	49.32±25.31
Visible spots scale, n	
0 (0-20%)	2
1 (21-40%)	8
2 (41-60%)	2
3 (61-80%)	4
4 (81-100%)	3
UV spots (%), mean±SD	95.37±2.71
Brown spots (%), mean±SD	86.74±8.01
Degree of Wrinkles by VISIA scan (%), mean±SD	44.63±22.19
Degree of Wrinkles scale, n(%)	
0	3

Variable	n = 19
1	5
2	7
3	4
4	0
Degree of Wrinkles by Glogau scale, n	
Type 1 (No wrinkles)	0
Type 2 (Wrinkles in motion)	5
Type 3 (Wrinkles at rest)	10
Type 4 (Only Wrinkles)	4

According to the aging sign parameter of participants presented in table 4.2. The finding revealed that the mean of visible spots was $49.32 \pm 25.31\%$, with the majority at the level of 21-40% for 8 subjects (42.1%), followed by 61-80% for 4 subjects (21.1%) and 81-100% for 3 subjects (21.1%), respectively. The mean of UV spot was $95.37 \pm 2.71\%$ and the brown spots were $86.74 \pm 8.01\%$. For the degree of wrinkles, measured by both VISIA scan and the Glogau scale, the mean percentage of wrinkles identified by VISIA scan was $44.63 \pm 22.19\%$. The majority were in 41-60% for 7 subjects (36.8%), followed by 21-40% for 5 subjects (26.3%) and 81-100% for 4 subjects (21.1%), respectively. The degree of wrinkles measured by Glogau scale mostly were Type 3 (Wrinkles at rest) for 10 subjects (52.6%), followed by Type 2 (Wrinkles in motion) for 5 subjects (26.3%) and Type 4 (Only Wrinkles) for 4 subjects (21.1%), respectively.

1.2.2 Clinical evaluation of serum vitamin D level

Table 3 Serum vitamin D levels

Variable	n = 19
Serum vitamin D levels (ng/ml), median (IQR)	28.9 (25, 31.4)
Serum vitamin D classification, n	
Deficiency (<20 ng/ml)	4
Insufficiency (21-29 ng/ml)	7
Sufficiency (31-100 ng/ml)	8

According to the serum vitamin D levels of participants presented in table 4.3, the finding revealed that the median of serum vitamin D levels was 28.9 (IQR 25, 31.4) ng/ml, The majority had sufficiency vitamin D (31-100 ng/ml) for 8 subjects (42.1%), followed by insufficiency vitamin D (21-29 ng/ml) for 7 subjects (36.8%) and deficiency vitamin D (<20 ng/ml) for 4 subjects (21.1%), respectively.

2. Discussion

Along with the aging process, wrinkles and age spots are most visible and commonest problem of skin aging. Both intrinsic and extrinsic aging processes can lead to develop these skin aging symptoms.

Vitamin D is important for cellular differentiation, proliferation and apoptosis processes. The anti-inflammation and anti-cell proliferation ability of vitamin D reduce the telomere shortening. There is a reduction of telomere length during aging and this leads to decrease in cell proliferation resulting in cellular senescence which characterizes the aging process.

The normal vitamin D status is required for prevention of premature aging. Vitamin D metabolites including active form of 1,25 di-hydroxyvitamin D₃ have protective effects on the skin. They influence on the process of premature aging by delaying both chronological and photoaging.

According to this study, the level of serum vitamin D shows no significant relationship with age spots. However, there is correlation between serum vitamin D level and degree of wrinkles measured by Glogau Scale.

Based on the results of VISIA Scan for aging spots, the finding revealed no significant correlation between vitamin D levels and visible spots ($p=0.974$), UV spots ($p=0.454$), and brown spots ($p=0.129$).

Moreover, the finding revealed no significant correlation between vitamin D levels and degree of wrinkles measured by VISIA Scan ($p=0.187$).

Nevertheless, the serum vitamin D levels was significantly negatively correlated with wrinkles measured by the Glogau scale ($\rho=-0.526$, $p=0.021$). This implies that higher vitamin D levels are associated with a lower rating on the Glogau scale, while lower vitamin D levels are associated with a higher rating on the Glogau scale. There are more wrinkles in volunteers with lower level of serum vitamin D.

There were no research studies about the correlation between serum vitamin D and degree of aging parameters. This may be the first and more researches about the relation may be required in various areas and various people. Correlation between the serum vitamin D levels and the aging parameter for age spots and wrinkles measured by VISIA scan. However, according to the statistical analysis result, the serum vitamin D levels and degree of facial wrinkles are significantly negatively correlated measured by the Glogau scale.

Conclusion

In this study, the level of serum vitamin D is correlated with aging parameters including age spots and wrinkles. The results demonstrated that there is no significant correlation between the serum vitamin D levels and the aging parameter for age spots and wrinkles measured by VISIA scan. However, according to the statistical analysis result, the serum vitamin D levels and degree of facial wrinkles are significantly negatively correlated measured by the Glogau scale.

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Session 3: Technology and Agricultural Innovation**322082****Exploring the potential for waste reduction by using sewage sludge as a fertilizer****Aumaporn Suwanwiset¹ Tunyaboon Laemthong¹ and Phanida Saikhwan^{1*}**¹Department of Chemical Engineering, Faculty of Engineering, Thammasat School of Engineering, Thammasat University, Klong 1, Klong Luang, Pathumthani 12120

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Abstract

This study explored the potential of utilizing sewage sludge from a chicken meat processing plant as a fertilizer. Both sludge without any treatment (Sample S) and sludge with composting were studied (Sample S100). The formulation given by the Land Development Department's guidelines was used in composting sludge. This formulation contains plant residues, animal manure, nitrogen fertilizer or liquid fish fertilizer and LDD1 containing microorganisms to fasten composting (*Trichoderma sp.* and *Actinomycetes Bacillus sp.*). To improve waste management in the factory, waste which is available within the plant's facilities, namely corn residues (corn cobs and leaves), and chicken manure were used as plant residues and animal manure, respectively. Nitrogen fertilizer or liquid fish fertilizer was not used in the composting as they are not readily available within the plant's facilities. Sample C was prepared following the reference formulation using corn residues as plant residues whereas Sample S100 was made by replacing plant residues with the sludge. Composting of Samples C and S100 was done for 6 weeks; temperature, moisture content, pH and electro conductivity (EC) were monitored throughout the composting phase up to 7 weeks. The temperature profile suggested that degradation of materials of Sample S100 occurred and finished within the first week whereas such degradation of Sample C could be observed in the beginning of 2nd week. Moisture contents of both samples increased around the first week and decreased. However, the moisture content of Sample S100 was constantly higher than the range suggested for the optimal composting conditions (50-60%) throughout the rest of composting period. pH of both samples increased to steady values around pH 8.5 which is acceptable by the organic fertilizer standard. EC of both samples decreased during composting. It should be noted that the final EC values of Sample C was at the top borderline of the acceptable EC range specified by the organic fertilizer standard.

Samples C, S100 and S were used to grow corn. Initial corn growth rates over the first four weeks were monitored in terms of plant height, stem diameter, and leaf count. The fertilizer formulations used had insignificant impact on the number of leaves. Considering plant height and diameter, samples C and S showed comparable good results whereas sample S100 gave only slightly shorter plant height and smaller diameter. The work showed the potential for using the sludge as a fertilizer.

Keywords: Sewage sludge, Organic fertilizer, Composting, Chicken manure

Introduction

Sewage sludge is the solid component generated during wastewater treatment. The sludge is generally disposed either by landfilling, incineration or ocean dumping depending on its components (Ye et al., 2022). As a large amount of water is treated every day in production lines worldwide, the amount of sludge to be disposed of is also considerably large. Recently, numerous studies have investigated utilization of wastewater sludge. Using sludge as a fertilizer or soil improver has been considered a good option based on economic and environmental perspectives (Maroušek et al., 2021). Chicken meat and chicken meat products production plant generates a substantial volume of wastewater containing blood, oil and grease, starch, and feathers. Hence, it is expected that the sludge should be rich of organic matter and can be potentially used as a fertilizer or soil amendment. Utilization of the sludge will not only reduce the amount of waste disposal but also save large amount of disposal costs that could incur. This concept while adopting a zero-waste approach, also aligns with the company's goals for sustainable waste management and resource efficiency.

However, a thorough study of the utilization of the sludge has not been conducted. Hence, this research aimed to study the utilization of wastewater sludge generated by a factory making chicken meat and chicken meat products. Consider the components that go through the wastewater line, the sludge could be rich in organic matters, but they may not be used readily by plants. could lack of some nutrients useful for plant's growth. Moreover, the organic matters present in the sludge could be in forms that cannot be used immediately by plants. Therefore, co-composting of the sludge with other organic by-products from the facility, such as poultry manure mixed with rice husk, corn leaves, and corn cobs, was explored in this study. The findings will be beneficial as it will provide an insight of how co-composting of the sludge with other organic by-products from the facility, such as poultry manure mixed with rice husk, corn leaves, and corn cobs, was explored in this study. The findings will be beneficial as it will provide an insight of how a sustainable sludge management for chicken processing plants could be established. The results could also be applied to other factories with similar products.

1. Research Objectives

1.1 Investigating the potential of sewage sludge from a chicken meat processing plant as an organic fertilizer.

1.2 Evaluating the effects of composting sludge with corn residues and chicken manure on its physicochemical properties.

1.3 Analyzing the performance of sludge-based fertilizers in promoting the growth of corn plants.

2. Materials and Methods

2.1 Sample Collection and Preservation

The sludge was collected from a chicken meat processing factory in central Thailand, specifically from the belt press dewatering system. The sludge was then evenly spread on plastic sheet in a shaded area to be air-dried. This step was to reduce moisture content of the sludge from 91.3% to approximately 36.5% (checked by a moisture analyzer, DSH-50-1, YuePing, China). The air-dried sludge samples were stored in clean, tightly sealed plastic bags and kept at room temperature in a dark environment for further analysis.

2.2 Preparation of Fertilizer From Sewage Sludge

Three fertilizer samples were prepared in this study as shown in Table 1. Sample S was the sludge without any composting whereas sample S100 was the sludge with co-

composting. The formula used for preparing sample S100 was based on the compost formulation recommended by the Department of Land Development (Department of Land Development., 2022). This formulation was used to prepare a control sample (Sample C) in this study.

The reference formula included four materials: 1,000 kg of plant residues, 200 kg of animal manure, 2 kg of nitrogen fertilizer or 9 liters of fish liquid fertilizer, and 1 packet of Land Development Department no.1 (LDD 1) containing eight strains of beneficial microorganisms (Cellulose Hemicellulose Lignin *Trichoderma sp.* Actinomycetes Bacillus sp.). The reference formula was slightly modified to contain only plant residues and animal manure as it was aimed to make organic fertilizers and fish liquid fertilizer was not available within the plant facilities. Corn cobs and leaves were used as the plant residue in this study whereas chicken manual was used as the animal manure. These are wastes readily available within the chicken meat processing plant facilities. Prior to composting, sludge, corn leaves, and cobs were shredded into smaller particles (~2–5 cm) to increase the surface area for microbial activity. The particle size was selected based on recommendations from previous studies (Haug, 1993) to optimize decomposition efficiency. It should be noted that the available chicken manure comes together with rice husks. This mixture, hence, was assumed to be equivalent to animal manure when composting was conducted.

Table 1. Formulas used to prepare fertilizer samples; sample C was based on the formulation by the Department of Land Development (Department of Land Development., 2022), sample S was the sludge without composting and S100 was the sludge with composting.

Components	Amount used		
	C	S	S100
Sludge	0 kg	1200 kg	1000 kg
Corn leaves and cobs	1000 kg	0 kg	0 kg
Chicken manure mixed with rice husks	200 kg	0 kg	200 kg
LDD 1	1 packet	NA	1 packet

Sample S was to evaluate the possibility of using the sludge as a fertilizer without any additional process whereas Sample S100 was to study effects of composting the sludge with other organic matters. Although the sludge could contain more organic matters and have components more similar to animal manure than plant residue, the amount of sludge used in S100 was based on replacing plant residue (corn leaves and cobs in this study) with the sludge. This was because the amount of sludge available in the chicken meat processing plant was larger than corn leaves and cobs. Hence, for the waste management in the plant to be feasible, the sludge must be used in a larger amount than corn leaves and cobs.

When sample C and sample S100 were prepared, their moisture contents were monitored and controlled within 50–60%, the recommended value for composting (Haug, 1993). Moisture content adjustments were made by adding water or drying materials as needed. Aerobic composting of these samples then was done in fertilizer bags with lid open to ensure accessibility of oxygen. The composting process lasted 42 days with periodic turning every 7 days. According to the reference formulation by the Department of Land Development, composting should be done for around 30 - 45 days; this is a shorter period compared to a typical composting process because LDD 1 was used. During the composting, pH, moisture content, temperature, and electrical conductivity (EC) were measured weekly.

The temperature was measured using a thermometer at five different points within the compost pile, including the center, edges, and surface, to ensure comprehensive monitoring

of thermal variations. Moisture content was determined using a Moisture Analyzer (DSH-50-1, **YuePing**, China), with each sample measured three times to calculate an average value for greater reliability.

For pH and electrical conductivity (EC) measurements, three subsamples were taken from different sections of the compost pile (in the center of the pile at the top (exposed to air), middle and bottom). pH and EC measurements were conducted using the protocol reported by Chen et al. (2018). Each subsample, weighing 5 grams, was mixed with 25 ml of distilled water at a ratio of 1:5 (w/v). The mixture was thoroughly stirred and left to stand for 1 hour to allow stabilization before measurements were taken. The pH and EC values were then determined using the calibrated pH/Conductivity Meter Kit (PC950, Apera Instruments, United States of America).

2.3 Preliminary study of effects on corn growth rates

The effects of three fertilizer formulations S, S100, and C on the growth rate of sticky corn (glutinous maize) were studied. Corn was selected as the test crop due to its high nutrient requirements, ease of observation for growth rates, and significance as an important economic crop. Corn plays a vital role in various industries, including animal feed, food production, and bioenergy. Additionally, the results from this experiment can be applied to other crops with similar nutrient demands. Overall, corn is a suitable choice for evaluating the quality of compost, as it effectively reflects the fertilizer's quality and efficiency within a short period. Moreover, the studied plant grows corns to feed chicken. If the sludge-based fertilizers gave good results on corn growth rates, the fertilizers could be used within the plant.

The three fertilizer formulations C, S100, and SC were used to grow corn and corn growth rates were observed. Corn seeds were sown in pots containing soil mixed with each fertilizer at equivalent application rates (Use 10 kilograms of planting soil and add 200 grams of fertilizer to the bottom of the planting hole. Then, mix the fertilizer with the soil slightly to ensure even distribution and reduce heat buildup. Afterward, plant the seeds in the pot, level the soil, and water thoroughly to help stimulate seed germination.) to ensure a fair comparison. To assess the impact of each fertilizer formulation on plant development, key parameters were measured weekly. The parameters included plant height, stem diameter, and the number of leaves. Plant height was measured from the soil surface to the base of the flag leaf (Abendroth et al., 2011). Stem diameter was measured at the base of the stem using calipers (Elmore et al., 2012). The number of leaves was counted from the first leaf with a visible collar to the uppermost leaf (Purdue University, 2024). Details of how each of these parameters were measured are listed in Table 2.

Table 2. Definitions of plant growth parameters and the instruments used in this research

Parameter	Definition	Instrument
Plant height	The vertical distance from the base of the stem to the base of the flag leaf	Measuring tape
The number of leaves	The number of leaves is counted as all fully expanded leaves with a visible leaf collar, from the first leaf with a visible collar to the highest leaf with a visible collar.	Counting Leaves
Stem diameter	The stem diameter of corn is measured at the base of the stem, just above the soil surface.	Caliper

Because of the time limitation, only the results of the first 4 weeks are present in this paper (expected growing time ~ 60 days). The 4-week period is considered as the initial growth phase of the corn where seed formation has not started.

3. Results & Discussion

3.1 Changes in physicochemical characteristics during composting

3.1.1 Temperature

Temperature measurements were taken throughout the composting process to monitor microbial activity and ensure optimal conditions for decomposition. Typical change in temperature during composting consists of three stages: (i) heating, thermophilic, and cooling maturity periods (Li et al., 2021).

In the first week of composting, (Figure 1) the temperature of the compost pile typically rises above the normal ambient temperature. This increase is primarily due to the metabolic activity of thermophilic microorganisms, which break down organic matter and release heat as a byproduct; this early stage of composting is when easily degradable materials such as sugars, proteins, and starches, are abundant (Haug, 1993). The elevated temperature not only accelerates the decomposition process but also helps reduce pathogens and weed seeds in the pile (Haug, 1993).

The results of the composting process revealed that during the first week, the compost temperature was higher than the ambient room temperature of 31°C, indicating active composting activity. Sample C showed a noticeable temperature increase during the first week, followed by a decline in the subsequent weeks, suggesting that the composting process primarily occurred in the initial phase. In contrast, the temperature of Sample S100 did not rise significantly, which may be attributed to a shorter active composting phase, likely lasting less than a week.

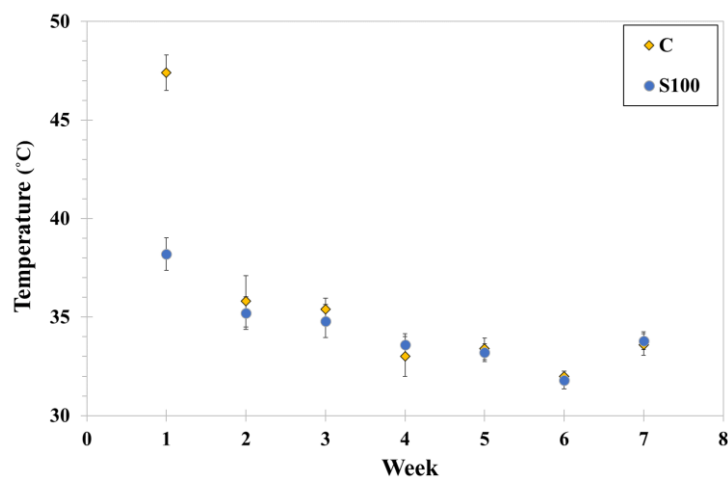


Figure 1. Temperature profiles during composting of samples C (Control) and S100 (Sludge Compost) over a 7-week period.

3.1.2 Moisture Content

Moisture levels were also monitored throughout the composting process as shown in Figure 2. It was observed that Sample SC exhibited relatively high moisture content, despite initial moisture control. This suggests that the composting process in Sample SC released a substantial amount of water. Excess moisture likely exceeded the optimal range for composting, potentially halting or slowing down microbial activity, which could explain the observed drop in temperature of SC sample within the first week of composting. (Figure 2).

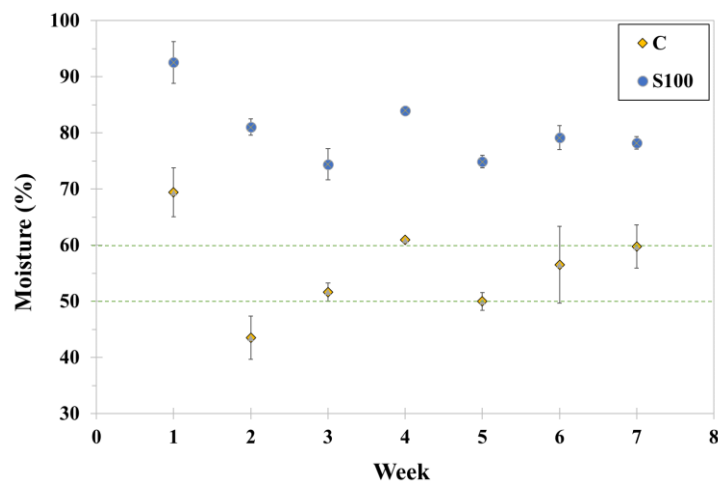


Figure 2. Moisture content of composting samples C (Control) and S100 (Sludge compost) over a 7-week period; appropriate temperature range for composting is between 50-60% shown by the dotted lines.

3.1.3 pH and Electrical Conductivity (EC)

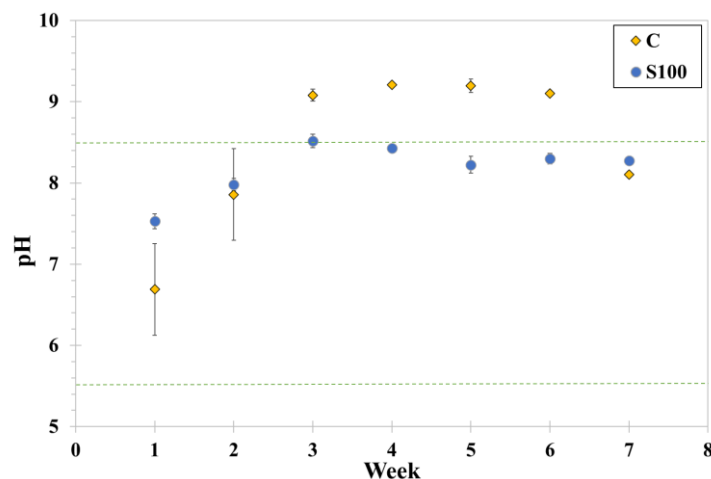


Figure 3. pH of composting samples C(Control) and S100 (Sludge compost) over a 7-week period; dotted-lines show the standard range for organic fertilizers (5.5–8.5) as specified by the Department of Agriculture's Fertilizer Act, (2005).

Both pH and EC decreased over time during the composting as shown in Figure 3 and Figure 4, respectively. By the end of the composting process, the pH values for both samples were similar and aligned with the upper limit of the acceptable pH range for compost, as per standard guidelines. Meanwhile, the EC value for Sample S100 was lower than that of Sample C, which remained at the upper threshold of the acceptable EC range.

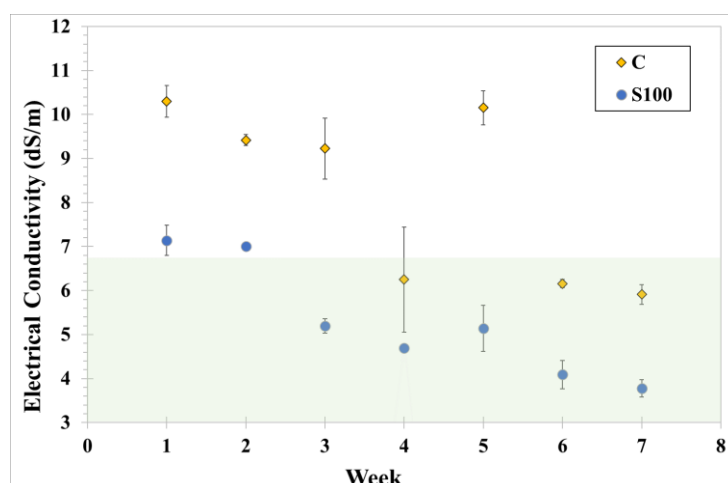


Figure 4. Electrical conductivity (EC) of composting samples C (Control) and S100 (Sludge compost) over a 7-week period; the maximum limit of EC specified by the Department of Agriculture's Fertilizer Act (2005) is shown by the dotted line.

3.2 Effects on initial growth rates of corns

Because of the time limitation, nutrient analysis of all the fertilizer samples was not completed. EC and pH of the three fertilizer samples were summarized in Table 3. It should be noted that EC and pH of samples C and S100 were the values obtained at the end of composting period shown in Figure 3 and 4, respectively.

Table 3. pH and EC values of samples C, S100 and S.

Sample	pH	EC (dS/m)
C	8.10 ± 0.04	5.91± 0.22
S100	8.27± 0.04	3.77± 0.20
S	6.54 ± 0.01	2.22± 0.12

According to Figure 5, the average plant heights observed with the three fertilizer samples were similar in the 1st week. In the 2nd week, the average height associated with sample C was higher than those from other samples. Nevertheless, from the 3rd week onwards, the average heights observed with samples C and S were similar. Although sample S100 gave shorter plants in overall, the range of plant height overlapped with the ranges observed with the other two samples as shown by error bars in Figure 5.

Consider changes of stem diameter over time (Figure 6), initially within the first two weeks, stem diameters monitored from all the plants were similar. In the 3rd week, plants grown using sample C had the highest stem diameters. Sample S100 gave slightly smaller stem diameters than sample C and these stem diameters were only slightly higher than those observed from the pants grown using sample S. However, in the 4th week, the average diameters observed with sample C and S were similar.

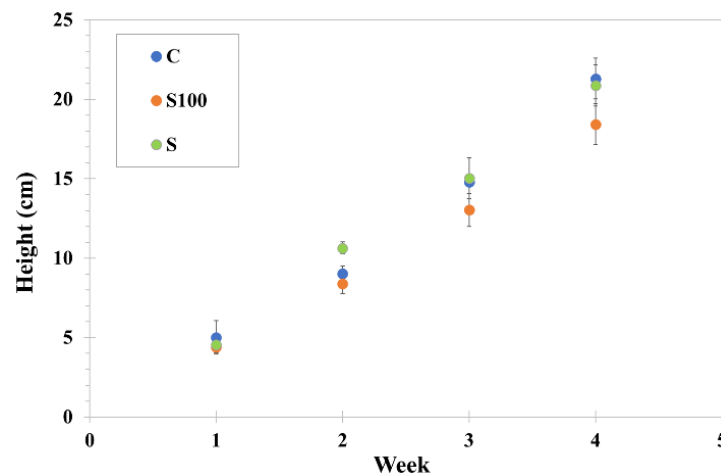


Figure 5: Effect of fertilizer formulations on corn plant height over time (4 weeks).

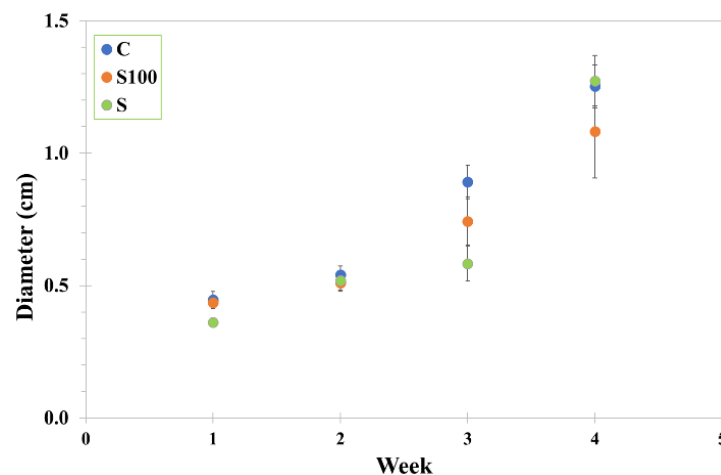


Figure 6: Effect of fertilizer formulations on stem diameter of corn plants over time (4 weeks).

From the results in Figure 5 and 6, it could be seen that an increase in growth rates in terms of plant height and stem diameter observed with sample C occurred before other samples. However, at the end of the observed period, samples C and S gave similar overall growth rates in terms of plant height and stem diameter. From the previous studies, such as those by Smith et al. (2018), sludge-based composts have been reported to be rich in essential nutrients like nitrogen, phosphorus, and potassium, which promote plant growth. The sludge in this work could have similar nutrients to the mixture of materials used to make sample C. However, composting could make the nutrients in sample C more readily easy to use than those in sample S.

Considering pH and EC, the pH of sample C was more suitable for plant growth compared to sample S. The higher pH in sample C falls within the optimal range for nutrient availability (6.0–7.5), while sample S exhibited a lower pH, which may limit the bioavailability of essential nutrients like nitrogen, phosphorus, and potassium. This is consistent with the findings of Brady and Weil (2008), who noted that pH outside the optimal range reduces nutrient solubility and uptake efficiency. Additionally, the EC of sample C was moderate, providing an adequate balance of dissolved nutrients without causing salinity stress. Marschner (2012) and Havlin et al. (2014) highlight the importance of maintaining moderate EC levels for efficient nutrient delivery and preventing osmotic stress, which could hinder water and

nutrient uptake by plants. These factors contribute to the superior growth performance of plants treated with sample C compared to sample S.

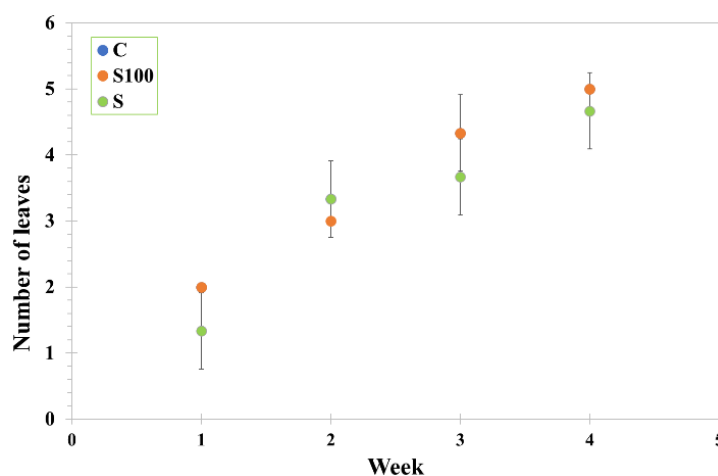


Figure 7: Effect of fertilizer formulations on leaf

number of corn plants over time (4 weeks); Data associated with sample C were missing because the number of leaves in Formula C is the same as in Formula S100 in weeks 1, 3, and 4, and the same as in Formula S in week 2.

According to Figure 7, the fertilizer formulations had insignificant impacts on the number of leaves observed within the 4 weeks. This is in accord with the literature reported that plant height gave overall plant vigor during the early stage of growth (Abendroth et al., 2011).

Soil pH and electrical conductivity (EC) are critical factors that collectively influence nutrient availability, water uptake and the potential stress on plants, as deviations from the optimal ranges can negatively affect growth (Havlin et al., 2014). The pH range of 6.0–7.5 has been reported to be crucial for efficient nutrient uptake in plants, particularly for corn (Abendroth et al., 2011). This pH range ensures that essential nutrients like nitrogen (N), phosphorus (P), and potassium (K) are in their most available forms for absorption (Marschner, 2012). Considering the optimal pH range, sample S was superior to samples C and S100, respectively (See Table 3). However, considering the suitable EC range for plant’s growth of 1–2 dS/m (Liu et al., 2020), EC values of sample S was closer to the optimal range than samples S100 and C, respectively (See Table 3). This could be the reason why sample S gave a slightly faster growth rate than sample S100. Nevertheless, sample C gave similar growth rate to Sample S. Because both optimal pH and EC improve nutrient uptake (Havlin et al., 2014), sample C could have more nutrients and the slightly lower nutrient uptake could not affect the growth rate. Further work should be conducted to confirm this.

4. Conclusion

This study demonstrated the potential of utilizing sewage sludge from chicken meat processing plants as an effective organic fertilizer through composting with corn residues and chicken manure. Temperature changes during composting suggested that degradation of materials in sample S100 started and ended within the first week whereas the degradation of sample C occurred later around in the 2nd week. Moisture content of sample S100 increased at the beginning of composting and was constantly above the optimal moisture range for composting. Similar changes of pH and EC of the two fertilizer samples were observed during

the composting and at the end of composting pH and EC of both fertilizer samples were within the range required by the standard for organic fertilizer. In comparison, the pH and EC values of sample S, which did not undergo composting, remained lower than those of the composted samples. The pH and EC of sample S were 6.54 ± 0.01 and 2.22 ± 0.12 , respectively. The pH was within the standard for organic fertilizer but the EC was lower than the range listed in the standard. This suggested that composting could improve EC of sludge to align within the standard.

Initial growth studies showed that fertilizer formulations used had no effect on number of leaves. Effects of fertilizer formulations on growth rates in terms of plant height and stem diameter were observed. Although sample C gave highest growth rates in term of these parameters in early weeks, at the end of the 4th week, samples S and C gave similar overall growth rates. In contrast, the S100 formulation, which involved composting sludge with husks and chicken manure, exhibited slightly slower plant growth. However, the differences were not statistically significant as the error bars overlapped among the three formulations.

The findings of this study highlight that sludge-based organic fertilizers not only reduce waste and disposal costs but also provide a sustainable source of nutrients for agriculture. Future research should focus on optimizing fertilizer formulations, conducting field-scale experiments, and evaluating long-term effects on soil quality and crop yields to ensure the sustainability of this fertilizer in both environmental and economic terms.

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Application of Ozone Technology in Leachate Treatment for Sustainable Development: a Brief Review

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Abstract

The application of ozone technology in leachate treatment is a new and promising direction. This article explores an overview of leachate, ozone technology, and the application of ozone technology in leachate treatment through analysis of studies on characteristics of leachate, sources, treatment efficiency, and challenges when using ozone technology to treat leachate. This underscores the importance of further studies to determine properly the advantages and disadvantages, as well as the industrial and broad applicability of ozone technology in leachate treatment, in order to ensure sustainable treatment efficiency, minimize the risk of adverse impacts on human health and the environment. Methods used in this study are information analysis, synthesis, and comparison to evaluate and make valuable comments. The research results are useful for those beginning to study leachate, ozone technology, and its application, helping them get an overview and orientation for their research.

Keywords: Ozone technology, Leachate, Characteristics, Challenges, Wastewater treatment

Introduction

Treatment of organic pollution in leachate is an urgent global issue and attracts special attention from scientists. Among them, ozone technology is a promising technology trend that is most proposed for mineralization of organic pollutants through the reactivity of active elements (typically OH^{*}).

Several technologies, such as biological treatment procedures, chemical precipitation, adsorption, and membrane technology, can be used to treat leachate [6]. In a 2001 study published in Chemosphere, C. M. Kao et al. [7] sought to assess the effectiveness of standard wastewater treatment procedures in lowering pollutant concentrations in leachate effluent. High organic content, colors, inorganic substances such as sodium hydroxide, hydrochloric acid, sodium chloride,... are components of leachate [5]. Ozone can cure leachate effluent. Leachate wastewater treatment with integrated ozone treatment yielded a direct-discharge effluent at 135 mg/l [8]. Gas chromatography–mass spectrometry with 100 mg/L ozone, 15.7 min contact time, and 2.9 gas–liquid ratio removed 100% of volatile phenols, sulfides, and aniline from wastewater [10].

The report of Rajkumar et al. [10] emphasized this issue and provided numerous remedies. Ozone technology transform toxic organic pollutants into harmless byproducts using oxidizing agents such as hydrogen peroxide and ozone. The application of ozone technology

to remediate leachate effluent has shown promise. According to studies, ozonation can increase the biodegradability of wastewater and enhance treatment performance [11], [12].

This short review paper aims to give readers an overview of the efficacy of ozone technology in eliminating various pollutants from leachate effluent. The article will also emphasize the difficulties and potential applications of ozone technology in treating leachate, as well as the benefits and drawbacks of its use and potential applications.

1. Research Objectives

1.1 To develop an automated vending machine capable of accepting all types of banknotes and coins as payment methods.

1.1 To study the implementation of microcontroller systems in developing automated vending machines.

1.3 To analyze the operational performance of the automated vending machine system.

2. Review of Related Literatures

Bharat and Sawant (2020) designed and developed a smart vending machine utilizing Arduino microcontroller as the primary control unit. Their research focused on enhancing vending machine efficiency through automation, error reduction, and improved user convenience. Their study demonstrated the feasibility of using Arduino to develop an efficient, user-friendly, and cost-effective automated vending machine that could be expanded for enhanced capabilities in the future.

Das, Kumar, and Sharma (2021) presented the development of a smart vending machine using Arduino UNO as the main controller. Their research aimed to enhance traditional vending machine functionality with modern conveniences and features. Their findings demonstrated that Arduino UNO could be effectively utilized to create modern, user-friendly, and cost-efficient automated vending machines, with potential for future integration of emerging technologies such as IoT and mobile payment systems.

Duangphasuk and Thanapatay (2023) proposed the development of an IoT-enabled smart vending machine that connects vending units to cloud systems for real-time data monitoring. Their research emphasized enhancing user convenience and modernizing system efficiency through technological integration.

Islam, Azam, and Hossain (2022) presented the development of a cost-effective smart vending machine using Arduino as the primary controller. Their research focused on designing an efficient system at a lower cost compared to commercial vending machines while maintaining operational effectiveness.

Singh and Kumar (2023) introduced a smart vending machine with an integrated inventory management system controlled by Arduino. Their research addressed the challenge of product shortages in vending machines and enabled real-time inventory monitoring for operators. The system demonstrated the potential for automated retail solutions to incorporate sophisticated inventory management capabilities while maintaining operational efficiency.

These studies collectively highlight the growing trend toward integrating microcontroller-based systems in vending machine development, with emphasis on cost-effectiveness, user convenience, and enhanced functionality through modern technology integration.

Materials and Methods

- Synthetic approach: The study uses this method to acquire data and information on leachate, ozone technology and the application of ozone technology in leachate treatment,

which is collected from studies published in prestigious scientific journals around the world. These include studies from 1981 to recent studies published in 2024.

- Analytical techniques: This study analyses previously published materials on leachate, ozone technology, and the application of ozone technology to treat leachate. This enables us to assess the current status of research, with a focus on complicated, unresolved issues in this subject.

- Data processing methods: Using comparison technique to generate statistical tables, compare published research results related to leachate, using ozone technology to treat leachate that this research has collected and summarized.

Results and Discussion

1. Leachate and its characteristics

1.1 Leachate and its characteristics

1.1.1. Leachate and its sources

Leachate is liquid that has absorbed dissolved substances in the waste as it passes through the waste in a landfill. Leachate has long been recognized as the second-largest contributor to global water pollution and waste. This sector's water-intensive processes and high levels of pollution discharge have substantially influenced global water supplies, worsening water scarcity issues [13].

Leachate contains many dissolved pollutants from the waste decomposition process and settles at the bottom of the landfill cell. The chemical composition of leachate is also very different and depends on the composition of the landfill waste as well as the landfill time. The amount of leachate formed in the landfill is mainly due to the following processes [9]:

- Water released from solid waste: waste always contains a certain amount of water. During the compaction process, water separates from the waste and joins the leachate.
- Water from the biological decomposition of organic matter: water is one of the products of the biological decomposition of organic matter.
- Rainwater seeps from above through the surface cover.
- Groundwater seeps through the bottom or body of the landfill cell into the landfill.

Rania Al-Tohamy et al. [1] researched the health concerns of leachate. The investigation results indicate that the wastewater contains many dangerous elements, including heavy metals and organic contaminants. These contaminants can pollute drinking water, increasing cancer risk, liver and kidney damage, and reproductive disorders. In addition, releasing untreated wastewater into water bodies can result in eutrophication, ecosystem deterioration, and a reduction in aquatic biodiversity. Based on their findings, the authors stated that wastewater from leachate should be cleaned before being released into the environment and that additional research is required to determine the long-term effects of this wastewater on human and environmental health.

Imtiazuddin et al. [17] conducted a study on the origins of wastewater from leachate. Research results show that: Aquatic toxicity of leachate industry wastewater significantly differs between production facilities. Possible sources of aquatic toxins include salts, surfactants, ionic metals and their metal complexes, toxic organic chemicals, biocides and toxic anions. Wastewater in the bleaching, polishing, dyeing, printing and finishing industries must be treated separately to reduce contaminant concentrations.

1.1.2 Characteristics of leachate

Several studies indicate that leachate has a high pH value, and a high concentration of suspended particles, chlorides, nitrates, and metals like manganese, sodium, lead, copper,

and chromium [14], [19], [20]. Moreover, the effluents from leachate typically have high levels of color, pH, suspended solids (SS), chemical oxygen demand (COD), and biochemical oxygen demand (BOD) [15]. Color, pH, electrical conductivity (EC), chemical oxygen demand (COD), biological oxygen demand (BOD), and hardness are further characteristics of leachate [21], [17]. These contaminants significantly threaten the ecosystem and can devastate aquatic life and human health.

A range of values indicating organic pollution in leachate has been reported. Leachate typically has COD concentrations ranging from 10 to 500 mg/l, 50 to 1000 mg/l, 150 to 3000 mg/l [15]. Other reports indicate that the COD of leachate pharmaceuticals ranges from 250 to 3000 mg/l in some industrial leachate effluents. Depending on the different types of catalysts used in the treatment process, the alkalinity reduction ranges from 10 to 22%. With values of 0.691, 0.688 and 0.711 compared to 0.398 in the untreated wastewater, the BOD5/COD ratio of the treated wastewater is significantly greater than that of the untreated wastewater [22].

Appropriate handling of leachate is essential for mitigating water contamination. Leachate is often alkaline due to its high concentrations of salt, COD, BOD, and color; if not adequately treated, it can have detrimental environmental effects. To efficiently treat this wastewater, its unique properties must be considered, and appropriate treatment techniques must be adopted to ensure compliance with local effluent standards and regulations. Generally, it is necessary to consider the sustainable use of water resources when managing wastewater.

1.2 Ozone technology and its applications

Ozone (O_3) technology offers several advantages over traditional disinfection techniques like chlorine, including faster disinfection times, no toxic byproducts, and the capacity to handle a variety of pollutants. As a result, it has become significantly important in water and air treatment. Ozone technology can be used in many sectors and is an efficient tool for odor control, disinfection, and purification. To avoid health hazards, it is crucial to utilize it correctly and safely, nevertheless. Ozone, a strong oxidizing agent, has been used in food processing since the early 1900s for its antibacterial qualities; according to A. J. Brodowska et al. [28], more research is needed to fully understand its benefits and drawbacks.

Ozone technology uses electricity to convert oxygen into ozone molecules [29]. This method is used in various sectors for odor control, purification, and disinfection [30]. Ozone technology has garnered considerable attention as a viable wastewater treatment method due to its potent oxidizing properties [31]. Ozone's high reactivity makes it an effective oxidizing agent capable of breaking down various organic pollutants, such as pesticides, petroleum-based, and persistent organic pollutants [32]. It can also remove color, odors, and other pollutants from wastewater. Furthermore, ozone technology can eliminate heavy metals, nitrogen-based contaminants, and other hazardous compounds from wastewater, as found in studies [33]. Notably, ozone technology doubles up as an efficient disinfectant, destroying bacteria and viruses in wastewater [34]. Ozone technology is also a cost-effective wastewater treatment method, making it an attractive option for industries and businesses. It can further minimize sludge production in the wastewater treatment process, reducing disposal costs linked to wastewater treatment. Therefore, ozone technology's broad range of applications in wastewater treatment makes it a popular choice for many industries. Ozone was discovered to be a powerful disinfectant capable of eliminating bacteria and other microbes. Moreover, ozone is remarkably effective at removing metal ions, organic pollutants, and molecules that provide water color from the environment [35].

It has been determined that ozone technology is a potent instrument for managing air pollution in both industrial and home settings. Ozone technology is a "new strategy for solving air quality challenges, with highly promising outcomes," according to L. Franken [35].

In addition to lowering the concentrations of particles, allergens, and other dangerous pollutants, it is excellent at removing smells and volatile organic compounds without using chemicals or other harmful materials, making it an affordable and secure solution for managing air quality in both industrial and home settings. Importantly, ozone can combine with sulfur and nitrogen dioxide to form less toxic compounds, improving air quality.

Recent research, such as in 2020, by Shin et al. [36] has looked at the potential dangers connected to ozone technology and its application in society. By using ozone gas to disinfect indoor air, ozone technology eliminates bacteria, odors, and other volatile organic compounds (VOCs). Ozone technology has been shown to lower air quality in specific situations, but its consequences on human health are still mostly understood. According to the World Health Organization, ozone is a harmful substance and should be handled with caution in public areas. Long-term exposure to ozone has also been linked to asthma-like symptoms and respiratory issues. Therefore, safety precautions must be taken when utilizing ozone technology. Moreover, the ozone concentration should be checked to ensure it is within permissible limits when used indoors.

1.3 Ozone technology for treating leachate

1.3.1. The application of ozone technology to treat leachate

Much research has been undertaken on using ozone technology to clean effluent from leachate. Our investigations demonstrate that ozone can be employed for the enhanced treatment of leachate effluent having a high concentration of indigestible dyes and other macromolecular organics [37]. The approach is predicated on the decolorization of the dye by ozone, and the color loss is proportional to the ozone concentration and pH value [38]. Current advancements in leachate treatment include catalytic ozonation, which has shown success for color removal in a short treatment period [39]. A review article analyses the mechanics of the interaction between ozone and aqueous solutions of organic dyes [40], whilst another review covers recent developments in the use of ozone for decontamination applications in many industries, including leachates [41].

Due to its efficiency at removing pollutants, catalytic ozonation has gained popularity as a method for treating wastewater from leachate companies. In their article titled "Water," authors Zhang et al. [42] examined the advantages of this technology. They discovered that catalytic ozonation increases the biodegradability of wastewater, assisting in sludge production reduction. Moreover, total organic carbon (TOC), chemical oxygen demand (COD), and total nitrogen (TN) contents in the water are all decreased by catalytic ozonation. The authors pointed out that in addition to other contaminants, colors can also be removed using this approach. They also pointed out the need for more study in this field by pointing out that the type of dye and the pH of the wastewater affect how effective catalytic ozonation is. The authors concluded that catalytic ozonation offers considerable advantages in pollutant removal and biodegradability and is a viable technology for cleaning wastewater from leachate manufacturers.

1.3.2. Effectiveness of ozone technology in the treatment of leachate

The findings demonstrated that about 100% color removal and 90% COD reduction could be achieved by adjusting process variables such as pH, ozone production rate, and temperature. According to the study's findings, the novel technique can replace the need for a separate end-of-the-pipe wastewater treatment system with an affordable on-site option.

Table 1. Catalytic ozonation processes condition for leachate

Catalyst material for ozonation processes	Target Dye(s)	Optimum conditions	Efficiency (% COD removal)	References
Carbon-doped magnesium oxide (C-MgO) dropped on an eggshell membrane powder	Real leachate	Ozone flow rate = 0.4 L/min, Catalyst dose = 0.23 g/L, Reaction time = 10 min, pH = 11	93	[44]
Poly aluminum chloride and alum	Real leachate	Reaction times = 30 min, Catalyst dose = 6 and 300 mg/L, pH = 7.4	89	[45]
g-C ₃ N ₄ modified with Al ₂ O ₃ nanoparticles	Real leachate	Oxygen flow rate = 1.5 L/min, Catalyst dosage = 0.5 g/L, pH = 7.1	77	[46]
O ₃ /UV	Azo red-60 dye	Initial concentration dye = 100 mg/L, Reaction time = 60 min, pH = 7.5	100	[47]
Modified pulsed low frequency US cavitation processes	Real leachate	Optimum O ₃ flow rate = 4 g/h, Reaction time = 60 min, pH = 9.34	86	[48]
KMnO ₄	Real leachate	KMnO ₄ dosage = 1.5 mM, O ₃ dosage = 10 mg/L, The reaction time of 30 min, pH = 7	80	[49]

According to the data in Table 1, multiple catalyst materials have been employed to treat leachate by ozonation. Different conditions have been tuned for each catalyst material to reach the necessary degree of COD removal efficiency. As a catalyst material, carbon-doped magnesium oxide (C-MgO) doped on eggshell membrane powder exhibited a high COD removal efficiency of 93% at pH 11 with a reaction time of 10 minutes and a catalyst dose of 0.23 g/L. Similarly, using poly aluminum chloride and alum as catalysts resulted in an 89% COD removal efficiency with a reaction time of 30 minutes and a catalyst dose of 6 and 300 mg/L, respectively, at pH 7.4. In addition, using g-C₃N₄ modified with Al₂O₃ nanoparticles as a catalyst material demonstrated a 77% COD removal efficiency at pH 7.1, with an oxygen flow rate of 1.5 L/min and a catalyst dosage of 0.5 g/L. In addition, the combination of O₃/UV treatment has produced a high dye removal efficiency of 100% for Azo red-60 dye, with an initial concentration of 100 mg/L, a reaction duration of 60 minutes, and a pH of 7.5. Also, using modified pulsed low-frequency US cavitation processes has demonstrated a COD removal effectiveness of 86% at pH 9.34, with an optimal O₃ flow rate of 4 g/h and a reaction duration of 60 minutes. Using KMnO₄ as a catalyst resulted in a COD removal efficiency of 80% at pH 7, with a KMnO₄ dosage of 1.5 mM, an O₃ dosage of 10 mg/L, and a reaction duration of 30 min. These studies indicate the potential of ozonation procedures for efficiently

treating leachate using various catalyst materials and under optimal circumstances. However, additional research is required to determine the viability and scalability of these methods for industrial use on a broad scale.

1.3.3. Challenges and limitations of using ozone technology for treating leachate

Ozone technology has been faced some obstacles and restrictions, such as the efficacy of ozone treatment is contingent on initial dye concentration, pH, and temperature of wastewater [36]. The use of ozone gas is more appropriate for wet processing machines, which may limit its application in certain leachate manufacturing processes [13]. Although ozonation has been described as having a lower environmental impact than conventional denim bleaching, it still requires careful consideration of water allocation, reuse, and recycling strategies [50].

The next drawback of Ozone technology is the high cost. According to Van Vuuren et al. [51], the high cost of ozone technology results from the energy-intensive process required to produce ozone. In addition, the system's maintenance costs are substantial due to the need for frequent replacement of parts and consumables. The costs of ozone technology are exacerbated by the need for skilled personnel to operate the system and by the stringent safety regulations required to ensure worker safety and the environment. The high cost of ozone technology has limited its adoption in many industries and led to the development of more cost-effective alternatives. However, the potential benefits of ozone technology cannot be ignored due to the growing demand for cleaner air and water and the growing awareness of the negative effects of pollution on human health and environment. Efforts should be made to reduce the cost of ozone technology through technological innovation and improving operational and maintenance efficiency.

Rice et al. [52] provide several potential strategies for mitigating these expenses. Initially, they advise using compressed or oxygen-enriched air as an alternative to pure oxygen. This approach can cut ozone manufacturing expenses and improve its efficiency. They propose using alternate reactor designs to enhance ozone mass transfer and lower energy usage. For instance, high-efficiency diffusers or microbubble aeration systems can increase ozone transfer rates and decrease energy requirements. Last but not least, they advocate the adoption of hybrid systems, such as ozone-biofiltration or ozone-UV procedures, which can improve the treatment system's performance and lower its overall costs. These alternatives can assist in overcoming the high cost of ozone technology and make it a more viable option for wastewater treatment. However, additional research and development are required to maximize the effectiveness and efficiency of these methods in real applications.

The application of ozone technology requires cautious handling and safety measures to avoid exposure to dangerous ozone levels. Material and safety data sheets contain information on the handling and storage of ozone, including using ozone-resistant tubing and pipelines, repairing leaks, and evacuating places with high ozone levels [53]. Ozone generators are linked to harmful health effects, and scientific evidence indicates that acceptable amounts of ozone are unlikely to be useful at reducing indoor air pollution [54].

Moreover, ozone technology can generate harmful byproducts such as bromate and aldehydes. Ozone can also be harmful to human health, especially for those with respiratory difficulties such as asthma and chronic bronchitis. Ozone exposure can aggravate lung diseases, increase the frequency of asthma attacks, and reduce lung function. While ozone is composed of three oxygen atoms, it is an unstable and highly reactive gas that can harm health [30]. Therefore, caution should be exercised when using ozone technology, and it is important to follow safety guidelines and regulations to minimize the risks associated with its use.

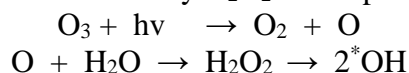
The presence of organic matter and other contaminants in wastewater might limit the efficacy of ozone as a disinfectant, hence affecting the efficiency of ozone technology [55]. According to Wang et al. [56], organic matter in water can devour ozone, diminishing ozone's

ability to remove contaminants. Since organic matter combines with ozone through a chain reaction, hydroxyl radicals compete with ozone for reaction sites. Thus, the overall effectiveness of ozone technology is diminished, resulting in insufficient removal of pollutants. However, the magnitude of this effect depends on the type and concentration of organic materials in the water. Wang et al. [56] discovered that the presence of humic acid, a common organic molecule in wastewater, affected the effectiveness of ozone technology by up to 40%. This emphasizes the significance of comprehending organic matter's influence on ozone technology's effectiveness and devising measures to limit its effects.

According to Silva and Jardim, one way to ensure efficient pollutant removal is to optimize the ozone dosage based on the concentration and type of organic matter in the water [57]. Consider the concentration of contaminants in the wastewater, the flow rate, and the contact duration to establish the best dosage. Combining ozone technology with advanced oxidation processes (AOPs) is another method. AOPs can improve the efficacy of ozone technology by producing hydroxyl radicals, which are extremely reactive species capable of oxidizing a wide variety of contaminants. The design of the ozone reactor can also affect its effectiveness. A reactor with a high surface-to-volume ratio can facilitate a more efficient mass transfer between ozone and contaminants, increasing its overall efficiency. In conclusion, following these measures can considerably enhance the efficacy of ozone technology in wastewater treatment plants, resulting in improved water quality and a cleaner environment.

3.4 Potential application of ozone technology in leachate treatment in Vietnam

Applying ozone technology in leachate treatment is initially being noticed in Vietnam. Vu Thi Bich Ngoc et al. have shown that among the oxidizing agents, O₃ is highly effective in breaking straight and unsaturated bonds in drug molecules dyeing, causing rapid discoloration of leachate [62]. Ozone strongly absorbs UV light (especially at 254 nm wavelength) producing H₂O₂, and immediately H₂O₂ decomposes to form *OH radical [58]:



In acidic environments, ozone directly oxidizes organic compounds using ozone molecules dissolved in water. Meanwhile, in high pH conditions or in conditions with favorable conditions for the generation of *OH radicals such as H₂O₂, UV, catalysts, etc., the indirect oxidation pathway through hydroxyl radicals will be essential and the oxidation efficiency is enhanced. As a result, researchers have looked for agents that can be combined with ozone or catalysts to trigger *OH radicals to improve the oxidizing efficiency of ozone when it is necessary to deal with stable, non-biodegradable compounds in water and wastewater [58].

Van Huu Tap et al. studied using metal slag from metallurgy as a catalyst for the ozone reaction to treat Reactive Red 24 in leachate. The research results show that, in the composition of the waste iron slag containing FeO, ZnO and SiO₂ oxides, it has a good effect for the catalytic ozone process of dye treatment (Reactive Red 24) with high efficiency, almost 100% color loss and decompose 85% of organic matter in leachate at the condition O₃ = 3,038 g/h, H₂O₂: 100 mg/L, iron slag content: 1000 mg/L and dye concentration: 300 mg/L [59].

Nguyen Trong Anh et al. evaluated the efficiency of leachate treatment by ozone technology combined with UV. The results show that the high-order oxidation using H₂O₂/O₃/UV gives the highest efficiency in color and COD treatment compared to using other single agents. At the pH value of 8.0, the reaction time is 40 minutes, the H₂O₂/O₃/O₃ content ratio is 0.5 and the UV light has wavelength $\lambda = 254$ nm, the color and COD treatment efficiency is 75 % respectively (185 Pt-Co) and 83.4% (166 mg/L). Combining higher oxidation with UV agent increases treatment efficiency due to higher production of free *OH radicals. Therefore, it is possible to combine ozone technology with UV to treat leachate for higher efficiency [60].

Nguyen Thi Hien et al. also evaluated the effect of 5 types of metal waste slag, including iron slag, zinc slag, copper slag, lead slag and cadmium slag as catalysts for the ozone process to degrade dyes Direct Black 22. Through COD analysis, the ability to treat dyes is from 66% to 76% with the condition that the dye concentration reaches 100 mg COD/L; concentration of O₃: 3,038 g/h, H₂O₂: 100 mg/L and the dose of catalyst is 250 mg/L [61]. The research results demonstrate that catalytic ozonation is an effective way to purify leachate in Vietnam due to pollutant removal and biodegradability. However, the studies also point to the need for further research by showing that the type of dye and the pH of the wastewater affect the efficiency of the catalytic ozonation process used in the treatment of leachate under conditions in Vietnam.

Conclusion

Leachate contributes significantly to water waste and pollution, posing grave environmental and human health threats. Due to its disinfection, purification, and odor control properties, ozone technology is viable for leachate treatment. Research on using ozone technology in leachate treatment is initially attracting attention in Vietnam with many studies being conducted. The results proved that ozone technology is a feasible technology to clean wastewater from leachate manufacturers in terms of conditions in Vietnam. Although ozone technology effectively treats high concentrations of indigestible dyes and other pollutants, its efficacy depends on several variables, including initial dye concentration, pH, and temperature. Additional research is required to comprehend its advantages and disadvantages completely, and caution should be exercised to avoid potential health risks. Investing in sustainable and efficient water treatment systems is vital for limiting the risks posed by leachate and enhancing water quality for human and environmental health.

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The relationship between organic fertilizer adoption on household food security in rice production in Vietnam

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Abstract

This research investigates the relationship between adopting organic fertilizers and household food security in Vietnam, with a particular focus on the food diversity index and food expenditure among rice-producing households. The study uses data from the 2020 Vietnam Household Living Standard Survey (VHLSS) and analyzes 2,101 observations related to rice production. To address potential selection bias, propensity score matching (PSM) was applied to estimate the average treatment effect for households using organic fertilizers. The findings reveal that households employing organic fertilizers demonstrate higher food diversity and increased food expenditures compared to those that do not. These results highlight the importance of promoting organic fertilizer use in rice farming, which could support sustainable livelihoods in rural Vietnam. Achieving this goal requires motivating smallholder farmers to adopt organic fertilizers. Government support, through training programs and skill development initiatives, can play a crucial role in enhancing farmers' knowledge and effective use of organic fertilizers.

Keywords: organic fertilizer adoption, household food security, rice production, Vietnam

Introduction

Rice cultivation plays a fundamental role in Vietnam's economy, food security, and cultural identity (Kien et al., 2023). The Mekong Delta region alone produces approximately 57% of the country's total rice output and over 90% of its rice exports, underscoring its significance in the global rice market (Dang et al., 2020; Duy, 2015). The rice sector not only feeds over 96 million Vietnamese people but also generates substantial income, with rice exports contributing around \$5.6 billion in 2018—almost 9% of the global total (Bui et al., 2022; Le et al., 2021).

The impact of rice farming extends beyond economic figures. It sustains the livelihoods of millions of Vietnamese families, particularly in rural areas where it serves as a primary source of income and nourishment (Chu, 2023; Chu et al., 2021). The agricultural sector, largely centered on rice cultivation, employs a significant portion of the workforce, fostering economic stability and growth (Chu, 2023). Moreover, Vietnam's agricultural policies, notably the Doi Moi reforms in the 1980s, transformed collective farming into individual contracts. This shift boosted production and positioned Vietnam as a leading global rice exporter (Bui et al., 2015).

However, the sustainability of rice cultivation faces multiple challenges, particularly from climate change and environmental degradation. These pressures threaten crop yields and economic stability, exposing farmers to natural disasters and fluctuating market prices (Addison et al., 2023; Masi et al., 2023). In recent years, many households have adopted organic fertilizers to promote sustainable agricultural development. Organic fertilizers, often derived from natural resources like manure and agricultural by-products, offer economic, social, and environmental benefits. They reduce costs compared to chemical fertilizers, which is especially beneficial for low-income households (Chau & Ahamed, 2022). Additionally, they enhance soil structure, increase fertility, and provide sustainable nutrients, improving rice yield and quality (Quynh & Kazuto, 2018). Organic fertilizers also help mitigate soil degradation and water pollution caused by excessive chemical fertilizer use. By enhancing soil health, they support long-term agricultural productivity. Furthermore, they reduce harmful chemical usage, protecting both farmers' and consumers' health (Matsubara et al., 2020). Since chemical fertilizers are subject to price volatility and global supply chain disruptions, organic fertilizers can stabilize long-term production (My et al., 2018).

Nevertheless, organic fertilizers have drawbacks that can impact agricultural outcomes. One major issue is their slow and inconsistent nutrient release, which may not meet crops' immediate needs during critical growth phases (Majeed et al., 2022). Additionally, their variable nutrient composition can complicate fertilization management and result in inconsistent plant nutrition (Parihar & Choudhary, 2022). Using large quantities of organic fertilizers to achieve adequate nutrient levels can also impose economic burdens, particularly in regions with limited or expensive organic resources. Moreover, organic fertilizers can introduce pathogens into the soil and contribute to greenhouse gas emissions during decomposition, raising environmental concerns (Ghaslani et al., 2024; Parihar & Choudhary, 2022). Nitrogen losses through volatilization and leaching are also significant challenges (Berger et al., 2018). Managing organic fertilizers requires careful monitoring, which can be labor-intensive and demanding for smallholder farmers lacking the necessary resources or expertise (Tikasz et al., 2019).

This study explores the relationship between organic fertilizer adoption and household food security, measured through food diversity and monthly food expenditure. The findings could influence organic fertilizer use in agricultural practices, offering insights applicable not only to Vietnam but also to other developing countries with low organic fertilizer adoption rates. By clarifying the connection between organic fertilizer use and food security in smallholder agriculture, this research contributes to strategies for enhancing agricultural resilience and improving farmers' livelihoods. The study's novel use of Propensity Score Matching (PSM) minimizes selection bias, revealing that households using organic fertilizers report higher food diversity and greater monthly food expenditures compared to non-users. These results provide valuable insights into the positive relationship between organic fertilizer adoption and household food security, with broader implications for sustainable agricultural practices in Vietnam and similar developing nations.

Research Methodology

1. Data source

Since 1993, the General Statistics Office (GSO) has conducted the Vietnam Household Living Standards Survey (VHLSS) to assess living standards and support policymaking and socio-economic development planning. Between 2002 and 2010, the survey was conducted biennially. From 2011 to 2020, the VHLSS became an annual survey, with odd-numbered years focusing solely on demographic, employment, and income data. The primary goal of the

VHLSS is to monitor and evaluate the implementation of the Comprehensive Poverty Reduction and Growth Strategy, as well as to contribute to achieving the Sustainable Development Goals (SDGs) and Vietnam's socio-economic development objectives. After merging various datasets, the study obtained 2,101 observations related to rice production in Vietnam, aiming to estimate the impact of adopting organic fertilizers on household food security.

To accurately measure this impact, the study incorporates various control variables, all derived from a thorough literature review of previous research. The adoption of organic fertilizers among farmers is influenced by several factors, which can be grouped into socio-economic characteristics, resource access, knowledge and training, and environmental perceptions. Understanding these determinants is essential for promoting organic fertilizer use, which can improve soil health and enhance agricultural sustainability.

One key socio-economic factor is the gender of the household head. Research indicates that male-headed households are generally more likely to adopt organic fertilizers than female-headed ones. This disparity is often linked to differences in resource access and household decision-making power (Veljanoska, 2022). Marital status also plays a significant role; married household heads tend to adopt organic fertilizers more frequently, possibly due to their heightened concern for household welfare and a greater willingness to invest in sustainable practices (Veljanoska, 2022).

Age is another important determinant. Younger farmers are often more receptive to innovative agricultural practices, including the use of organic fertilizers. They are typically more open to adopting new technologies compared to older farmers, who may be resistant to change due to established farming routines and unfamiliarity with organic methods (Koovalamkadu Velayudhan et al., 2021; Serebrennikov et al., 2020). Education also plays a crucial role in the adoption of organic fertilizers. Studies show that better-educated farmers are more likely to understand the benefits and proper application methods of organic fertilizers (Muluneh et al., 2022; Wasil et al., 2023). This knowledge enables them to make informed decisions that enhance productivity and sustainability.

Furthermore, farmers' adoption of organic fertilizers is hindered by poverty. Poor households generally prioritize immediate necessities above organic fertilizers, which may cost more upfront than chemical fertilizers. Credit is vital here. Farmers with credit are more likely to buy organic fertilizers because they can pay the upfront expenditures and get the long-term benefits of soil health and crop yields (Y. Chen et al., 2022). Without financing, people may choose cheaper, less sustainable choices, perpetuating poor productivity and poverty (Bidzakin et al., 2023). In addition, savings affect organic fertilizer adoption. Savings allow households to experiment with organic gardening, including organic fertilizers. Larger farms can generate economies of scale that lower organic fertilizer prices, making them more affordable (Y. Chen et al., 2022). Smallholder farmers may struggle to use organic fertilizers due to greater costs and reduced yields (Bidzakin et al., 2023). Additionally, organic fertilizer uptake depends on rice production areas and the number of plots. Larger areas allow for more organic practice investment because the advantages can be distributed over more output. Due to higher returns and better agricultural support services, farmers with larger plots are more likely to use organic fertilizers (Y. Chen et al., 2022). Fragmented landholdings may prevent farmers from using organic fertilizers since they lack the resources to manage various plots (Muluneh et al., 2022). Furthermore, the perception of health risks associated with organic fertilizers can deter their adoption. Farmers' risk attitudes, shaped by personal or familial health experiences, can significantly influence their willingness to utilize organic fertilizers. If a household has experienced negative health outcomes linked to the use of organic fertilizers, this may lead to

a general aversion to their use, regardless of the potential benefits (Chen et al., 2018; Ren, 2023)

Table 1. Summary statistics

Variable	Observation	Mean	Std. dev.
<i>Outcome Variables</i>			
Food diversity index	2,101	6.919	2.662
Amount spent on food (1000 VND)	2,101	3240.762	2288.414
<i>Interest variable</i>			
Organic fertilizer adoption (1: Yes; 0: No)	2,101	0.797	0.403
<i>Control Variables</i>			
Gender of household head (1: Male; 0: Female)	2,101	0.891	0.311
The Age of Household Head (Years)	2,101	49.362	12.015
Married status (1: Single; 2: Married; 3: The others)	2,101	2.097	0.376
Access to the Internet (1: Yes; 0: No)	2,101	0.424	0.494
Type of household (1: Poor Household; 0: Non-Poor Household)	2,101	0.136	0.343
Access to credit (1: Yes; 0: No)	2,101	0.207	0.405
Saving (1: Yes; 0: No)	2,101	0.090	0.286
Total area of Rice production (m2)	2,101	3087.523	4135.736
Number of Plot for Rice Production	2,101	2.513	0.990
Health Risk (1: Yes; 0: No)	2,101	0.079	0.271
The educational level of the Household head (Year)	2,101	7.413	3.016

2. Methodology

This study aims to evaluate the impact of organic fertilizer adoption on household food security in rice production. Our objective is to calculate the Average Treatment Effect on the Treated (ATT). To effectively evaluate the impact of organic fertilizer adoption, it is essential to compare the outcomes of households that have adopted organic fertilizer with those that have not. The challenge lies in the inability to directly observe results without implementing organic fertilizer adoption, known as the counterfactual. Consequently, this study aims to tackle this issue.

In impact evaluation, it is crucial to select a control group that has not adopted organic fertilizer to provide a valid comparison. While randomized experimental designs often include comparing outcomes between treatment and control groups, our study does not utilize random assignment. The organic fertilizer adoption is influenced by personal choice, perhaps leading to self-selection bias. In the absence of empirical evidence, non-experimental methodologies such as Instrumental Variable (IV), Propensity Score Matching (PSM), Difference-in-Differences (DID), or a combination of PSM and DID are essential for evaluating the Average Treatment Effect on the Treated (ATT) (Nguyen et al., 2024).

Instrumental Variables (IVs) are commonly utilized to mitigate selection bias arising from unobservable variables. For an instrumental variable (IV) to exert a meaningful influence, it must correlate with the capacity for adoption while not directly influencing the outcomes. Nonetheless, the endeavor of identifying a reliable IV is challenging and may yield skewed

outcomes if conducted incorrectly. In light of this, we select Propensity Score Matching (PSM) as a more suitable method to address selection bias.

PSM entails the preliminary assessment of the likelihood of households adopting organic fertilizer by a logit model, considering specific factors. This calculation generates a propensity score for both the treated group (those who have adopted organic fertilizer) and the control group (those who have not adopted organic fertilizer). The logit model is articulated as:

$$P(X) = \text{logit}(D=1) = \alpha + \beta X$$

The variable D denotes the treatment state, indicating the adoption of organic fertilizer. The variable X encompasses observable characteristics that are unaffected by this therapy. Before executing matching, it is essential to fulfill two critical conditions. It is essential to delineate the common support region, which includes the spectrum of propensity score values where both the treated (adoption) and control (non-adoption) groups are present. In instances when a certain household in the adoption group lacks a comparable match in the non-adoption group, individuals with propensity scores that surpass the maximum or fall below the minimum of the non-adoption scores are eliminated. This approach guarantees that only dwellings inside the common support zone are utilized for matching, hence avoiding biased comparisons between dissimilar households. Implementing common support constraints enhances the robustness of estimates and improves match quality by minimizing adverse matches.

The second criterion requires meeting the balancing property test (Dehejia & Wahba, 2002), which posits that observations with identical propensity scores must have the same distribution of observable characteristics (X variables), irrespective of their access status. Established standards are absent for delineating acceptable levels of imbalance in propensity scores. The optimal standardized difference for particular components is often recommended to be between 10% and 25%.

In the last step, adoption is correlated with non-adoption based on analogous tendencies. The formula for determining the average treatment effect on the treated (ATT) with the propensity score matching (PSM) estimator, as delineated by Becker & Ichino (2002), is as follows:

$$ATT^{PSM} = E\{Y_{iA}|D = 1, P(X)\} - E\{Y_{iN}|D = 0, P(X)\}$$

where ATT measures the effect of the adoption of organic fertilizer on the observed outcomes of adoption such as household food diversity index, and spending for food. D denotes the treatment (the adoption of organic fertilizer) status of the household. Y_{iA} and Y_{iN} are ATT measures of the effect of the adoption of organic fertilizer on the observed outcomes of the adoption, X is a vector of the observed characteristics, P(X) denotes the propensity score of each household given the observed covariates, and ATT^{PSM} is the difference in outcomes between the adoption and non-adoption appropriately matched by the propensity score P(X).

Result and discussion

The investigation commences by delineating the systematic disparities between the treatment group and the control group. Table 2 presents a concise review of the particular agricultural characteristics employed in the model. The analysis entails performing balance tests on each covariate before and after matching, for both the unpaired and matched cohorts. After the matching method, the majority of covariate means in the treatment and control groups exhibited no significant differences. The findings indicate that, following the matching procedure, the determinants of organic fertilizer use are more uniformly distributed, hence mitigating the endogeneity issue.

Table 2. Balance tests comparing unmatched and matched samples

Variables	Unmatched			Matched		
	Treatment	Control	P-value	Treatment	Control	P-value
Gender of household head	0.898	0.864	0.042	0.898	0.901	0.818
The Age of Household Head	49.141	50.227	0.095	49.141	48.901	0.571
Married status	2.090	2.124	0.091	2.090	2.065	0.044
Access to the Internet	0.415	0.459	0.102	0.415	0.443	0.108
Type of household	0.144	0.105	0.038	0.144	0.154	0.410
Access to credit	0.194	0.255	0.005	0.194	0.196	0.896
Saving	0.079	0.133	0.000	0.079	0.081	0.799
Total area of Rice production ¹	7.449	7.643	0.001	7.449	7.533	0.028
Number of Plot for Rice Production	2.526	2.459	0.210	2.526	2.511	0.638
Health Risk	0.076	0.091	0.311	0.076	0.068	0.350
The educational level of the Household head	7.304	7.843	0.001	7.304	7.254	0.635
Observation	1,674	427	2101	1,674	427	2101

Source: Authors Calculate

¹ in log form

Propensity Score Matching (PSM) employs the propensity score to equilibrate the pre-treatment attributes of the treatment (adoption) and control (non-adoption) groups. The first stage entails evaluating the convergence of the propensity score distributions for both groups. The distributions of the propensity scores are depicted in Figure 1 following the use of the matching procedure. The graph demonstrates a significant concentration of probability at 0 or 1. Moreover, the computed densities demonstrate considerable resemblance, and their principal masses align. Consequently, there is no evidence of a violation of the overlap assumption.

Propensity Score, Adoption = Non-Adoption

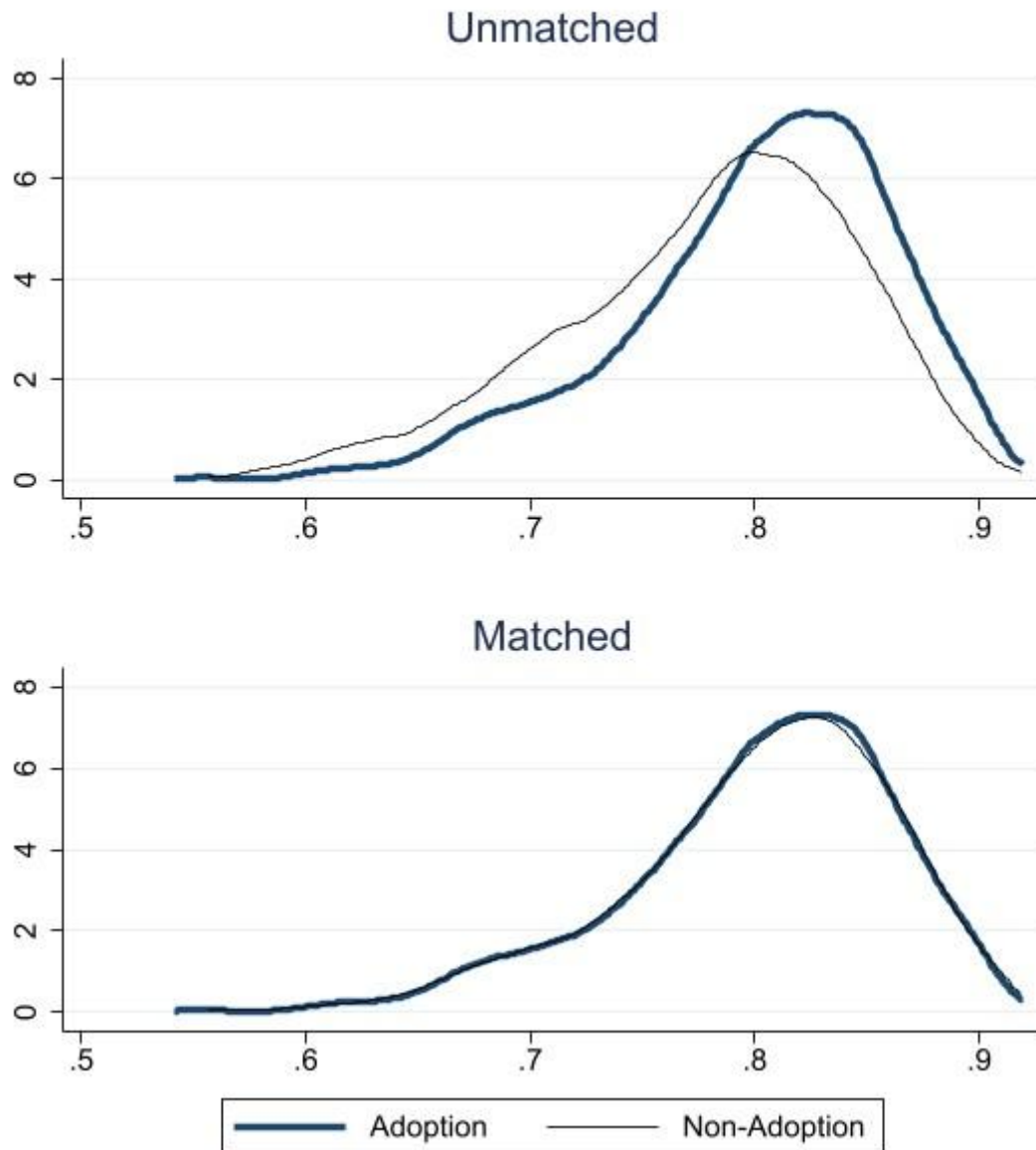


Figure 1. Distribution of Propensity Scores before and after matching

Table 3 indicates the parameters associated with farmers' adoption of organic fertilizer in rice production, as determined by Logit Estimation. The connections are depicted utilizing a logit estimate technique that includes marginal effects.

Among various factors belonging to farm characteristics, the result shows that the Total area of Rice production has a negative effect on the adoption of organic fertilizer. This means that an increase in total rice area tends to reduce the probability of adopting organic fertilizers. The marginal effect implies that smallholders in rice production have a probability of organic fertilizer adoption by 2.3%. In addition, the relationship between access to credit and organic fertilizer adoption is negative and significantly at the level of 1%. This means that households without access to credit tend to use more organic fertilizer than others. Similarly, households

with savings negatively correlate to organic fertilizer adoption with a coefficient of -0.528, and a significant level of 1%. This means that households with savings tend to reduce the adoption of organic fertilizer in rice production. The marginal effect provides that the probability of adopting organic fertilizer for households without saving is 8.4%. surprised, that the education level of the household head does not encourage rice farms to adopt organic fertilizer. The marginal provides that an increase in the educational level of household heads reduces the probability of adopting organic fertilizer by a significant level of 5%.

Table 3. Factor linked to the adoption of organic fertilizer (Logit Model)

Variables	- Coefficient	Marginal Effect Coefficient
	0.235	0.037
Gender of household head	(0.198)	(0.031)
	-0.005	-0.001
The Age of Household Head	(0.005)	(0.001)
	-0.189	-0.030
Married status	(0.165)	(0.026)
	-0.097	-0.015
Access to the Internet	(0.126)	(0.020)
	0.175	0.028
Type of household	(0.183)	(0.029)
	-0.402***	-0.064***
Access to credit	(0.130)	(0.020)
	-0.528***	-0.084***
Saving	(0.176)	(0.028)
	-0.143***	-0.023***
Total area of Rice production ¹	(0.052)	(0.008)
	0.034	0.005
Number of Plot for Rice Production	(0.056)	(0.009)
	-0.153	-0.024
Health Risk	(0.196)	(0.031)
The educational level of the	-0.048**	-0.008**
Household head	(0.020)	(0.003)
	3.322***	-
Constant	(0.708)	-
Observations	2,101	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

¹ in log form

Table 4 indicates the cause-and-effect relationships between organic fertilizer adoption and household food security in rice production. Propensity score matching (PSM) was used to mitigate selection bias, and the impact of adoption or not adoption on household food security was assessed. After matching, some calculations were modified with the Propensity Score Matching (PSM) method, particularly concerning the impacts of organic fertilizer adoption on household food security such as food diversity index and amount spent on food in rice production.

After using the PSM program, the group with the adoption tended to get a higher food diversity index than others. The difference between these two groups was statistically significant, with a p-value of 1%. In addition, the amount spent on food by households with organic fertilizer adoption is higher than that without adoption. In summary, the result implies that households with organic fertilizer can improve household food security in rice production.

Table 4. The effect of household food security on rice production

VARIABLES	Food diversity index	Amount spent on food
	Coefficient	Coefficient
Adoption organic fertilizer (Yes = 1; Otherwise, = 0) - Unmatched	0.606*** (0.190)	173.848* (159.204)
Adoption organic fertilizer (Yes = 1; Otherwise, = 0) - Matched	0.669*** (0.209)	171.031* (174.048)
Observations	2101	2101

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: Author's Calculate

Conclusion

The implementation of organic fertilizer is seen as a successful technique for transforming livelihoods in rural Vietnam. Organic fertilizers confer economic, social, and environmental advantages to rice-producing households in rural Vietnam. Organic fertilizers are often derived from natural resources such as manure and agricultural by-products, allowing rice-growing households to reduce costs compared to artificial fertilizers (Chau & Ahamed, 2022). An investigation into the adoption of organic fertilizers in rice cultivation and its effects on household performance would illuminate how modern agricultural practices might enhance economic, environmental, and social outcomes, leading to more sustainable and profitable production systems.

The main objective of this study is to ascertain the causal impact of utilizing organic fertilizer on household food security, specifically on the food diversity index and expenditure on food. This research combines cross-sectional data from the national level provided by VHLSS and employs propensity score matching (PSM) to clarify the causal effect of organic fertilizer usage on household food security. The data suggest that adopting organic fertilizers can improve household food security, leading to a higher food diversity index and increased expenditure on food relative to alternatives. These findings suggest that measures may be taken to promote the significance of organic fertilizer use for household food security in rice cultivation in rural Vietnam.

Notwithstanding the innovative findings in our study, specific limitations remain that necessitate improvement in future research. Standard Propensity Score Matching (PSM) using cross-sectional data may just consider selection based on observable characteristics, neglecting unobserved variability that could affect adoption and results. Employing panel data, an alternative methodology can address time-invariant unobserved heterogeneity when assessing the causal association between the adoption of organic fertilizer and household food security indicators, such as the food diversity index and expenditure on food.

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Sustainable Aquaculture: How to Reduce Nutrient Pollution in Pangasius Farming in Vietnam

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Abstract

The rapid expansion of aquaculture, particularly pangasius farming, has intensified environmental challenges, including nutrient pollution, water contamination, and biodiversity loss. This study employs a combination of the Data Envelopment Analysis (DEA) method and the Material Balance Principle (MBP) model to evaluate environmental efficiency in pangasius farming operations in Vietnam. The findings reveal that farms release an average of 19 tons of nitrogen annually, equivalent to over 21 tons per hectare of pond area or 53 kilograms per ton of product. The environmental efficiency score averaged 0.57, indicating a need to reduce nutrient input levels by 43% to achieve efficiency. Imbalances and misallocations in input factors were identified as key contributors to inefficiency.

Technical consultations and wastewater treatment systems were associated with higher environmental efficiency, while frequent sludge removal and product contracts correlated with greater nutrient emissions. The study provides actionable recommendations for reducing emissions and balancing economic and environmental priorities in pangasius farming. These findings contribute valuable insights to the sustainable development of aquaculture and highlight the trade-offs between productivity and environmental stewardship.

Keywords: nutrient pollution, environmental efficiency, pangasius farming, DEA, MBP

Introduction

Aquaculture has emerged as the primary source of seafood for human consumption (Tovar *et al.*, 2000; Marra, 2005). According to the FAO (2018), it is the fastest-growing food production activity globally. However, the rapid expansion of aquaculture has intensified its environmental impacts (Read and Fernandes, 2003; Farmaki *et al.*, 2014; Gu *et al.*, 2017; Ahmed and Thompson, 2018; Olaussen, 2018). These environmental challenges not only threaten ecosystems but also undermine aquaculture's productivity and yield (Asche and Tveteras, 2005; Asche, Roll and Tveteras, 2009; Hung *et al.*, 2010; Lee, Hartstein and Jeffs, 2015; Minh *et al.*, 2016). Consequently, achieving sustainable development in aquaculture has become a pressing concern, requiring a balanced evaluation of economic and environmental factors.

Vietnam is the world's largest producer of pangasius catfish (*Pangasianodon hypophthalmus*), contributing over 75% of global production (Thong *et al.*, 2020). Recognized as one of Vietnam's most critical aquaculture species, the pangasius industry has grown rapidly, becoming a cornerstone of the national economy. In 1997, pangasius production was just

23,000 tons, but by 2022, it had surged to 1.6 million tons, with a farming area of nearly 5.5 thousand hectares—a remarkable 70-fold increase over 25 years. The export value of pangasius products reached USD 2.4 billion, accounting for 30% of Vietnam’s total seafood export revenue in 2018 (VASEP, 2022a). Beyond economic contributions, the sector supports over 200,000 jobs, particularly in the Mekong Delta region, and exports pangasius products to 149 countries and territories worldwide (Quân, 2013; Nhu *et al.*, 2016).

Despite its economic importance, pangasius farming poses significant environmental challenges, including water pollution, excessive chemical use, and biodiversity loss (Anh *et al.*, 2010; Bosma, Anh and Potting, 2011; Henriksson *et al.*, 2015). Addressing these issues is critical to meet international sustainability standards and maintain access to markets such as the European Union while expanding into others (Nhu *et al.*, 2016). Improving nutrient utilization efficiency is central to achieving sustainable aquaculture (Boyd *et al.*, 2007), yet research on minimizing nutrient pollution from pangasius farming without compromising production remains scarce. Understanding this relationship is vital for assessing trade-offs between economic and environmental factors, thereby equipping policymakers with the data necessary to balance economic gains and environmental sustainability.

In line with Vietnam’s 2021–2030 National Environmental Protection Plan for Fisheries, which emphasizes pollution control in aquaculture (Prime Minister, 2022), this study aims to address these challenges. Specifically, it seeks to propose solutions to reduce emissions from pangasius farming, promoting sustainable development in the sector. The research focuses on measuring environmental efficiency and analyzing factors influencing production’s environmental impact using the Data Envelopment Analysis (DEA) method combined with the Mass Balance Principle (MBP) model. Additionally, bootstrapped truncated regression is employed to identify other factors affecting efficiency.

Research methodology

1. Materials Balance Principal

This study considers the case of n farms (Decision-Making Units, DMUs), where each farm utilizes K inputs (x) to produce M conventional outputs (y). During this production, emissions of a polluting substance (z) are generated. The emissions are quantified based on the material balance principle as follows:

$$Z = a'x - b'y \quad (1)$$

Here, a and b are constant coefficients representing the nutrient content in inputs and outputs, respectively. Certain elements of vector a may have zero values for inputs that do not contain nutrients. In this study, the emissions (z) released into the environment were considered pollution. A farm is deemed environmentally efficient if it can produce its outputs while minimizing pollution, with z in equation (1) minimized under given outputs (y).

2. Materials Balance Based Data Envelopment Analysis

Minimizing pollution occurs when the nutrient content in inputs ($a'x$) is minimized. Accordingly, the DEA model for nutrient minimization is formulated as:

$$\text{Min}_{\lambda, x_i^{EE}} a_i' x_i^{EE} \quad (2)$$

Subject to

$$\begin{aligned} -y_i + Y\lambda &\geq 0, \\ x_i^{EE} - X\lambda &\geq 0, \\ \sum_{i=1}^N \lambda_i &= 1 \\ \lambda &\geq 0 \end{aligned}$$

This equation is analogous to the cost-minimization DEA model by T. Coelli et al. (2005), where x_i^{EE} represents the nutrient-minimizing vector of input quantities for the i -th farm. In this framework, nutrient content (a) is treated as analogous to input price (w) when minimizing costs.

Environmental efficiency (EE) is defined as the ratio of minimum nutrient content ($a'_i x_i^{EE}$) to observed nutrient content ($a'_i x_i$):

$$EE = a'_i x_i^{EE} / a'_i x_i \quad (3)$$

Using the classical definition of input-oriented technical efficiency, the technically efficient input vector x_{TE} , allows technical efficiency (TE) to be expressed as:

$$TE = \theta = \frac{x_{TE}}{x} = a' x_{TE} / a' x \quad (4)$$

Input-oriented environmental efficiency (EE) combines technical efficiency (TE) and environmental allocative efficiency (EAE) as follows:

$$EE = \frac{a' x_{EE}}{a' x} = \frac{a' x_{EE}}{a' x_{TE}} \times \frac{a' x_{TE}}{a' x} = EAE \times TE \quad (5)$$

Where environmental allocative efficiency is:

$$EAE = a' x_{EE} / a' x_{TE} \quad (6)$$

The values of environmental efficiency, environmental allocative efficiency, and technical efficiency range from zero to one. A value of one indicates full efficiency, while values below one suggest inefficiency in the respective metric.

3. Bootstrapped truncated regression

To identify the determinants of environmental efficiency in pangasius farming in Vietnam, this study applies a bootstrapped truncated regression with left truncation at $1 - K_i \beta$.

$$\bar{\delta}_i = \alpha + K_i \beta + \varepsilon_i, i = 1, \dots, n$$

where K_i is a vector of specific variables, α is a constant, β is a vector of parameters, and ε_i is the statistical noise, $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$. $\bar{\delta}_i$ is the reciprocal of the bias-corrected environmental efficiency scores.

4. Data and variables

In Vietnam, An Giang, Can Tho, and Dong Thap are the top provinces in pangasius farming (VASEP, 2022b). These provinces, therefore, were selected to do field survey in this study. In total, 195 farmers were interviewed using a structured questionnaire. The interviews include information on inputs and output the pangasius production cycle for the period 2020 – 2021.

Table 1. Descriptive statistics for input and output used in materials balance-based DEA

	Mean	Min	Max	SD
Per farm				
<i>Output</i>				
Pangasius production (tons)	353.9	60.0	2,000.0	323.1
<i>Inputs</i>				
Feed (tons)	574.2	94.8	3,300.0	535.0
Fingerling (tons)	15.5	2.5	64.7	13.7
Labor (man hours)	678.8	200.0	3,000.0	507.4
Per hectare				
<i>Output</i>				
Pangasius production (tons)	403.3	260.0	571.4	78.7
<i>Inputs</i>				
Feed (tons)	648.6	421.2	936.2	136.5
Fingerling (tons)	17.7	10.0	24.9	4.8
Labor (man hours)	867.4	500.0	1,750.0	311.3
Per ton of output				
<i>Inputs</i>				
Feed (tons)	1.61	1.40	1.87	0.09
Fingerling (tons)	0.04	0.02	0.07	0.009
Labor (man hours)	2.2	1.1	5.0	0.8

A review of previous studies reveals that feed, fingerlings, and labor are the primary inputs in pangasius farming within the study area (Anh Ngoc *et al.*, 2018). Among these, feed constitutes the largest proportion of total production costs (Anh Ngoc *et al.*, 2018). Additionally, pangasius farming involves various other inputs such as vitamins, medicines, water quality, and machinery. However, to minimize bias in the results and reduce the number of constraints in the Data Envelopment Analysis (DEA) model when estimating efficiency, this study focuses on analyzing a few key inputs: fingerlings (tons), feed used (tons), and the number of labor days involved throughout the farming process (man-hours). The output variable used in the model is the pangasius yield produced by the surveyed farms in the study area (tons). Detailed information on the inputs and outputs is presented in Table 1.

The result in Table 1 indicates that the average yield per farm is 353.9 tons. To achieve this output, the average amount of fingerlings stocked per farm is nearly 15.5 tons, though there is considerable variation among households, ranging from 2.5 tons to almost 65 tons. The size of fingerlings stocked also varies significantly. According to the survey, the most commonly stocked fingerling size in the study area is approximately 30 fish per kilogram. Some farms stock larger fingerlings, around 10 fish per kilogram, aiming for higher survival rates. Conversely, farms stocking much smaller fingerlings, with sizes reaching up to 80 fish per kilogram, may face higher mortality rates, though favorable conditions can still lead to high yields. This variation contributes to the significant range in the average amount of fingerlings stocked per ton of output, which spans from a minimum of 20 kg to a maximum of 68 kg. On average, each farms stocks 17.7 tons of fingerlings per hectare.

Regarding feed usage, a pangasius farm consumes approximately 574 tons of feed throughout the farming cycle on average. This equates to 1.61 tons of feed per ton of output or nearly 650 tons of feed per hectare of pond area.

Results and discussion

1. Nutrient Discharge from Pangasius Farms

To estimate the nutrient discharge into the environment, this study utilized information on the nutrient composition of inputs and outputs obtained through surveys and prior studies. Specifically, the survey revealed that the majority of the feed used for pangasius farming in the study area contains 26% protein. Additionally, according to Bosma (2011), the protein content in pangasius is 16%. The nutrient content in feed and fish was calculated based on the dry matter ratios of 90% and 30%, respectively, as used in Bosma's study (2011). Using the formula for crude protein content ($P = N \times 6.25$), the nitrogen content in feed, fingerlings, and harvested fish was estimated. Detailed information on the nitrogen content of inputs, outputs, and the discharged nitrogen is presented in Table 2.

The analysis in Table 2 shows that, on average, each farm consumes nearly 22 tons of nitrogen through input usage, with the majority coming from feed. Furthermore, Table 2 indicates that the nitrogen content in the harvested product is only about 2.7 tons per farm on average. Based on the principle of mass balance outlined in Section 1.2.3.1, it is estimated that, on average, nearly 19 tons of nitrogen per farm is discharged into the environment (Table 2).

When calculated per hectare, the nitrogen content in inputs used is over 24 tons. Meanwhile, the nitrogen content in pangasius products reaches only 3.1 tons per hectare. Therefore, the average nitrogen discharge per hectare is over 21 tons. The average nitrogen content per ton of pangasius product is 7.68 kg. Meanwhile, the nitrogen input used to produce one ton of product exceeds 60 kg. Consequently, the nitrogen discharged into the environment from producing one ton of pangasius is approximately 53 kg.

Table 2. Nitrogen emission from pangasius farms (Unit: kg)

	Mean	Min	Max	SD
Per farm				
<i>Nitrogen content in output</i>	2,718	460	15,360	2,482
<i>Nitrogen content in input</i>	21,616	3,568	124,049	20,137
- Feed	21,497	3,549	123,552	20,031
- Fingerling	119	19	497	106
Nitrogen emission	18,898	3,108	108,689	17,655
Per hectare				
<i>Nitrogen content in output</i>	3,098	1,997	4,389	605
<i>Nitrogen content in input</i>	24,421	15,858	35,766	5,163
- Feed	24,284	15,781	35,575	5,111
- Fingerling	136	77	191	37
Nitrogen emission	21,323	13,861	31,377	4,558
Per ton of output				
<i>Nitrogen content in output</i>	7.68	-	-	-
<i>Nitrogen content in input</i>	60.45	52.57	70.56	3.27
- Feed	60.12	52.42	70.01	3.20
- Fingerling	0.34	0.15	0.52	0.07
Nitrogen emission	52.77	45.02	62.71	3.21

2. Environmental efficiency

Table 3. Environmental efficiency

	Mean	Min	Max	SD
TE	0.913	0.789	0.981	0.041
EAE	0.622	0.406	1.000	0.157
EE	0.568	0.377	0.951	0.147

The efficiency analysis results in Table 3 indicate significant variations in efficiency indices, particularly environmental efficiency and technical efficiency, among the farms. The technical efficiency of pangasius farms ranges from 0.789 to 0.981, while environmental efficiency varies from 0.377 to 0.951. The analysis results in Table 3 also indicate that, overall, pangasius farms in the study area are environmentally inefficient. The average environmental efficiency score is 0.568, suggesting that, on average, farms could improve their environmental efficiency by 43.2% if they operated on the frontier. This implies that pangasius farms could reduce nitrogen discharge into the environment by up to 580 kg while maintaining the same production levels (Table 5).

In other words, if farms achieved environmental efficiency, they could reduce nitrogen discharge by an average of 1 kg per ton of product or 482 kg per hectare of pond area (Table 5). To achieve this, pangasius farms need to adjust their production practices. Specific recommendations for these changes will be discussed in the following sections.

3. Factors Affecting the Environmental Efficiency of Pangasius Farms

3.1. The Impact of Component Efficiency Indices on Environmental Efficiency

The results of the correlation test between the components of the environmental efficiency index in Table 4 indicate that the environmental inefficiency is primarily due to the households' ineffective coordination of input factors. This implies that improving environmental efficiency requires, first and foremost, an improvement in allocative efficiency. At the time of the study, the average environmental allocative efficiency index for pangasius farms was 0.622. Compared to the best-performing households, this indicates that the input combinations among farms were suboptimal. On average, each farm could reduce nutrient consumption by 37.8% without affecting production output.

This finding is linked to the fact that this study focuses on environmental efficiency directly associated with nutrient utilization in pangasius farming within the study area. It also suggests that, for a constant level of output, the nutrient discharge into the environment would be minimized if farms selected a reasonable combination of inputs based on the nutrient content of each input.

Table 4. Spearman's rank test for the correlation between efficiency measures

	TE	EAE	EE
TE	1		
EAE	-0.004	1	
EE	0.164	0.602***	1

*** indicate significance at 1 %

3.2. The Impact of Input Usage on Environmental Efficiency

As mentioned above, to achieve environmental efficiency—or in other words, to minimize emissions from pangasius farming without affecting output levels—Farms need to adjust their farming practices and modify input usage reasonably. This study utilized information on input usage from the most efficient farms and compared it with less efficient farms to calculate the required adjustments for each input to achieve environmental efficiency. These estimated adjustments are presented in Table 5.

The analysis results in Table 5 show that, to minimize nutrient emissions while maintaining production levels, each farm should, on average, reduce 6.7 tons of fingerlings, 14 tons of feed, and 112 labor days compared to the most efficient farms. On a per-hectare basis, the inputs to be reduced are more than 7,800 kg of fingerlings, 11 tons of feed, and 162 man-hours. When calculated per ton of product, farms should reduce more than 19 kg of fingerlings, 0.02 tons of feed, and 0.4 man-hours on average.

These adjustments are necessary because, based on the nutrient composition of the inputs directly contributing to the nutrient content of the output, the data envelopment analysis (DEA) method identified an optimal and efficient combination of these inputs. By comparing this optimal combination with the current input structure, the study determined the required adjustments.

If pangasius farms implement these changes, the nutrient emissions, specifically nitrogen emissions, could decrease significantly—by approximately 0.58 tons per farm. This corresponds to a reduction of 0.48 tons of nitrogen emissions per hectare of pond area or more than 1 kg per ton of product.

Table 5. Input changes in pangasius farming to be environmentally efficient

Per farm	Mean	Min	Max	SD
Input changes				
- Fingerling (tons)	- 6.7	0	-39.3	6.5
- Feed (tons)	-14	-226	59	42
-Labor (man-hours)	-112	-1,472	491	257
Nitrogen emission change (kg)	-580	-8,611	1,995	1,599
Per hectare				
Input changes				
- Fingerling (tons)	-7.9	-1.4	0	4.2
- Feed (tons)	-11	-151	65	39
-Labor (man-hours)	-162	-1,161	327	294
Nitrogen emission change (kg)	-482	-5,741	2,375	1,474
Per ton of output				
Input changes				
- Fingerling (tons)	-0.02	-0.04	0	0.009
- Feed (tons)	-0.02	-0.31	0.17	0.09
-Labor (man-hours)	-0.40	-2.75	0.78	0.70
Nitrogen emission change (kg)	-1.04	-11.67	6.39	3.37

3.3. Determinants of Environmental Efficiency of Pangasius Farms

3.3.1. Influence of Farm Owner Characteristics on Environmental Efficiency

Based on previous studies, such as Anh Ngoc et al. (2018), this study hypothesizes that higher educational levels and greater farming experience among farm owners would lead to higher efficiency. However, the analysis in Table 6 reveals that these characteristics have no statistically significant impact on farm efficiency. This suggests that education and experience are not as beneficial as anticipated, especially during unforeseen challenges like the COVID-19 pandemic (FAO, 2020). This finding aligns with studies by Tho et al. (2021) in Vietnam and Khan et al. (2021) and Ferdous Alam (2011) in Bangladesh, which examined technical and economic efficiency but did not consider environmental efficiency in pangasius farming.

Currently, pangasius farmers not only receive advice and training from agricultural extension agencies but also technical consultations from sales representatives of feed and aquaculture medicine companies. These consultations provide guidance on disease management, technical practices, and updates on market conditions and prices. As such, this study hypothesizes that farms receiving technical consultations would be more efficient than those without such support. The results in Table 6 confirm this hypothesis, showing that technical consultations have a statistically significant effect on environmental efficiency. The coefficient ($-8.94e-02^*$) indicates that technical consultations positively influence pangasius farm's efficiency. Overall, farms receiving technical support exhibit higher environmental efficiency, emphasizing the importance of consultations and market information during uncertain times like the pandemic.

3.3.2. Influence of Production Characteristics on Environmental Efficiency

Tho et al. (2021) identified a nonlinear positive relationship between pond size and economic efficiency in pangasius farming in Vietnam. Based on this finding, the study hypothesized that pond size would also influence the environmental efficiency of pangasius farming in the study area. However, the analysis presented in Table 6 shows no statistically significant relationship between pond size and environmental efficiency.

Conversely, longer farming durations were predicted to negatively impact efficiency. Extended farming periods require additional inputs to sustain the stock, resulting in minimal output gains due to size limitations and market requirements for fish size. This could lead to increased emissions per production cycle, thereby reducing environmental efficiency. Nonetheless, the study found no statistically significant relationship between farming duration and environmental efficiency, a result consistent with Ferdous Alam (2011) and Alam (2011), who reported similar findings on technical efficiency in Bangladesh.

This study also investigated the influence of fry sources (in-province vs. out-of-province) on efficiency, considering that transport distance affects fry quality and survival rates (Bao Binh, 2020). Surprisingly, Table 6 indicates an inverse relationship, with farms sourcing fry from out-of-province achieving higher environmental efficiency. This suggests that transportation distance may be less critical when scientific transport methods are employed, and fry quality may depend on other factors. Bui et al. (2013) similarly observed that transportation has minimal impact on survival rates.

3.3.3. Influence of Contractual and Environmental Factors on Efficiency

Currently, only 15.9% of surveyed farms have contracts with buyers, which are intended to stabilize output and prices. This was expected to enhance efficiency. However, Table 6 reveals a statistically significant but inverse relationship between contracts and environmental efficiency. Farms with contracts exhibit lower environmental efficiency, potentially due to contractual obligations requiring fixed output levels, which limit scale

reductions or input adjustments. Extended farming periods during the pandemic may have further exacerbated this inefficiency.

Environmental factors, such as sludge removal frequency, were anticipated to positively impact environmental efficiency. Regular sludge removal helps maintain clean ponds, reduce fish mortality, and improve yields (Anh et al., 2010; Phú and Tính, 2012; Nhut, 2016). However, Table 6 indicates an inverse relationship, with higher sludge removal frequency associated with lower environmental efficiency. Frequent removal may stress fish, disrupting their environment and reducing yields. This finding suggests that increased sludge removal frequency is not an optimal solution for improving efficiency.

In contrast, wastewater treatment after use positively impacts environmental efficiency. Table 6 demonstrates that farms treating wastewater achieve higher efficiency, consistent with previous studies by Anh et al. (2010) and Nhut et al. (2019). Treating wastewater not only mitigates pollution but also aligns with sustainable aquaculture practices.

Table 6. Determinants of environmental efficiency of pangasius farming

	Coefficient	Confident interval
Intercept	7,30e-01***	4,20e-01 1,02e+00
Farmer’s characteristics		
Experience	4,30e-03	-3,65e-03 1,26e-02
Education	6,15e-03	-5,96e-03 1,89e-02
Technical advice	-8,94e-02*	-1,90e-01 -4,38e-03
Production characteristics		
Area	1,56e-06	-2,60e-07 3,95e-06
Farming cycle	6,25e-04	-1,60e-02 1,94e-02
Source of fingerling	1,50e-01*	2,17e-02 2,74e-01
Signing contract	1,18e-01*	2,63e-02 2,33e-01
Production environment		
sludge removal frequency	2,79e-02***	1,48e-02 4,25e-02
wastewater treatment	-1,29e-01**	-2,28e-01 -3,50e-02

- *, **, *** indicate significance at 10, 5 và 1 %

Conclusion

This study utilized a combination of the Data Envelopment Analysis method and a Materials Balance model to address environmental challenges in pangasius farming in Vietnam. By focusing on environmental efficiency—defined as minimizing emissions without reducing output—this research uniquely identified inefficient farming operations and quantified the reductions in input factors needed for improved environmental performance. The findings offer valuable insights for balancing environmental and economic considerations in future studies on pangasius farming.

The analysis revealed significant nutrient emissions from pangasius farms, with an average discharge of nearly 19 tons of nitrogen per farm, equating to over 21 tons per hectare of pond area or approximately 53 kilograms per ton of product. The average environmental efficiency score was 0.57, suggesting that nutrient inputs must be reduced by 43% to achieve efficiency. Imbalances and misallocations of input factors were identified as key drivers of inefficiency.

Certain farm characteristics also influenced environmental performance. Farms with technical consultations and wastewater treatment systems exhibited higher efficiency, while those with product purchase contracts or sourcing fingerlings from local hatcheries showed increased nutrient emissions. Frequent sludge removal correlated with lower efficiency, emphasizing the need for improved waste management practices.

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Technology And Innovation for Sustainable Development in Lao Cai Province

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Abstract

This paper focuses on applying technology and innovation to promote the sustainable development of Lao Cai province, a region with great potential but also facing challenges in economic, social, and environmental aspects. It analyzes suitable technologies in agriculture, tourism, industry, and environmental protection. The paper also proposes solutions such as digital technology, artificial intelligence (AI), and renewable energy to enhance production efficiency, conserve resources, and improve people’s livelihoods.

Keywords: Technology, Innovation, Sustainable Development, Lao Cai Province

Introduction

Lao Cai province, located in Vietnam’s Northwest region, has diverse terrain, a unique climate, and great potential in tourism, agriculture, and mineral resources. However, it also faces several challenges:

- Climate change impacts agricultural production.
- Mining activities affect the environment.
- Tourism services lack consistency and do not fully utilize their potential.
- Limited adoption of modern technology in production and resource management.

To address these challenges, technology adoption and innovation are crucial for the province’s sustainable development.

Main Content

1. Technology Application in Sustainable Agriculture

- Smart Farming: Using IoT sensors to monitor soil moisture, crop nutrition, and weather forecasts to optimize agricultural production.
- Organic Agriculture Combined with Digital Technology: Applying blockchain for product traceability to increase the value and credibility of Lao Cai’s agricultural products.
- AI and Big Data Applications: Analyzing consumer behavior and market trends to adjust agricultural production accordingly.

2. Smart Tourism Development

- Virtual Reality (VR) and Augmented Reality (AR): Creating digital tourism experiences to promote destinations such as Sa Pa and Bac Ha.
- AI-Powered Tourism Services: Chatbot systems providing tourists with information about locations, culture, and local customs.

- Cashless Payment Systems: Integrating QR code technology and e-wallets to facilitate easy payment for tourists.

3. Mining and Environmental Protection through Technology

- Green Technology in Mining: Using eco-friendly ore processing technologies to minimize the impact on water and soil.
- AI and IoT-based Environmental Monitoring: Sensor systems measuring air and water quality and providing early pollution warnings.
- Biological Waste Treatment: Applying microbiological technology to treat wastewater from mining activities, ensuring ecological balance.

4. Renewable Energy – A Solution for Sustainable Development

- Solar and Wind Energy Development: Utilizing renewable energy potential to reduce dependence on the national power grid.
- Energy Storage Systems: Helping households and businesses maximize the use of renewable energy.
- Waste-to-Energy Technology: Reducing environmental pollution while generating clean energy.

Conclusion

Technology and innovation are the keys to helping Lao Cai province develop sustainably by maximizing its potential and addressing existing challenges. Applying technology in agriculture, tourism, mining, and renewable energy will not only improve residents’ quality of life but also contribute to environmental protection and economic sustainability.

To achieve this, cooperation among the government, businesses, and local communities is essential to invest in technology, raise awareness, and promote new development models.

Appendix

Indicator	Value
Economic Growth (GRDP)	7.38% compared to 2023
Economic Scale	VND 77,223 billion, up 11.8% from 2023
GRDP per capita	VND 97.5 million/person/year, an increase of VND 8.9 million from 2023
Industrial production value	VND 45,728 billion, up 7.4% from 2023
Total retail sales of goods and services	VND 43,000 billion, up 9.6% from 2023
Total state budget revenue	VND 12,800 billion, reaching 100% of the provincial estimate and increasing by 35.9% from 2023
Total number of tourists	7.5 million visitors, up 3% from 2023
Total tourism revenue	VND 25,000 billion, up 12.4% from 2023

The translated statistical table on Lao Cai province’s socio-economic development in 2024

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Application of ASMR in Advertising in the Fast Food Industry: The Mediating Role of Emotional Response

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Abstract

This study explores the role of ASMR advertising in the fast food industry of a multinational brand on purchase intention, based on the SOR theory with the PAD emotional response model as a mediator. An online survey of 385 participants was analyzed using SmartPLS 4 and SPSS 24. Structural Equation Modeling (SEM) analysis revealed that auditory and visual stimuli directly and positively influenced PAD emotional responses. These responses not only played a mediating role but also directly impacted purchase intention. The study also found that females were more arousal to strong stimuli, while males responded more positively to dominance. Theoretical and practical implications for marketing were also discussed.

Keywords: ASMR advertising, fast food, SOR, PAD emotion, auditory stimuli, visual stimuli.

Introduction

ASMR (Autonomous Sensory Meridian Response) is a cognitive condition in which audio-visual stimuli, like soothing sounds of crackling snacks or fizzing drinks, induce a relaxing and pleasant tingling sensation initially in the head and neck area and may spread to other areas of the body (B. Fredborg et al., 2017). Popularized since 2010 and facilitated by platforms like YouTube and TikTok, ASMR has become a global trend, with over 500,000 ASMR channels and 25 million videos by 2022 (del Campo & Kehle, 2016; Richard, 2022). In Vietnam, ASMR creators are on the rise, with TikTok alone featuring over 30 million related keywords (Thao, 2024). ASMR is also gaining traction in marketing, with brands like Michelob Ultra, KFC, and McDonald's incorporating sensory elements like chewing or packaging sounds to create engaging advertisements (Tiffany, 2019). The fast food industry, experiencing robust growth globally and in Vietnam, has leveraged ASMR's unique appeal to enhance consumer engagement and purchase intentions (Shruthi & Ahmed, 2024).

While there have been many reports in the literature on the ASMR phenomenon in psychophysiology, social context or neuroscience, exploring its triggers and effects on individuals (E. L. Barratt & Davis, 2015; del Campo & Kehle, 2016; Poerio et al., 2018; De Kerpel et al., 2023; Gotsch & Gasser, 2024), its effectiveness in influencing consumer behavior remains underexplored, particularly in specific industries like fast food. Fast food refers to types of food that are quickly prepared and can be enjoyed immediately on-site or packaged for takeaway (Rosenheck, 2008). This sector, with its inherent sensory appeal through sounds

of crunchy bites or soda fizzing, can leverage ASMR to enhance engagement and relaxation (Sands et al., 2022). The evidence is the success of YouTubers in the field of food mukbang (a form of ASMR) with a huge number of subscriptions on various platforms. In Vietnam, the fast food industry is thriving thanks to rising incomes and a tech-savvy younger demographic (Chieu et al., 2023). However, multinational brands like KFC and McDonald’s face challenges competing with local food vendors deeply rooted in cultural preferences. ASMR offers an attractive opportunity to differentiate these brands in a competitive digital market. Furthermore, previous studies on ASMR have primarily focused on intrinsic motivations through theories such as the Uses and Gratifications Theory (UG) and the Compensatory Internet Use Model (CIUM) (Kircaburun et al., 2021; Jiang et al., 2024), paying little attention to external stimuli, which are central to ASMR, such as sound, visuals, and tactile sensations. These elements directly impact the nervous system, eliciting feelings of relaxation and satisfaction. This study addresses the gap by applying the Stimulus-Organism-Response (SOR) model to explain how external stimuli (S) influence behavior (R) through internal states (O).

This study aims to achieve three objectives: (1) to explore how ASMR advertising stimuli (auditory and visual) impact emotional responses (pleasure, arousal, and dominance), (2) to investigate the relationship between emotional responses and consumer purchase intentions, and (3) to explore the moderating role of gender in the relationship between emotional responses and purchase intention. These insights aim to advance ASMR advertising theory and offer marketers strategies to design emotionally engaging advertisements.

Literature review & Hypothesis development

Stimuli-Organism-Response theory

To understand the process of motivation influencing human behavior, this study uses the SOR theoretical model proposed by Mehrabian & Russell (1974), based on environmental psychology to scientifically explain consumer behavior. This model proposes a relationship between three stages: the environment contains stimuli (S) that will affect the organism (O) and drive response (R) (Mehrabian & Russell, 1974). The first stage, “stimulus” (S), refers to the environmental factor that stimulates internal organism states (S. Song et al., 2021). The stimulus is often classified into two broader categories: psychosocial stimuli which originate from the individual’s environment, and object stimuli related to the complexity, time of consumption, and product-related features (Arora, 1982). In ASMR ads, audio-visual elements are classified as object stimuli, as they feature product-related details. The second stage, “organism” (O), involves the internal processes that occur within the individual as a response to a stimulus (Erensoy et al., 2024). Individual users analyze previous external stimuli and use their cognition and emotions to consider relevant information before responding to them (Sun et al., 2021). In this study, the three PAD emotion factors including pleasure, arousal, and dominance are considered as the emotional state in organisms. Eroglu et al. (2003) define pleasure (P) as the extent to which a person feels comfortable, happy, or satisfied, thereby measuring an individual’s ability to perceive an environment as enjoyable or dull. Arousal (A) refers to the level of sensory stimulation, energy, or excitement (Eroglu et al., 2003). Dominance (D) refers to the extent to which a person is affected or controlled by the environment (Mehrabian & Russell, 1974). “Response” (R) represents the individual’s final decisions and behaviors based on emotional and cognitive states in response to stimuli (Sherman & Smith, 1987). Actions or intentions, whether approach or avoidance, can be considered as response content (Sherman et al., 1997). In the field of marketing, many scholars apply purchase intention to explore consumers’ behavioral intentions in various contexts (Liu et al., 2013; B. Zhu et al., 2020). Purchase intention refers to the probability that consumers

will purchase a product or service and plays a key role in consumers’ actual purchase behavior (Yoo et al., 2000). The SOR framework is widely used to study consumer behavior such as e-marketing, online shopping, tourism, and influencer marketing (Rajaguru, 2014; Kamboj et al., 2018; Z. Song et al., 2022). Its flexibility in selecting constructs makes it adaptable to various contexts (Jacoby, 2002). Therefore, this study applies the SOR model to explore consumer purchase intention in ASMR-based fast food advertising.

Conceptual framework & Hypothesis

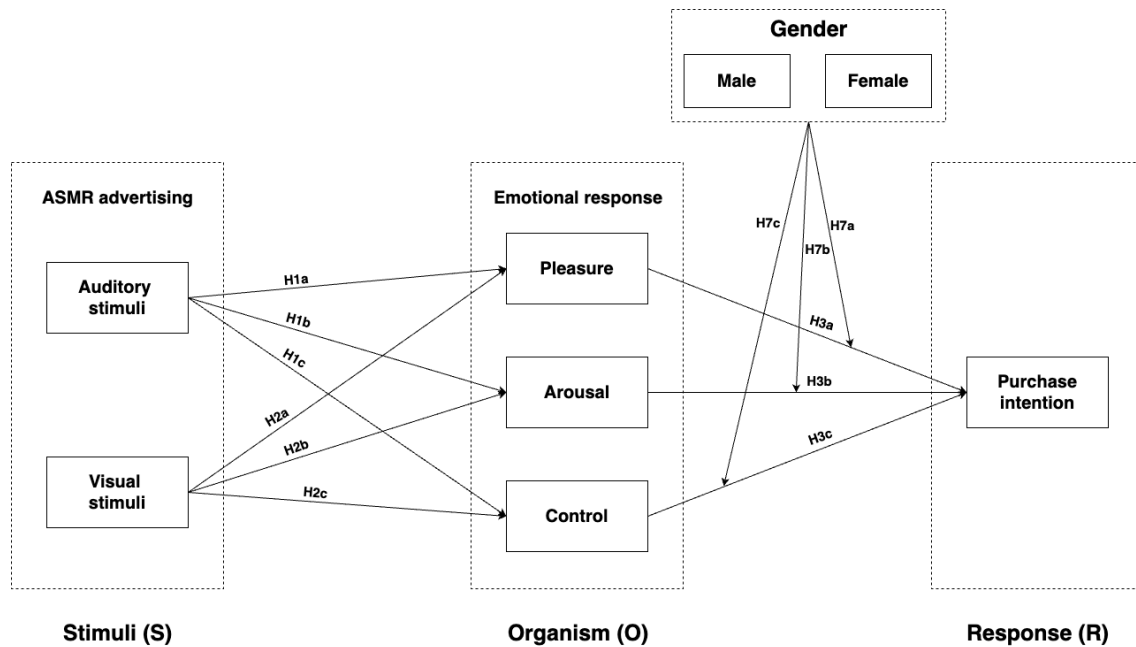


Figure 1. Proposed study model.

The PAD model - pleasure, arousal, and dominance - proposed by Mehrabian & Russell (1974), provides a comprehensive framework for understanding the impact of emotional responses elicited by environmental stimuli. Auditory stimuli in ASMR ads refer to the carefully curated sounds, such as whispering, tapping, crinkling, and other quiet auditory triggers, that evoke physical tingling sensations and psychological relaxation in the audience (E. L. Barratt & Davis, 2015; Lochte et al., 2018). Whispering, the most effective ASMR trigger, is experienced by 75% of participants (Barratt & Davis, 2015). Low-pitched, soft voices are perceived as gentle and trustworthy, enhancing emotional connection and consumer preferences in ASMR video (E. Barratt et al., 2017; Motoki et al., 2019). These auditory triggers activate brain regions linked to feelings of pleasure and satisfaction (E. L. Barratt & Davis, 2015; Mori & Zatorre, 2024). In ASMR fast food ads, dynamic sounds boost emotional immersion, fostering brand connection and appeal (B. K. Fredborg et al., 2018). Poerio et al. (2018) also suggest that ASMR sound elements enhance perceived control over emotions and decisions. Therefore, it is hypothesized that:

H1a. Auditory stimuli positively influence customers’ pleasure.

H1b. Auditory stimuli positively influence customers’ arousal.

H1c. Auditory stimuli positively influence customers’ dominance.

Visual stimuli in advertising refer to any elements that can be perceived through sight, including images, colors, movements, and visual textures (Elder & Krishna, 2012). These external stimuli have been shown to influence the three dimensions of the emotional PAD model in previous studies (Loureiro, 2015; Tantanatewin & Inkarojrit, 2018). Graf & Landwehr

(2017) found that appealing images enhance satisfaction levels, particularly in food advertising, where vibrant colors and image textures evoke satisfaction and craving. Research into color psychology through the PAD model of Z. Zhu et al. (2024) has revealed that warm colors, such as red and orange, promote arousal and excitement, while cool colors, like blue and green, foster relaxation and a sense of calmness. Reimann et al. (2010) noted that bright colors and dynamic compositions increase arousal while Park & Young (1986) found that structured visuals provide a sense of control over the sensory experience. Therefore, it is hypothesized that:

H2a. *Visual stimuli positively influence customers' pleasure.*

H2b. *Visual stimuli positively influence customers' arousal.*

H2c. *Visual stimuli positively influence customers' dominance.*

Purchase intention reflects the consumer's likelihood to choose a particular brand or product under certain conditions, indicating potential purchase behavior (S. Shah et al., 2012). Stronger purchase intentions indicate a higher likelihood of consumers buying the product (Turney et al., 2003). The academic literature provides compelling theoretical and empirical evidence of the strong relationship between the PAD model and purchase intention (Ward & Barnes, 2001; Chen & Hou, 2024). When consumers become more interested in fast food advertisements that use the ASMR effect, their purchase motivation may increase. Strong, rapid, and unexpected arousal can bring about feelings of happiness and promote seeking behavior (Holbrook & Gardner, 1993; Babin & Darden, 1995). Furthermore, the perception of control plays an important role in directly influencing behavior (Bagozzi, 1992). Therefore, it is hypothesized that:

H3a. *Pleasure positively influences customers' purchase intention.*

H3b. *Arousal positively influences customers' purchase intention.*

H3c. *Dominance positively influences customers' purchase intention.*

Previous studies have shown that the “organism” acts as a mediator in the S-R relationship, explaining how internal emotional states influence behavioral outcomes (Huang et al., 2017; Martinez & McAndrews, 2021). This study uses the PAD model to further clarify this by highlighting how pleasure, arousal, and dominance, triggered by sensory stimuli in ASMR advertising, can enhance purchase intentions (Smith & Snider, 2019). Pleasure and arousal serve as mediators between design aesthetics and purchase intention, whereas arousal specifically mediates the connection between innovative visual and auditory elements and user retention (Kumar & Shah, 2021; A. M. Shah et al., 2022). Furthermore, elements that evoke a sense of power and control, can influence recommendations on purchase intention. Therefore, it is hypothesized that:

H4a. *Pleasure mediates the impact of auditory stimuli on purchase intention.*

H4b. *Pleasure mediates the impact of visual stimuli on purchase intention.*

H5a. *Arousal mediates the impact of auditory stimuli on purchase intention.*

H5b. *Arousal mediates the impact of visual stimuli on purchase intention.*

H6a. *Dominance mediates the impact of auditory stimuli on purchase intention.*

H6b. *Dominance mediates the impact of visual stimuli on purchase intention.*

Gender is defined as the genetic and biological distinction between individuals as male or female (Wilson, 2002). It is considered an important moderating variable in marketing (Darley & Smith, 1995), influencing how consumers process advertising stimuli and make purchase decisions (Holbrook, 1986; Palmer & Bejou, 1995). Psychologically, the empathy-systemizing theory argues that women's thoughts and behaviors are largely guided by emotional factors, while men's are mainly driven by cognitive reasoning (Baron-Cohen, 2016). Additionally, studies have found that women tend to prioritize emotional factors over practical

concerns, while men focus more on functionality than emotions (Dittmar et al., 2004). These differences between gender may influence how men and women perceive and process stimuli and, therefore, influence the effects of ASMR advertising as theorized in previous hypotheses. Therefore, it is hypothesized that:

H7a. *Gender moderates the relationship between pleasure and consumers' purchase intention.*

H7b. *Gender moderates the relationship between arousal and consumers' purchase intention.*

H7c. *Gender moderates the relationship between dominance and consumers' purchase intention.*

Research methodology

Measurement instruments

The scale development process, encompassing Auditory Stimuli, Visual Stimuli, the PAD model (Pleasure - Arousal - Dominance), and Purchase Intention was based on previous researches and expert evaluations to ensure clarity, accuracy, and relevance to the context of ASMR research. The scale was then refined to improve the semantics of some items through a small pilot test with 20 participants. The research model includes an auditory stimuli scale with four items from Wiedmann et al. (2018) and one expert-derived item (AD5) on chewing sounds in ASMR ads. The visual stimuli scale consists of six items adapted from Cyr et al. (2010). The PAD framework (Mehrabian & Russell, 1974) measures pleasure (3 items), arousal (4 items), and dominance (4 items) on a 5-point semantic differential scale (e.g., “unpleasant - pleasant”). The purchase intention scale includes three items adapted from Zhang (1996) and Bock et al. (2012). All items, apart from those on the PAD scale, were measured using a 5-point Likert scale, with 1 indicating “strongly disagree” and 5 indicating “strongly agree”. The final questionnaire was divided into two main sections: (1) evaluating constructs through 25 observed variables and (2) collecting socio-demographic information.

Data collection

The target population for this study consisted of Vietnamese citizens from diverse demographic backgrounds, including various age groups, genders, and income levels. To reach a broad and diverse sample, the research team disseminated the questionnaire via multiple channels, including social media platforms, local community groups, and ASMR-specific communities where the target audience was likely to be engaged. To ensure respondents understood the concept of ASMR and its application in advertising, the survey began with a brief explanation, accompanied by an advertising video featuring ASMR effects for a fast food product from a multinational brand in Vietnam for those who had not previously experienced it. Additionally, a filter question is added in the questionnaire to check the attention of respondent “Please select “Disagree” if you are still reading this form” for the question “When viewing advertisements using ASMR effects for fast food from multinational brands,...”. Responses that do not meet the requirements will be discarded. The survey was conducted in November, collected 475 responses. After screening, 90 invalid responses were excluded, resulting in a final dataset of 385 valid responses.

Research results

Descriptive statistics

Table 1. Survey respondent profile (n = 385).

Characteristics	Categories	Frequency	Percentage (%)
Gender	Male	167	43.4%
	Female	218	56.6%
Age (years)	Less than 18	67	17.4%
	18-29	217	56.4%
	30-39	74	19.2%
	More than 40	27	7.0%
Income (million VND)	Less than 1	108	28.1%
	1-5	120	31.2%
	5-10	92	23.9%
	More than 10	65	16.9%

The results in **Error! Reference source not found.** show that 56.6% were female, prevailing 43.4% male respondents among the 385 valid surveys. Regarding age distribution, the majority of respondents were aged 18-29 (56.4%), followed by 30-39 (19.2%), under 18 (17.4%), and the rest of over 40 (7.0%). In terms of income, most respondents reported a monthly income of 1 to 5 million dong (31.2%), while only 16.9% of respondents have a level of income over 10 million dong. The demographic distribution shows that fast food may be a suitable option for addressing the need for quick meals without requiring significant spending, which aligns with younger individuals with low to middle income levels.

Measurement model evaluation

Exploratory factor analysis

EFA was conducted using SPSS 24 software with 200 survey forms to evaluate the strength and relationship of each common factor with related tests (Fabrigar & Wegener, 2012). The results of Cronbach's alpha analysis of latent variables ranged from 0.737 to 0.897, greater than 0.7, showing that all scales have good reliability and are qualified to measure variables (Bryman & Bell, 2011). The KMO value of the observed variables ranged from 0.715 to 0.926 (>0.5), which is sufficient to conduct factor analysis (Kaiser, 1974). Bartlett's test yielded a significance value of < 0.01, meeting the standard threshold of < 0.05. This result confirms that the observed variables are sufficiently correlated for factor analysis (Bartlett, 1954). The smallest Eigenvalue is 1.059 (>0.7) and the smallest total variance extracted is 62.825% (>50%), showing that the EFA model was suitable (Jolliffe, 1972; Fornell & Larcker, 1981). Based on the viewpoint of J. Hair et al. (2014), observed variables with factor loading > 0.5 are considered to have practical significance. Conducting separate EFA tests for each type of variable, the results in **Error! Reference source not found.** show that 25 observed variables are re extracted into 6 factors, ensuring the requirements when analyzing linear regression. In which the factor loading of all observed variables is > 0.642, showing that the EFA model is suitable.

Confirmatory Factor Analysis

The final measurement model showed a fairly good overall goodness-of-fit and most of the fit indices were above or close to the required minimum threshold. The ratio of minimum discrepancy of confirmatory factor analysis to degrees of freedom (Chi-square/df = 2.461) met

the recommended threshold of < 5 or preferably < 3 (Hu & Bentler, 1999). CFI = 0.935 and TLI = 0.925 were greater than 0.9 indicating that the model fit values were satisfactory (Bentler, 1990).

The results of the reliability analysis of the scales are shown in

Table 3. It can be seen that Cronbach's alpha of all scales meets the condition > 0.7 , confirming that the observed variables are reliable scales of the corresponding variables (Bryman & Bell, 2011). All observed variables satisfy the requirement of Corrected item - Total correlation > 0.3 (Nunnally, 1978). The analysis results show that the smallest Composite reliability (CR) of this model is 0.775 (> 0.7), so the overall reliability of this scale is good and acceptable (Netemeyer et al., 2003). The AVE score is used to assess the convergent value of a scale with a specified threshold > 0.5 (Hair Jr. et al., 2021). The results of this study have the smallest AVE of 0.634 (> 0.5), indicating that all indicators are suitable. Moreover, the outer loading factor > 0.7 ensures the quality of observed variables, with the smallest result of this study being 0.712, indicating good quality of observed variables (J. F. Hair et al., 2013). The square root AVE of each construct was greater than its correlation coefficient with other constructs, indicating that the discriminant validity between the constructs was satisfactory (Fornell & Larcker, 1981). These results are presented in Table 2.

Table 2. Correlations among latent constructs (Fornell- Larcker Criterion).

	AVE	AD	VS	P	A	D	PI
AD	0.641	0.801					
VS	0.669	0.734	0.818				
P	0.679	0.650	0.627	0.824			
A	0.634	0.670	0.646	0.685	0.796		
D	0.650	0.601	0.640	0.605	0.621	0.806	
PI	0.713	0.769	0.789	0.694	0.771	0.727	0.844

Structural model evaluation

Evaluation of direct effects

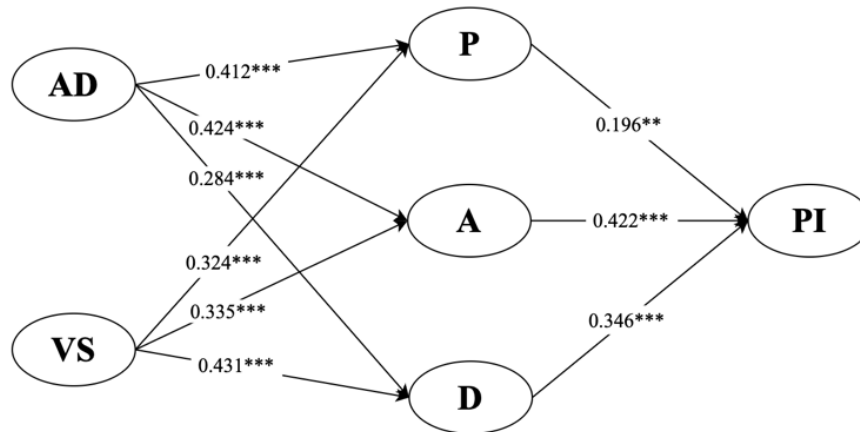
The path coefficients, and model hypotheses are presented in Figure 2. The results indicate that all relationships are statistically significant ($p < 0.05$). Specifically, Auditory Stimuli positively influences Pleasure ($\beta = 0.412$, $p = 0.000$), Arousal ($\beta = 0.424$, $p = 0.000$), and Dominance ($\beta = 0.284$, $p = 0.000$).

Table 3. Analysis of reliability and validity.

Constructs/Dimensions	Item Code	Outer loading	Cronbach's alpha	CR (rho_a)	CR (rho_c)	AVE
Auditory Stimuli (AD) - Wiedmann et al. (2018)			0.860	0.865	0.899	0.641
The whispering is very nice to listen to.	AD1	0.785				
The swallowing sounds are very satisfying.	AD2	0.832				
The chewing sounds are realistic.	AD3	0.820				

Constructs/Dimensions	Item Code	Outer loading	Cronbach's alpha	CR (rho_a)	CR (rho_c)	AVE
The appealing tones are very noticeable.	AD4	0.786				
The crunching sounds are very stimulating.	AD5	0.780				
Visual Stimuli (VS) - Cyr et al. (2010)			0.901	0.901	0.924	0.669
The delicate mouth movements are captivating.	VS1	0.813				
The food image is pleasing.	VS2	0.829				
The colours are eye-catching.	VS3	0.848				
The colour matching is emotionally appealing.	VS4	0.830				
The food arrangement is visually harmonious.	VS5	0.803				
The visual aesthetic is professional and well-designed.	VS6	0.781				
Pleasure (P) - Mehrabian & Russell (1974)			0.765	0.775	0.864	0.679
1 = unpleasant, 5 = pleasant	P1	0.804				
1 = unsatisfying, 5 = satisfying	P2	0.812				
1 = disgusting, 5 = enjoyable	P3	0.855				
Arousal (A) - Mehrabian & Russell (1974)			0.807	0.811	0.873	0.634
1 = calm, 5 = exciting	A1	0.820				
1 = unaroused, 5 = aroused	A2	0.767				
1 = sleepy, 5 = wide awake	A3	0.758				
1 = bored, 5 = stimulated	A4	0.836				
Dominance (D) - Mehrabian & Russell (1974)			0.819	0.829	0.881	0.650
1 = controlled, 5 = controlling	D1	0.850				
1 = restrained, 5 = free	D2	0.858				
1 = guided, 5 = autonomous	D3	0.797				
1 = influenced, 5 = influential	D4	0.712				
Purchase Intention (PI) - Zhang (1996) and Bock et al. (2012)			0.798	0.799	0.882	0.713
I become interested in making a purchase.	PI1	0.861				
I am willing to purchase the product being advertised.	PI2	0.863				
I will probably purchase the product being advertised.	PI3	0.807				

Therefore, H1a, H1b, and H1c are accepted. The study results also confirm that Visual Stimuli positively impacts Pleasure ($\beta = 0.324$, $p = 0.000$), Arousal ($\beta = 0.335$, $p = 0.000$), and Dominance ($\beta = 0.431$, $p = 0.000$). Hence, H2a, H2b, and H2c are accepted. Furthermore, the findings demonstrate the positive effects of Pleasure, Arousal, and Dominance on Purchase Intention, with coefficients of ($\beta = 0.196$, $p = 0.001$), ($\beta = 0.422$, $p = 0.000$), and ($\beta = 0.346$, $p = 0.000$), respectively. As a result, H3a, H3b, and H3c are accepted.



Note: *** $p < 0.01$, ** $p < 0.05$.

Figure 2. Results of direct effects evaluation.

Evaluation of indirect effects

The bootstrapping method Zhao et al. (2010) was employed to examine the mediating effects of the three PAD factors in the proposed causal relationships within the model. The results in Table 4 indicate that all hypotheses have p -values < 0.05 , and the confidence intervals do not include 0. Thus, H4b, H5a, H5b, H6a, and H6b are accepted. Among these, Arousal emerges as the strongest mediating role in all indirect relationships. However, Pleasure does not exhibit a significant mediating effect in the relationship between Auditory Stimuli and Purchase Intention, as the 95% confidence interval includes 0. Hence, H4a is rejected.

Table 4. Intermediary test of Pleasure, Arousal and Dominance

Hypothesis	Path	β	p-value	Bootstrap 95% CI	Test result
H4a	AD \rightarrow P \rightarrow PI	0.0628	0.004	-0.0028 - 0.1478	Rejected
H4b	VS \rightarrow P \rightarrow PI	0.0611	0.026	0.0075 - 0.1293	Accepted
H5a	AD \rightarrow A \rightarrow PI	0.2045	0.000	0.1207 - 0.2951	Accepted
H5b	VS \rightarrow A \rightarrow PI	0.1939	0.001	0.1215 - 0.2788	Accepted
H6a	AD \rightarrow D \rightarrow PI	0.1629	0.001	0.1032 - 0.2297	Accepted
H6b	VS \rightarrow D \rightarrow PI	0.1372	0.000	0.0821 - 0.1953	Accepted

Multigroup analysis - MGA

The moderating role of Gender is examined through multigroup analysis to evaluate differences and their significance in specific parameter estimates within a predefined dataset (Hair et al., 2018). The results of the PLS-MGA parametric test in **Error! Reference source not found.** indicate that H7b and H7c are accepted with $p\text{-value} < 0.05$. Specifically, the standardized path coefficient difference for H7b is $-0.279 < 0$, showing that Arousal has a stronger impact on Purchase Intention among Females than Males. For H7c, the standardized path coefficient difference is $0.206 > 0$, suggesting that Dominance has a stronger impact on Purchase Intention among Males than Females. Conversely, H7a is rejected as the $p\text{-value}$ is $0.812 > 0.05$.

Table 5. The results of the moderating role of Gender

Hypothesis	Path	Male (A)	Female (B)	A - B	p-value	Test result
H7a	P → PI	0.197 (p-value = 0.010)	0.170 (p-value = 0.042)	0.028	0.812	Rejected
H7b	A → PI	0.285 (p-value = 0.002)	0.564 (p-value = 0.000)	-0.279	0.021	Accepted
H7c	D → PI	0.456 (p-value = 0.000)	0.250 (p-value = 0.000)	0.206	0.029	Accepted

Evaluation of predictive capability

In this study, SmartPLS was used to obtain the coefficient of determination (R^2). In the model, the R^2 values of Pleasure, Arousal, Dominance, and Purchase Intention are 47.1%, 50.1%, 44.7%, and 71.3%, respectively. According to the general rule of Henseler et al. (2009), the R^2 values of Pleasure, Arousal, Dominance, and Purchase Intention demonstrate moderate predictive accuracy, ranging from 40% to less than 75%. Second, to evaluate the predictive relevance of the model, Q^2 value is assessed using the PLSpredict procedure (Shmueli et al., 2016). The results obtained Q^2 values of Pleasure, Arousal, Dominance, and Purchase Intention as 0.458, 0.489, 0.435, and 0.665, respectively. All Q^2 values are greater than 0, indicating that the prediction errors of the PLS-SEM results are smaller than those based on mean values, demonstrating adequate predictive relevance of the proposed model (Geisser, 1974). In summary, the results of R^2 and Q^2 confirm that the research model achieves predictive capability.

Discussion

Theoretical implications

ASMR has become a popular phenomenon in recent years; however, existing studies have primarily focused on users' internal motivations (e.g., the UG or CIUM frameworks), overlooking external environmental stimuli crucial to the ASMR effect. To address this gap, the study applies the SOR model.

Firstly, the study presents the direct relationships within the SOR model. Results show that auditory cues, such as steady rhythms and subtle volume variations, significantly enhance Arousal by directly stimulating the auditory nervous system. These cues also moderately evoke Pleasure by creating a realistic and interactive experience for viewers. However, their effect on Dominance is negligible because this feeling is often related to the level of control and initiative

of the viewer in the experience situation. These findings also reinforce the previous study by P. Li et al. (2022). In addition, the study highlights how Visual Stimuli affect the three PAD dimensions. Advertisements with appealing designs, harmonious colors, and lighting increase viewers' sense of control over their environment. This finding extends the research of Tantanatewin & Inkarojrit (2018), emphasizing the central role of Visual Stimuli in enhancing the sense of Dominance. Vivid colors and strong lighting in ASMR advertisements can also heighten excitement, stimulate the nervous system and increase consumer Pleasure, albeit to a lesser degree. Pleasure varies based on individual preferences, making the impact of Visual Stimuli differ across study groups. The study also discusses the impact of organism (O) factors on response (R). The direct relationships between the PAD dimension and Purchase Intention show a positive correlation. Arousal is the strongest driver of Purchase Intentions, as it fosters excitement, engagement, and immersion, prompting quicker actions. This study expands on the work of Yang et al. (2020), suggesting that the three PAD dimensions can directly enhance Purchase Intention without the involvement of any mediating factors.

Secondly, the study explores the mediating role of the organism in the SOR model. Auditory Stimuli and Visual Stimuli from ASMR ads do not directly drive consumers' Purchase Intentions but indirectly through PAD emotional states. Consumers' emotions bridge multisensory experiences and purchase intentions, highlighting the need for advertisements to evoke both aesthetic appeal and genuine emotional engagement. The mediation roles of Pleasure and Arousal in the relationships between Auditory Stimuli and Visual Stimuli and consumers' Purchase Intentions align with previous findings by Yang et al. (2020). Additionally, this study extends the work of P. Li et al. (2022) by uncovering the mediating role of Dominance. However, Pleasure doesn't mediate relationship between Auditory Stimuli and Purchase Intention, likely due to ASMR sounds lacking the intensity to evoke enough satisfaction or comfort to drive purchases.

Finally, this study also contributes to research on moderating effects, highlighting Gender as a moderator in the relationship between Arousal and Dominance with Purchase Intention of viewers. Females are more likely to generate Purchase Intention when experiencing Arousal emotions such as curiosity and excitement. Meanwhile, Males exhibit a stronger increase in Purchase Intentions when they feel a sense of control or autonomy during the shopping process. This moderation is consistent with previous research, as Mehrabian & O'Reilly (1980) noted that men tend to be less aroused but have higher levels of control than women. However, Gender does not moderate the relationship between Pleasure and Purchase Intention, suggesting that this emotion affects Purchase Intentions equally in both Men and Women. Thus, Pleasure is a highly universal emotional state. The moderating role of Gender expands upon Huang et al. (2017) by emphasizing the psychological and physiological differences between Males and Females in processing emotions that drive Purchase Intentions after exposure to ASMR advertisements.

Practical implications

This study provides valuable information for businesses in measuring and evaluating the effectiveness of ASMR advertising campaigns. Marketing departments can use the research findings to optimize advertising by focusing on stimuli that evoke desired emotions. Specifically, using visual product sounds such as crunchy bites, pouring sounds to evoke arousal, or whispering and light chewing sounds to connect with pleasure. Sharp images with close-up angles or slow motion during product presentation can enhance the sense of dominance. Businesses can also increase purchase intention through arousal content generated primarily by auditory stimuli. Based on the findings that gender has effects on how emotions impact consumers' purchase intention; businesses can segment advertising content according

to customer gender. For female audiences, advertisements should use pleasant, clear sounds like whispers or rustling. For men, focusing on messages and camera angles that emphasize control, power, or dominance is essential. To compete with local businesses in Vietnam, leaders of multinational fast food brands can use this study’s findings to make informed decisions in allocating budgets and optimizing resources, building and developing comprehensive marketing strategies to ensure that all marketing activities are most effective.

This research not only helps businesses improve their marketing effectiveness internally but also brings value to customers and external stakeholders. Modern life and work pressures drive people to seek balance and relaxation. Amid the Internet boom and an overload of noisy advertisements, gentle and delicate content is gaining traction thanks to its ability to provide viewers with comfort and tranquillity. The application of ASMR advertising in the fast food industry helps Vietnamese citizens enjoy a unique and interesting experience, helping them connect their emotions with the brand. Customers will be inspired to shop from auditory and visual stimuli, meeting both consumption and emotional needs. This research contributes to the fast food industry in Vietnam by uncovering the potential of ASMR, helping brands generate unique ideas, improving ad quality, and influencing customer and market behavior.

Conclusion & Limitation

The study applied the SOR model to explore the impact of stimuli from ASMR advertisements on consumers’ purchase intention through emotional responses (PAD) as mediators. The results show that auditory and visual stimuli in ASMR ads influence emotions, which play a key role in forming purchase intention. The study also indicates that gender affects relationship between emotion and purchase intention of customers. These findings highlight how ASMR can be effectively utilized in marketing strategies.

Due to resource and time constraints, the study acknowledges limitations and suggests future research directions. First of all, this study applied the SOR model to analyze the impact of stimuli from ASMR advertisements on purchase intention through emotional responses. However, by focusing solely on the emotional aspect of the subject (O), it overlooks cognitive aspects, such as the ability to evaluate or reason, which could play an important role in consumer behavior. Future research could apply integrated models to simultaneously assess the impact of both emotional and cognitive factors on purchasing behavior. Second, this study uses gender as a moderating variable while overlooking several potential demographic factors, such as age, income level, or consumers’ individual personalities. Future research could consider these factors to evaluate their influence on how consumers perceive and respond to ASMR advertisements. Finally, the data collection method in this study has certain limitations that may affect the accuracy and diversity of the results. Future studies should combine data collection methods, such as surveys, in-depth interviews, and content analysis of ASMR ads, to better understand their impact on consumer behavior.

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Appendix

Table 6. Rotated Factor Matrix

Constructs	AD	VS	P	A	D	PI
AD1	0.818					
AD2	0.759					
AD3	0.747					
AD4	0.736					
AD5	0.700					
VS1		0.782				
VS2		0.776				
VS3		0.775				
VS4		0.766				
VS5		0.764				
VS6		0.714				
P1			0.761			
P2			0.785			
P3			0.737			
A1				0.764		
A2				0.750		
A3				0.653		
A4				0.769		

Constructs	AD	VS	P	A	D	PI
D1					0.794	
D2					0.776	
D3					0.769	
D4					0.642	
PI1						0.850
PI2						0.845
PI3						0.860

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Innovation for Food Safety in Vietnam: An Application of the One Health Approach in Agri-food Supply Chain

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Abstract

Food safety is essential for public health and food security, ensuring safe production, processing, transport, storage, and consumption to prevent foodborne illnesses. In Vietnam, a country of nearly 100 million people, food safety concerns present significant human health, agricultural, and economic challenges. This study examines food safety concerns in the supply chains of fresh vegetables (water spinach and green mustard) and fish (tilapia), key dietary staples in Vietnam. Using an innovative approach - One Health framework, we assess the human health implications of food safety issues in Hue City and estimate the associated cost-of-illness. To quantify these impacts, we conducted a face-to-face survey of 400 households in Hue City to elicit consumer preferences for food safety improvements and measured willingness-to-pay (WTP) for safer food through a choice experiment. Our findings indicate high WTP for improved food safety, with variations based on the type of safety measures proposed. The study underscores the substantial social costs of unreported foodborne illnesses and the economic benefits of reducing pesticide and antibiotic use in agriculture and aquaculture. By integrating plant and animal health with human health, we contribute to the One Health literature. Our insights provide a strong foundation for policymakers, practitioners, and researchers to develop effective strategies for improving food safety in Vietnam. Addressing these multifaceted food safety issues will enhance public health outcomes and strengthen Vietnam's food supply chain.

Keywords: Innovative approach, One Health framework, food safety, Vietnam

Introduction

Food safety is vital for healthy communities. The concept covers the safe production, processing, transport, storage and preparation of food to prevent food-borne illness and is an integral part of food security (WHO, 2016). The human health consequences of breaches in food safety are significant – foodborne disease is estimated to cost \$12 million lost disability-adjusted life years (DALYs) annually in Southeast Asia (Havelaar et al., 2015). Vietnam is a Southeast Asian country of almost 100 million people. It is mid-ranked amongst ASEAN nations based on GDP per capita, making the challenges faced in Vietnam broadly representative of the region. Vietnam faces food safety challenges from agricultural, human health and economic perspectives (WB, 2017). Unsafe foods cause human morbidity and mortality and diminish the credibility of Vietnamese agricultural products in domestic and international markets (WB, 2017). Based on official government data, the WHO reports that

there were an average of 668,673 cases and 21 deaths related to foodborne diseases per year from 2011-2016 (WHO, 2024). In addition to these officially reported cases, there is likely to be many more unreported cases of foodborne ailments (KSU, 2014). These unreported cases are likely to bare significant burden and costs to society. Given the importance of food safety to consumers and the consequences of consuming unsafe foods, there is expectation that consumers would be willing to pay higher prices for foods that are certified or perceived to be safer.

We focus on safety of consuming fresh vegetables and fish, which are staples in the daily diets and are a major concern for the public in Vietnam using an innovative approach (Ha et al., 2019). The Vietnamese government has placed a high priority on food safety to address human health and grow food export markets (Wertheim-Heck et al., 2015). However, despite training programs like “Safe Vegetables” and “VietGAP” (Vietnam Good Agricultural Practices), many vegetable products fail to meet food safety standards (Figuié et al., 2004). Ruth to add a sentence here about food safety challenges in aquaculture. We assess some food safety concerns within supply chains for specific fresh vegetables (water spinach and green mustard) and fish (tilapia). We then use a One Health framework to analyse the effects of those food safety concerns to human health amongst the population of Hue City in Central Viet Nam, and the associated cost-of-illness. In doing so, we specifically focus on the underreporting of food related ailments, which often have relatively mild and/or cumulative symptoms, and are therefore not reported by those affected, and do not appear in official health statistics. Nevertheless, we suspect that due to the widespread incidence of such unreported ailments, the cost-of-illness attributable mostly to loss of productivity and wages and cost of treatment are staggering.

We obtain estimates of these costs that confirm the magnitude of the suspected problem. These estimates were obtained based on a survey of 400 households in Hue City that we conducted face-to-face between December 2022 and January 2023. This survey was also used to elicit the preferences for food safety by consumers of fresh vegetables and fresh fish. We elicited the willingness-to-pay (WTP) for food safety attributes by conducting a choice experiment. We use these estimates of WTP to make an assessment about the demand for food safety by Vietnamese consumers. We find that the consumers in Vietnam have high WTP for improved food safety, but that the WTP varies substantially dependent on the type of improvements proposed. By taking this holistic approach we also contribute to the One Health literature in the sense of linking plant and animal health to human health. For example, we find probable over-application of pesticides in fresh vegetables supply chains resulting with high pesticide residues in the fresh food, which is likely driven by the aim of farmers to protect their plants from pests and diseases. However, high pesticide residues in food harms human health. Reducing the need for pesticide application by better agronomic practices that reduce susceptibility of plants to pests and diseases would therefore have tangible social benefits in terms of improved food safety. We find that consumers are willing to pay for such improvements.

1. Research Objectives

1.1 To apply a multidisciplinary approach that identifies key food safety concerns in three supply chains of common fresh foods in Vietnam

1.2 To investigate how these concerns translate to burden of disease from unreported cases of food ailments associated with consuming these foods

1.3 To estimate consumer demand for improved food safety of these foods

2. Review of Related Literatures

Major food safety hazards for fresh vegetable consumers include pesticide residues and microbial contamination. Pesticides are used during production to reduce crop damage from pathogens, weeds and pests. Gupta (2012) provides evidence of widespread off-label use of pesticides in Southeast Asia, with significant human and environmental health risks and impacts (Schreinemachers et al., 2015; Hoi et al., 2016). Van Hoi et al. (2009) estimated that 75% of farmers use off label rates of pesticides and up to 98% use mixtures containing several kinds of pesticides. Off-label use of pesticides risks poisoning and the development of antimicrobial resistance in agricultural and human pathogens. Farmers demonstrate their own awareness of food safety risks and restrict pesticide use to crops destined for sale, while avoiding pesticide use on food crops for their own consumption.

Pesticide use is driven by market forces amidst rapid social, economic and commercial transitions. Pesticides are viewed as a labour-saving technology that compensates for labour shortages that constrain intensification to meet demands of the growing urban population. There is the belief that providing information and promoting safe pesticide use will create change in farmer practice. These assumptions do not consider the broader livelihoods context of farmer’s decisions to use agrichemicals in response to market pressures, increasing urbanisation and labour shortages (Carter et al., 2022; World Bank, 2017). They also fail to recognise that weak governance structures and policing, especially in local markets, leaves gaps between policy and practice. Consequently, Carter et al. (2022) recommend shifting responsibility for pesticide use to include other players in the value chain.

Contamination with microbes or parasites, along with exposure to zoonotic diseases and antimicrobial resistance, are also major issues in food supply chains especially for fresh fish and meat supply chains (Unnevehr, 2000). Microbial contamination also affects safety of fresh vegetables when animal manures are used as organic fertilisers, when produce is contaminated by unclean irrigation water, when there is poor postharvest storage and transportation, and when food preparation is unhygienic (Ho et al., 2014; World Bank, 2017).

In terms of consumers’ attitudes to food safety concerns, Hue (2021) estimates that 87% of consumers in Vietnam are significantly concerned about food safety. Improving consumer awareness and willingness to pay may reward farmers using pesticides safely. Hue (2021) found that Vietnamese consumers are willing to pay higher prices for safe vegetables and pork, while My et al. (2021) showed that willingness to pay for certified rice depends on trust in certification and consumer income. Previous studies have investigated consumers’ willingness to pay (WTP) for food safety in Asian countries. For example, Liu et al, 2013, estimated WTP for reduced pesticide residues in vegetables in China. In the context of Thailand, Posri et al. (2006) estimated consumers’ WTP for safe vegetables, and Sriwaranun et al. (2015) estimated WTP for organic products. Thus, multiple studies have investigated food safety, but a limited number have considered the issue along the supply chain, especially from a multi-point perspective, such as using the One Health Approach.

Research Methodology

1. Conceptual framework

Looking at food safety through a One Health lens involves recognizing the interconnection between human, animal, and environmental health (FAO, 2023). In conceptualising this study, we added an additional component to this triad, namely plant health. Improving plant health by implementing good management practices, such as e.g. avoiding monoculture cropping, or including nitrogen fixating legumes in the crop rotation, reduces the need to use pesticide and synthetic fertilizer, which has important One Health benefits. To aid

conceptualisation, we propose a mind map that articulates the interconnectedness of human, animal, plant and environmental health, and puts that interconnectedness in the context of food safety (Figure 1).

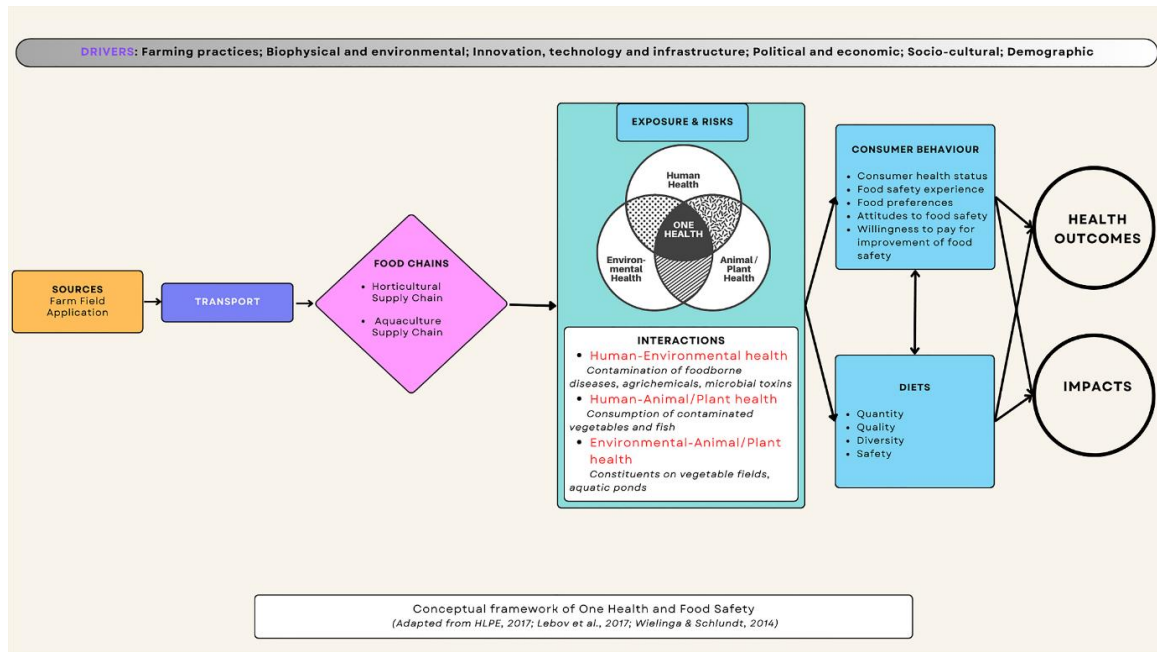


Figure 1. A mind map for One Health and Food Safety (Adapted from Lebov et al., 2017)

Lebov et al. (2017) present a framework for adopting the One Health (OH) approach in research, which ensures that human, animal, and environmental health concerns are addressed collectively and comprehensively. This integrated approach offers a deeper understanding of issues and potential solutions compared to fragmented approaches. HLPE (2017) identifies various drivers—biophysical, environmental, natural, political, economic, as well as innovation, technology, and infrastructure—that influence the performance of food systems and their capacity to provide healthy and sustainable diets. Additionally, Wielinga & Schlundt (2014) highlight the increasingly global nature of food production and trade, indicating that certain food-related challenges have become global issues. Therefore, we consolidate insights from these studies to develop a more inclusive framework for analyzing the impact and interactions of Food Safety in Vietnam using a One Health Approach. Our conceptual framework emphasizes the holistic approach and builds on previous studies using this approach to food safety in Vietnam (HLPE, 2017; Lebov et al., 2017; Wielinga & Schlundt, 2014). It underscores the importance of prevention, collaboration, and ongoing improvement to safeguard public health and enhance food safety practices. Within this framework, the main components include various actors along the food supply chains of interest (in our case the vegetable supply chain and the fresh fish supply chain), the exposure and risks, the One Health interactions, consumer behaviour, household diets, and consequential health outcomes and impacts. Through this approach, our study seeks to provide a robust foundation for policymakers, practitioners, and researchers to institute effective strategies ensuring the safety of the food supply chain in Vietnam

2. Research Instrument (s)

2.1 *Fresh Vegetables Supply Chain Analysis*

Farm visits of vegetable producers and managers were conducted in three locations at Huong Long and Kim Long Cooperative, and at Thuan Thanh Ward, Hue City (Figure 3). During the visits eleven farmers were selected to conduct in-depth interviews concerning the safety of the vegetables they produce (5 households in Huong Long, 5 households in Kim Long and 1 household in Thuan Thanh. Interviewers who conducted the interviews with farmers were trained to by “watching, doing and practicing” following instructions from the lead researchers. Three categories of vegetables: green mustard, lowland kang kung and upland kang kung were collected for analysis of heavy metals, pesticide residues and microorganisms. The samples were collected in the fields of interviewed farmers, and at the Cho Thong market near the Huong Long cooperative. Five households out of the eleven households were interviewed, and vegetable samples were taken for analysis of cypermethrin (insecticide) and *Escherichia coli* (*E. coli*) in Huong Long and Kim Long Cooperative and one household in Thuan Thanh ward.

2.2 Analysis of consumer health status, attitudes to, and WTP for food safety

To elicit the incidence of experienced food related health ailments and preferences for food safety, including WTP for improved food safety among general population, a survey was designed and conducted in Hue City between December 25, 2022 and January 15, 2023 using a Computer-Assisted Personal Interview (CAPI) method. Face-to-face interviews were conducted with iPads used as assisted devices to display the questions and record the responses. Participants were recruited from five wards across Hue City, with two in the City’s North (i.e., Tay Loc, Gia Hoi) and three in the City’s South (i.e., Thuy Bieu, Phuong Duc, Tay Loc) (Figure 3).

3. Samples

Participants were recruited using a stratified sampling method. The sampling technique followed a systematic approach: on each street, a random household was selected, starting from the 3rd house in the street. Interviewers knocked on the door and asked to conduct an interview with the head of the household, or the person in the household responsible for procuring and preparing food. If the household on whose door was knocked was unavailable or refused to participate, the adjacent house on the left was approached. This process continued in intervals of three households until the street was covered or the targeted sample size of 400 was achieved. Inclusion criteria involved being a Hue City resident aged 18 or above, willingly participating in the survey, and speaking Vietnamese. Exclusion criteria encompassed individuals unable to communicate without specific aids (e.g. due to blindness or deafness).

The process of collecting data proceeded as follows: Well-trained interviewers, comprising of researchers, lecturers, and medical students at Hue University, contacted and invited representative of individual households, as described above, to participate in the survey voluntarily. Participants were asked for consent before the survey initiation. Each interview took about 20-30 minutes (with an average of 22 minutes and standard deviation of 5.8 minutes). Participant information was obtained and kept confidential and for scientific purposes only. In total, 403 individuals participated in the face-to-face interviews, with 3 individuals excluded due to form submission errors, resulting in the final sample of 400 participants.

Figure 3 shows the spatial distribution of the respondents by their residential location. It can be seen from Figure 3 that the interviewers intercepted and interviewed residents living across the city of Hue.

Exploratory analysis of the collected data was conducted using descriptive statistics and visualisation techniques to inform model development and estimation. Subsequently, several econometric model specifications were tested to determine the most suitable model for the data, including multinomial logit models (MNL), mixed logit models, scaled MNL, and generalised mixed logit models (see, e.g., Hensher et al., 2015).

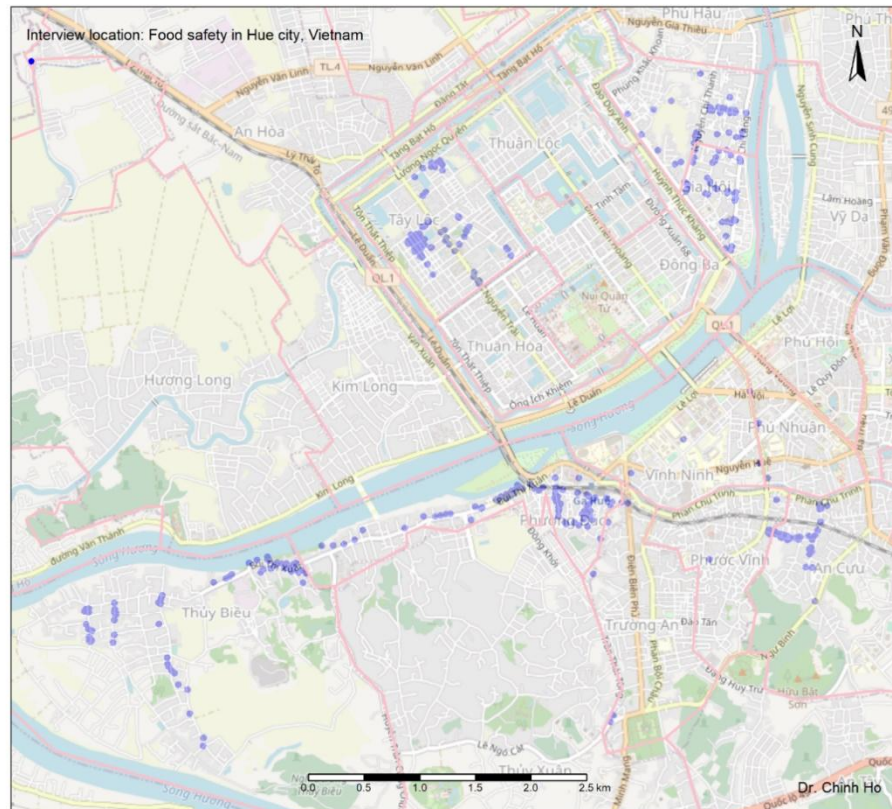


Figure 3. Spatial distribution of the consumers-sample households by residential location within Hue City

4. Statistics for Data Analysis

The best-fitting model, identified via log-likelihood ratio tests, was a mixed logit model, providing estimated willingness to pay (WTP) for each product safety attribute. For a choice set of three alternatives used in this placemaking survey, equations (1) and (3) are identical; so are equations (2) and (4). The latter can be proved by multiplying both numerator and denominator of equation (4) by $\exp(V_1 + V_2)$, and the former by $\exp(V_2 + V_3)$ (see Ho and Hensher, 2017). Thus, the empirical analysis of the best-worst data will use the best–worst and the worst-best processing rules (i.e., equations (1) and (2)). Both processing rules will be explored and compared against each other to select the one that fits better to the empirical data. Importantly, both processing rules shared the same utility specification which takes a form similar to the following where the observed utility is a linear-in-parameter function of food attributes.

$$V_j = asc_j + \sum_k \beta_k X_{kj} + \beta_{cost} Cost_j \quad (1)$$

where j = Option A, B or C; β_k are the parameters associated with a set of attributes X_{kj} that together describe the product (i.e., vegetable or fish), asc_j is the alternative-specific constant, β_{cost} is the cost parameter and $Cost_j$ is the unit price of the product the respondent

faces in the SP choice task. The marginal WTP for one-unit improvement in attribute X_k is calculated as: $WTP_k = \frac{\beta_k}{-\beta_{cost}}$ (2)

Given that the cost in the best-worst stated preference survey is computed for the entire household (i.e., based on council rate, renting cost – both are household expenditure) and is shown as \$ per unit of measurement (bunch of vegetable ~ 250gr or 1kg of tilapia fish), the WTP calculated in (7) will have a unit of \$ per household per bunch of vegetable or per kg of tilapia.

Results

1. Findings from the analysis of fresh vegetables supply chain

The results from the interviews of vegetable farming households showed that most of them produced vegetables for sale in markets around the city near the production site. Households producing organic vegetables only apply organic fertilizers, microbial formulations and do not use pesticides. Income from producing and selling vegetables is not high, but enough to meet daily living needs. Most vegetable producing households cannot invest in preliminary processing and cold storage, so most vegetables must be sold out within a day and cannot be kept longer. The area on which these households grow green mustard and kang kung was between 100 to 1000 square meters, and the total production was between 100 to 300 kg per household per season, and income was approximately 1.5 million VND/season.

Some households that produced green mustard and kang kung used organic farming methods, while others used conventional farming methods. Chemical fertilizer was applied between 3 to 5 times per season for those practicing conventional farming, while organic and microbial fertilizer was applied for organic production. For conventional methods of production, farmers were aiming to maximise yield, rather than produce high quality product. Most of the interviewed farmers do not participate in VietGAP program, but they stated that they are interested in exploring the possibilities for organic production. Most farmers consumed the vegetables they grew and they had the demand of pre-processing vegetables before sale.

There are more than 11 types of pesticides that are commonly used to treat vegetable crops by conventional producers. Chemical pesticides were applied regularly and more than 5 times per season, however, the interviewees states that the last spraying was more than 6 days before harvest. Farmers used mask, gloves, raincoat, respirator, boots, and glasses for personal protective equipment. Most farmers make their own decisions about which pesticide to apply. The results of the analysis presented in Table 8 showed that there were 2 samples of kangkong (sample id 23DY244: purchased at Huong Long market and sample id 23DV249: collected from conventional vegetable producer) where pesticide residues were found. Residual levels of the pyrethroid insecticide cypermethrin exceeded the maximum allowable limit for vegetables (MRL <0.2 ug/kg fw) according to Vietnamese standards in three out of eighteen (11.1%) samples. One sample (5.5%) of mustard greens (sample id 23DV250: collected from conventional vegetable producers) also contained excessive levels of cypermethrin above the MRL level. Eleven samples (61.1%) of mustard greens and kang kung (wet and dry) from both conventionally produced and organically produced were contaminated with E coli: green mustard sample ids BDY242, 23DV243, 23DV250, 23DV251, 23DV257), wet kangkong (sample id 23DY244, 23DV259) and dry kangkong water spinach (sample ids 23DV245, BDY262, 23DV263, 23DV258).)

2. Findings from the analysis of consumer health status and WTP for food safety

Figure 4 shows that 7% of the sampled households in Hue City stated that they experienced symptoms of food related ailment in the last 3 months. Some 55% of these households sought medical attention, overwhelmingly from family and friends, but seeking medical treatment from pharmacy and hospital also accounted for about 17% of total sample (see Figure 5).

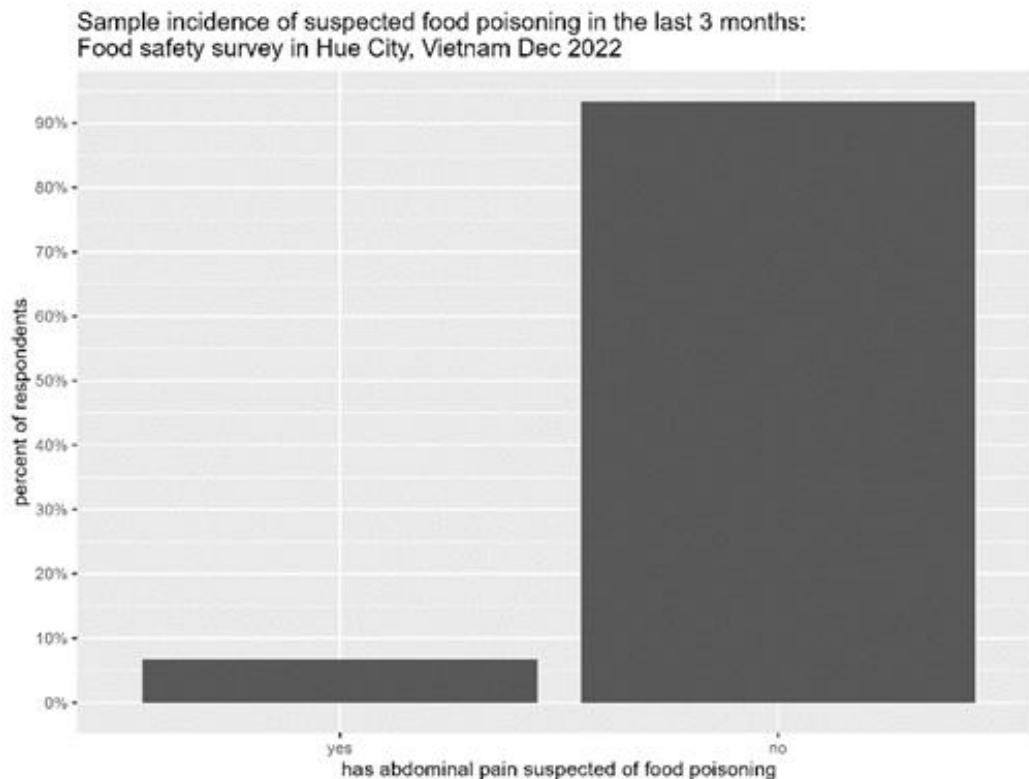


Figure 4. Proportion of sampled households that experienced food borne ailment in the last 3 months

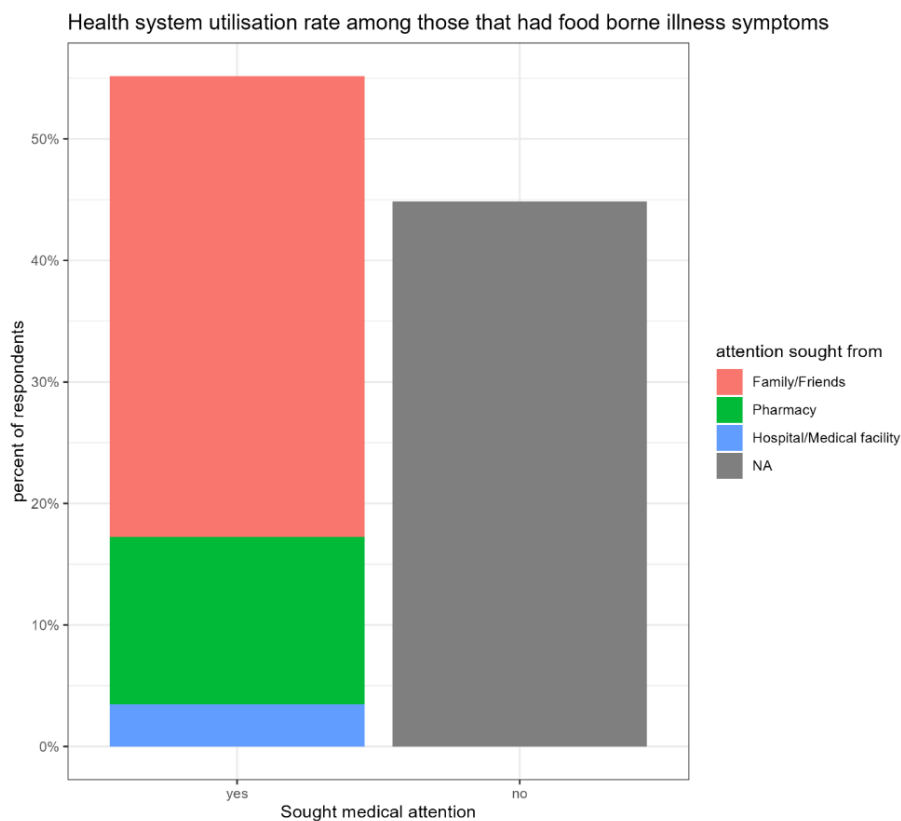


Figure 5. Health system utilisation rate among those that had experienced food borne ailment symptoms

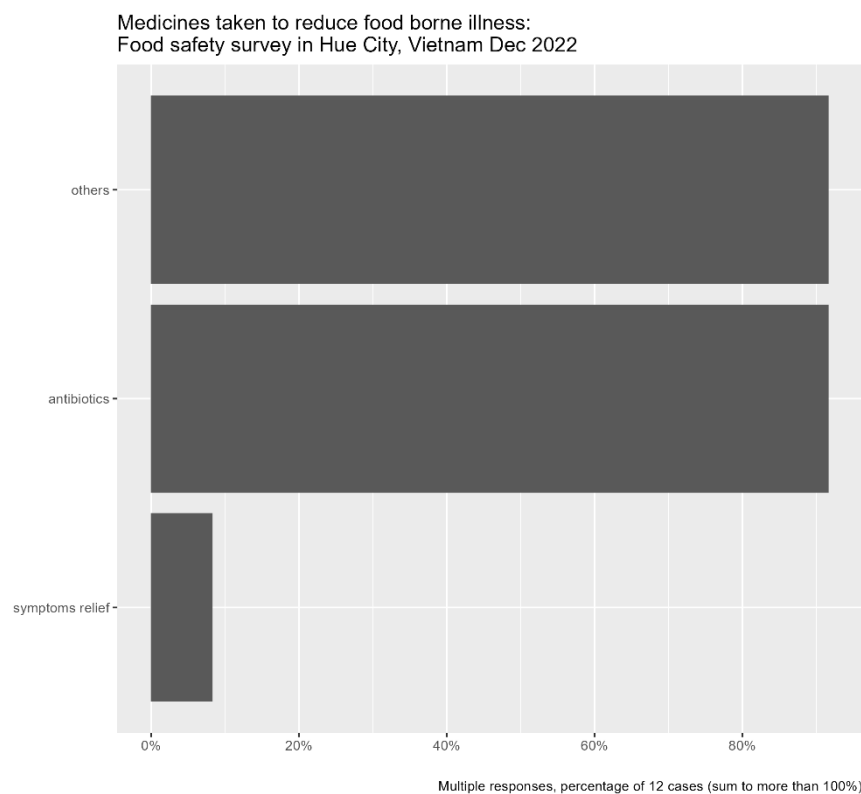


Figure 6. Medicines taken by those reporting experiencing food borne ailment in the last 3 months.

More than two in three people (69%) who experienced food borne ailment in the last three months took some medicines to reduce their symptoms. The most common treatment was antibiotics, followed by ‘others’ and medicines for symptomatic relief (see Figure 6). Most people who had food borne illnesses missed work or school for at least 0.5 days and at most 7 days (hospitalised), with an average of 1.5 days/case

Given the findings from the analysis of consumer health status and the health system utilisation discussed above we can conduct a simple calculation to provide a notional estimate of the likely social costs of unreported cases of food borne ailments in Hue City. For that purpose, we use cost of illness estimates reported in the literature specifically for food borne ailments in Vietnam (Hoang et al., 2015). As reported in the literature, on average, the costs per treatment episode and per hospitalization day for foodborne diarrhea case in Vietnam were US\$ 106.9 and US\$ 33.6 respectively. Indirect cost (costs of time to patient, their relatives due to the patient’s illness) made up the largest share (51.3%) of this total cost of illness. Direct medical costs accounted for 33.8%, while direct non-medical costs (to the patient and to their relatives) represented 14.9% of the estimated total cost of illness.

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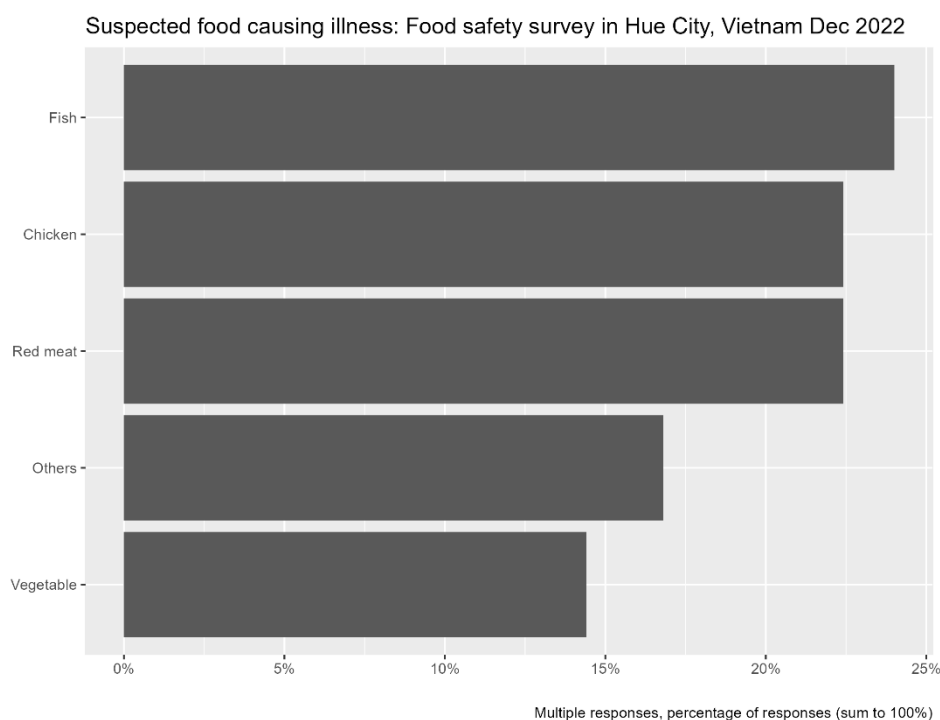


Figure 7 Suspected food that was a cause of food borne ailment in the last 3 months

3. The results of Willingness to Pay (WTP) by households for improving food safety)

Applying these costs estimates to the context of food borne ailments in Hue City as per our findings, suggests very high costs of illness. Given that 7% of surveyed respondents in Hue City reported food borne ailment in the last 3 months, that amounts to a total of some 45,000 cases across Hue City over 3 months, given a population of 650,000, and assuming that our findings of the incidence of illness can be extrapolated to the population. Using a very conservative cost-of-illness estimate of half of that reported in the literature (i.e. US\$ 53.5 per episode), we arrive at total cost of illness for Hue City at some US \$2.4 mill/3 months. This amounts to some US \$10 million annually in terms of cost of illness attributed to food borne ailments in Hue City. This is a very large social cost that warrants to be reduced.

The findings from the analysis of the consumers’ WTP for food safety, based on the choice experiment and models presented in Table 1.

Table 1. Estimated Willingness to Pay (WTP) by households for improving food safety in Hue City, Vietnam.

	WTP (‘000VN D)	si g	t- value	95%CI	
<i>WTP for 1 bunch (~250g) of Kangkong, Green Mustard</i>					
Organic vegetable certified by government authority	61.825	**	7.56	45.800	77.851
Safe vegetable certified by government authority	48.187	**	5.75	31.753	64.620
Organic vegetable certified by third party	46.629	*	6.29	32.088	61.170
Vegetable with no certificate	3.553		1.38	-1.496	8.602
Fresh vegetable	3.203		1.56	-0.822	7.228
Naturally taste vegetable	9.333	*	3.22	3.661	15.006
Vegetable with basic information on the supply chains	25.946	*	4.16	13.729	38.162
Vegetable with full information on the supply chains	45.851	*	5.55	29.660	62.042
<i>WTP for 1 kg of black and red Tilapia</i>					
Wild fish certified by government authority	125.55	**	2.02	3.842	247.27
Farmed fish certified by third party	-0.334		-0.01	-55.413	1
Wild fish certified by third party	60.256	*	1.81	-5.151	125.66
Fish with no certificate	-21.083		-1.03	-61.277	4
Fresh fish	4.397		0.29	-25.302	19.112
Naturally taste fish	39.218	*	1.71	-5.751	34.095
Farmed fishes with basic supply chains information	63.670	**	2.66	16.723	84.187
Farmed fishes with full supply chains information	115.15	**	2.39	20.625	110.61
					7
					209.69

Note: ***, **, * denotes significance at 1%, 5%, 10% level. CI = Confidence Interval. 1USD = 23,572 VND

As can be seen from the table, the surveyed consumers in Hue City state high and significant WTP for various aspects of perceived improvement in food safety. The table shows that there is a strong preference for certification of organic status (implying pesticide residue free) and food safety by government agency. Estimated WTP amounts are quite high, and this is consistent with other studies conducted in similar contexts (e.g. Vuong et al., 2024). We suspect that these high estimates are influenced by the fact that interviewed households reside in a major urban area, where incomes are quite high, and there is greater awareness towards food safety and financial ability to express that awareness. There could also be effects of hypothetical bias (Hensher, 2010), as the interviewed households may not be entirely clear about what various types of certification, for example, might actually mean for the attributes of their interest. Nevertheless, the results point to considerable WTP that consumers express of

improvement in food safety for both vegetables and fresh fish. For fresh fish, the preference is clearly for wild caught specimens compared to farmed fish. However, there is a substantial WTP for farmed fish on which there is full information about its supply chain

Conclusion

Findings from the study indicate that fresh vegetable supply chains (except those that are produced and certified organic) are plagued with pesticide and E. Coli contamination. Fresh fish supply chain is completely focused on ‘freshness’, represented by live fish. This can mask serious food safety concerns, and warrants further investigation. In the fish supply chain, freshness overlaps with food safety. Fish that is not fresh, including tilapia, may lead to poisoning. There is also awareness of the importance of fish health, but not so much of chemical residue concerns. There are substantial social costs from unreported food borne ailments due to loss of productivity and cost of treatment. Consumers (at least higher-income ones, and this is increasingly the case in VN) are willing to pay substantial premiums to be assured that the food they are consuming is safe. Reducing pesticide and antibiotic use in agriculture/aquaculture would have substantial benefit in terms of One Health outcomes. The One Health interactions, consumer behaviour, household diets, and consequential health outcomes and impacts provide a robust foundation for policymakers, practitioners, and researchers to institute effective strategies ensuring the safety of the food supply chain in Vietnam. The innovation approach used in this study provides significant insights into food safety issue from multi perspectives.

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The Impact of Human Resource Management System on Employee Performance in ABC Express Company: The Mediating Role of Employee Flexibility and Work Engagement

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Abstract

In a dynamic business environment with rapid technological progress and changing market demands, the importance of an effective human resource management system (HRMS) is self-evident, but there are significant gaps in the current research on express delivery companies such as ABC Express. Therefore, this paper proposes the following research questions: How does HRMS affect the employee performance of ABC Express? What is the relationship between employee flexibility and work engagement? How do they mediate the relationship between HRMS and employee performance? Based on collecting the data of 400 grassroots employees of ABC Express company through a questionnaire survey, this paper uses descriptive statistics, correlation analysis, and regression analysis to process and analyze the data. The results showed that HRMS had a significant positive impact on employee performance ($r = 0.676$, $p < 0.01$). Employee flexibility had a significant positive effect on work engagement ($r = 0.354$, $p < 0.01$). Employee flexibility and work engagement play a significant mediating role between HRMS and employee performance, and together explain 69.1% of employee performance variation. The results of this paper confirm the positive effects of HRMS, employee flexibility, and work engagement on employee performance and their mediating role between HRMS and employee performance. This study contributes to filling the gap in HRMS research for express delivery companies, offering valuable insights for improving employee performance through strategic HR practices, flexibility, and engagement.

Keywords: human resource management system, employee performance, work engagement, work flexibility

Introduction

In the face of rapid technological advancements and changing market demands, the role of an effective HRMS becomes even more critical (Davidescu et al., 2020). HRMS includes a wide range of practices and policies that manage the workforce, such as recruitment, selection, performance management, and talent development (Sharma et al., 2023; Qadir & Agrawal, 2017). The aim of HRMS is not only to optimize human capital but also to enhance employee engagement, ultimately driving improved organizational performance (Jain & Sharma, 2024;

Tende & Alagah, 2017). By focusing on these components, the study seeks to understand how HRMS contributes to employee performance, especially in a competitive and rapidly evolving business landscape.

While extensive research exists on the relationship between HRMS and employee performance, much of this work has focused on service industries such as finance, healthcare, and IT. Consequently, there is a noticeable gap in the literature concerning the impact of HRMS in the express delivery sector, including companies like ABC Express. Express companies face unique operational challenges, including complex supply chains, strict regulatory requirements, and a need for constant process improvement, which may influence how HRMS affects employee performance differently from service industries (Silic et al., 2020; Hammouri et al., 2023). Understanding how HRMS influences employee performance in the express industry is crucial for several reasons. First, the express sector is a key driver of economic growth, contributing significantly to job creation and wealth generation (Appiah et al., 2023). Improving employee productivity and performance is therefore vital for maintaining competitiveness and sustainability. Second, the sector’s increasing adoption of technology and automation has transformed work processes, requiring HRMS to adapt to the evolving skills and needs of its workforce (Gechbaia et al., 2020; Goulart et al., 2022).

ABC Express operates in a highly competitive global marketplace, where factors such as cost efficiency, product quality, and innovation are critical to success. In this environment, HRMS goes beyond administrative tasks, encompassing strategic workforce planning, talent acquisition, and development programs to foster continuous improvement and innovation (Hammouri et al., 2023). By optimizing HRMS to address the specific challenges of express operations, companies can maximize employee potential, drive operational excellence, and achieve sustainable growth in today’s business climate.

Building on the background presented, this paper seeks to explore key research questions related to the human resource management system (HRMS) at ABC Express. The first question examines how the HRMS of ABC Express influences employee performance, assessing its direct impact on workforce outcomes. The second inquiry investigates the relationship between employee flexibility and work engagement, exploring how these factors interact within the company. Furthermore, the study aims to understand the mediating role of employee flexibility in the connection between HRMS and employee performance. Finally, it addresses how work engagement serves as a mediator in this same relationship, offering insights into the comprehensive effects of HRMS on employee performance at ABC Express.

1. Research Objectives

1.1 To examine the effect of the human resource management system (HRMS) on employee performance in ABC Express Company.

1.2 To explore the relationship between employee flexibility and work engagement in ABC Express Company.

1.3 To identify the mediation effect of employee flexibility the relationship between HRMS and employee performance in ABC Express Company.

1.4 To identify the mediation effect of work engagement on the relationship between HRMS and employee performance in ABC Express Company.

2. Review of Related Literatures

2.1 Human resource management system and employee performance

A human resource management system (HRMS) refers to an integrated software platform designed to streamline and automate various HR functions, such as recruitment,

performance management, payroll, and employee records management. The system aims to enhance organizational efficiency by simplifying administrative tasks and improving data-driven decision-making processes (Armstrong & Taylor, 2023). Some scholars believe that human resource management system has a significant positive impact on employee performance. Li Fenglian (2016) concluded that HRM system can not only promote the innovation of enterprises but also improve the internal collaboration of management, but also identify effective HRM measures, thus improving the innovation ability of enterprises and the performance of employees. Liu (2019) believes that human resource management system can stimulate employees' enthusiasm, improve work efficiency, and enhance employees' performance. The implementation of high-level human resource management practices can not only bring better performance results to the organization, but also promote employee performance. Several scholars have emphasized that for a Human Resource Management System (HRMS) to effectively improve employee performance, it must be designed to align with the overall strategic goals of the enterprise. Li et al. (2018) argued that the recruitment, training, and reward mechanisms of HRMS should be tailored to the company's specific circumstances, adhering to principles of coordination, diversity, and a people-oriented approach. This alignment increases the likelihood of enhancing employee performance. Similarly, Li (2016) suggested that HRMS should work in synergy with the enterprise's efficiency goals by integrating various human resource functions, such as recruitment, training, performance evaluation, compensation, and incentives. By ensuring these practices complement each other, employee performance can align with the overall optimization of the organization, rather than focusing solely on the performance of a particular department.

Hijazi et al. (2024) emphasized the importance of selecting an HRMS that matches the corporate strategy, noting that this approach ensures effective management of human resources. By improving recruitment, employee training systems, incentive methods, and performance management, organizations can better promote employee performance. Several scholars have examined the complex mechanisms between human resource management systems (HRMS) and employee performance. Li (2020) argued that emotional commitment acted as a mediating factor, while the dual environment played a moderating role between HRMS and employee performance. The relationship was viewed as intricate, involving interactions between HRMS and employees' knowledge, skills, attitudes, and behaviors. Wei et al. (2008) found that HRMS positively influenced employee performance through enhanced employee satisfaction and engagement. The literature further indicated that human resource practices could affect employee satisfaction and performance via emotional consumption, with HRMS positively impacting employees' emotional commitment and organizational identity through cross-hierarchical analysis techniques.

2.2 Human resource management system and employee flexibility

Employee flexibility refers to the ability of employees to adapt to changing work conditions, roles, or tasks within an organization. It encompasses a range of behaviors and competencies, such as adjusting to new technologies, shifting work environments, or evolving job responsibilities. Employee flexibility allows individuals to respond efficiently to organizational changes, helping businesses remain competitive and resilient in dynamic market conditions (Beltrán-Martín & Roca-Puig, 2013). This concept is also linked to employees' willingness to learn new skills, work across departments, or take on additional tasks, which can enhance both individual and organizational performance.

Most existing studies indicated that specific Human Resource Management (HRM) system practices were positively related to employee flexibility. Zhu et al. (2019), in their empirical research involving 650 employees from public organizations, found that the resource

allocation within the HRM system significantly impacted employee flexibility. Xie & Dong (2021) demonstrated in their research on logistics enterprises that the alignment between the HRM system and the external environment influenced employee flexibility. Moreover, Zhu et al. (2019) examined the factors affecting employee flexibility at individual, group, and organizational levels, finding that HRM system planning had a considerable influence on employee flexibility.

Further supporting this, Martínez-Sánchez et al. (2020), through the analysis of 445 questionnaires from new R&D institutions, concluded that strategic HR planning had a more pronounced positive impact on employee flexibility in these settings. Li & Wang (2012), based on a survey of 535 employees, found that HRM system resource allocation had a significant direct effect on employee flexibility. Additionally, Li et al. (2021) revealed that HRM system resource allocation significantly influenced employee flexibility under China's national conditions. Wang et al. (2024), using a structural equation model and focusing on China's collectivist perspective, also confirmed that HRM system planning had a significant effect on employee flexibility.

2.3 Human resource management system and work engagement

Work engagement refers to the emotional and cognitive commitment employees have towards their work, characterized by energy, dedication, and absorption in their tasks (Hendrik et al., 2021). Engaged employees tend to show higher levels of enthusiasm, satisfaction, and loyalty, which often leads to improved performance and organizational outcomes. According to Bereznowski et al. (2023), work engagement reflects how invested employees are in their jobs and how deeply they align with the goals of the organization. Engaged employees are more likely to contribute positively, stay motivated, and maintain a sense of purpose in their roles. Research on work engagement has increasingly highlighted various factors that influence it, with particular attention to the role of the Human Resource Management System (HRMS). Rahim et al. (2024) found that the resource allocation within HRMS had a significant impact on work engagement, as demonstrated through a relevant adjustment model. Similarly, Yang (2021) analyzed 317 valid samples from three express enterprises in Nanchang and Jiujiang, Jiangxi Province, concluding that resource allocation within HRMS influenced work engagement. Zhao (2021) collected data from 433 employees in domestic enterprises via online questionnaires and, through empirical research, determined that HRMS resource allocation significantly affected work engagement. Additionally, Zhang et al. (2019) argued that HRMS resource allocation plays a critical role in shaping employees' work involvement.

2.4 Conceptual framework

The conceptual framework for this study examines the relationships between the Human Resource Management System (HRMS), employee flexibility, work engagement, and employee performance, highlighting both direct and indirect pathways (Figure 1). HRMS is hypothesized to directly impact employee performance by providing structured practices, policies, and systems that enhance workforce effectiveness (Katou & Budhwar, 2006; Rosyafah & Pudjowati, 2024). However, an unexpected negative relationship is proposed between HRMS and employee flexibility, potentially due to the rigidity and standardization inherent in HRMS practices, which may limit employees' adaptability.

Employee flexibility, defined as the ability to adjust to various job demands and conditions, is expected to positively influence work engagement (Tladinyane & Van der Merwe, 2016; Sekhar et al., 2018; Suparman, 2024). Work engagement, characterized by emotional and psychological investment in one's work (Bakker et al., 2008; Schaufeli, 2013; Mazzetti et al., 2023), is hypothesized to mediate the relationship between HRMS and employee performance by fostering higher levels of productivity, commitment, and proactive

behavior. Similarly, employee flexibility is anticipated to mediate the relationship between HRMS and employee performance, despite the negative direct effect of HRMS on flexibility, as flexible employees can better adapt and meet organizational demands (Hijazi et al., 2024).

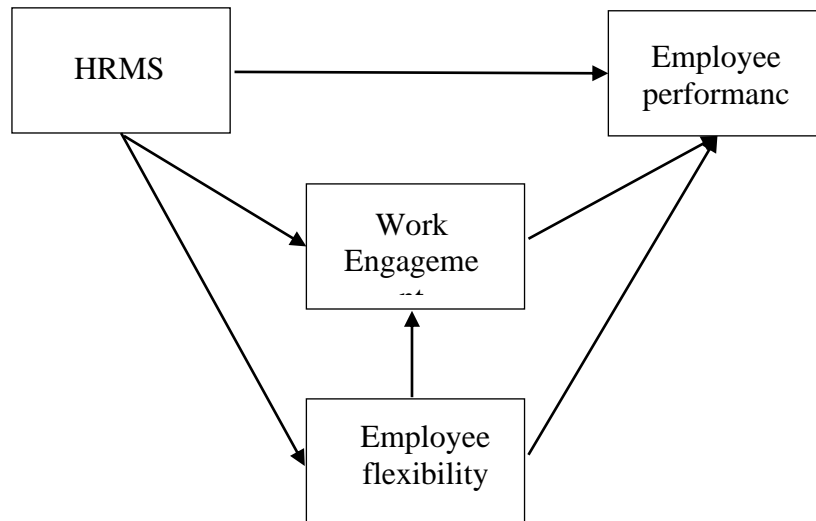


Figure 1 Conceptual framework

In addition to these mediation effects, the framework suggests a positive relationship between employee flexibility and work engagement, emphasizing the interconnection between these mediators (Yucel et al., 2023). This conceptual framework not only highlights the mechanisms through which HRMS impacts employee performance but also provides insights into the roles of flexibility and engagement in enhancing organizational outcomes. It offers a nuanced understanding of how HRMS operates within ABC Express Company and emphasizes the importance of balancing structured HR practices with initiatives that foster adaptability and engagement among employees.

Research Methodology

This study employed a quantitative approach to explore how HRMS influences employee performance and how employee flexibility impacts work engagement. It also examines the mediating effects of flexibility and engagement in the relationship between HRMS and performance, offering valuable insights into optimizing HRMS strategies. This study will randomly select 400 employees from ABC Company, based on the company's 2023 financial statement, using Yamane's formula to calculate the sample size with a 95% confidence level (Yamane, 1967):

$$n = \frac{N}{1 + Ne^2}$$

Where: n = study sample size;

N = Total sample size = 80,000

e = allowable error, the error selected in this paper is 0.05, the corresponding confidence level is 95%;

According to the company's financial report, the current number of employees of ABC Company in the study area is about 80,000. According to the above formula, the expected sample size n calculated in this paper is rounded to 400, so the sample size for this study is 400.

The questionnaire, distributed anonymously, will be divided into six sections: an introduction explaining its academic purpose, personal information of grassroots employees, HRMS (training, salary, work content), employee flexibility (work stress, work-life balance), work engagement (enthusiasm, experience), and employee performance (meeting work requirements, problem-solving). The validity analysis of the questionnaire shows a KMO value of 0.820, indicating very good suitability for data extraction. The Bartlett’s test of sphericity yields a Chi-square value of 91,027.589 with a p-value of 0.000, confirming that the data is appropriate for factor analysis. This suggests strong validity of the questionnaire (Field, 2013).

The reliability analysis of the questionnaire, based on Cronbach’s α coefficient, indicates that the overall reliability is 0.749, which is considered acceptable (George & Mallery, 2003). The HR department will oversee the distribution and collection of the questionnaire within two weeks. The data analysis employed correlation analysis, regression analysis, and mediation tests to examine the relationships between variables. Multiple regression equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon$$

$$\text{Employee Performance} = \beta_0 + \beta_1(\text{HRMS}) + \beta_2(\text{Employee Flexibility}) + \beta_3(\text{Work Engagement}) + \epsilon$$

Where:

Employee Performance (Y): Dependent variable.

HRMS (X_1): Human Resource Management System.

Employee Flexibility (X_2): Mediating variable and independent variable.

Work Engagement (X_3): Mediating variable and independent variable.

β_0 : Intercept (constant).

$\beta_1, \beta_2, \beta_3$: Regression coefficients representing the effect of each independent variable on employee performance.

ϵ : Error term accounting for unobserved factors.

Mediation testing framework:

Step 1: Effect of HRMS on Employee Performance (Total Effect)

$$\text{Employee Performance} = \beta_0 + \beta_1(\text{HRMS}) + \epsilon_1$$

Step 2: Effect of HRMS on the Mediators

Employee Flexibility (Mediator 1):

$$\text{Employee Flexibility} = \beta_0 + \beta_1(\text{HRMS}) + \epsilon_2$$

Work Engagement (Mediator 2):

$$\text{Work Engagement} = \beta_0 + \beta_1(\text{HRMS}) + \epsilon_3$$

Step 3: Effect of HRMS, Mediators on Employee Performance (Direct and Indirect Effects)

$$\text{Employee Performance} = \beta_0 + \beta_1(\text{HRMS}) + \beta_2(\text{Employee Flexibility}) + \beta_3(\text{Work Engagement}) + \epsilon_4$$

The **indirect effect** through each mediator is calculated as:

HRMS → Employee Flexibility → Employee Performance: $\beta_1 \times \beta_2$

HRMS → Work Engagement → Employee Performance: $\beta_1 \times \beta_3$

Total Effect = Direct Effect + Indirect Effect

The data analysis employed correlation analysis, multiple regression analysis, and mediation tests to examine the relationships between variables. Diagnostic tests of the linear

regression model assumptions were conducted to ensure the reliability of the results. Linearity was verified through correlation analysis, multicollinearity was assessed using the Variance Inflation Factor (VIF), and autocorrelation was evaluated using the Durbin-Watson (DW) statistic. These methods provided a comprehensive understanding of how HRMS, employee flexibility, and work engagement impact employee performance while ensuring the robustness of the regression model.

Results

1. Respondent's data

The respondents consisted of 400 employees from ABC Express Company, with diverse demographic characteristics. Of the participants, 51.5% were male (206) and 48.5% were female (194). In terms of age, the distribution was fairly even: 23.75% of respondents were between 20-30 years old (95), 25% were between 31-40 years old (100), 25.5% were between 41-50 years old (102), and 25.75% were aged 51 and above (103).

Regarding monthly income, 24.25% earned between 5000-10000 CNY (97), 29.75% earned between 10000-15000 CNY (119), 23.5% earned between 15000-20000 CNY (94), and 22.5% earned above 20000 CNY (90). The marital status was nearly evenly split, with 50.25% married (201) and 49.75% unmarried (199). The participants were spread across various departments within the company: 11.75% were in the enterprise development department (47), 8.75% in public affairs (35), 12% in human resources (48), 10.75% in the finance department (43), 15.25% in general management (61), 14.5% in information technology (58), 15.25% in the operating department (61), and 11.75% in the business unit (47).

In terms of job level, 35.75% were ordinary staff (143), 35% were department managers (140), and 29.25% were company directors (117). Lastly, the years of service varied, with 24% having less than a year of experience (96), 24.5% between 1-5 years (98), 25% between 6-10 years (100), and 26.5% having more than 10 years of service (106). These diverse characteristics ensure that the sample is representative of the overall employee population at ABC Express Company, providing a comprehensive foundation for the study's findings.

2. Correlation analysis

Before starting to analyze the linear relationship between variables and the intermediary effect, this paper can first conduct correlation analysis test for each variable and preliminarily analyze the correlation among them. The analysis results are shown in Table 1.

Table 1 Results of correlation among all variables

	Mean	SD	Employee performance	HRMS	Employee flexibility	Work engagement
Employee performance	3.960	0.410	1			
HRMS	3.647	0.690	0.676 **	1		
Employee flexibility	3.170	0.604	0.262 **	0.221 **	1	
Work engagement	4.184	0.338	0.556 **	0.255 **	0.354 **	1

* $p < 0.05$ ** $p < 0.01$

As can be seen from the above Table 1, correlation analysis was used to study the correlation between performance and system flexibility, flexibility and engagement, and

Pearson correlation coefficient was used to represent the strength of the correlation. Specific analysis shows that: There is significance between performance and system, flexibility and engagement. The relative values are 0.676, 0.262 and 0.556, respectively, and the relative values are all greater than 0. It means that there is a positive correlation between performance and system, flexibility and engagement.

3. Linear regression analysis

3.1 Results of baseline regression

After obtaining the preliminary correlation analysis results, this paper will conduct in-depth analysis of the linear relationship between variables. In order to see this relationship, this paper first conducts a baseline linear regression to observe whether there is a significant linear relationship. The results are shown in Table 2:

Table 2 Results of linear regression analysis

	Nonnormalized coefficient		Coefficient of standardization	<i>t</i>	<i>p</i>	Collinearity diagnosis	
	B	Standard Error	Beta			VIF	Tolerance
Constant	0.434	0.146	-	2.974	0.003 *	-	-
HRMS	0.402	0.018	0.676	22.004	0.000 *	1.213	0.824
Employee flexibility	0.214	0.022	0.315	9.904	0.000 *	1.297	0.771
Work engagement	0.331	0.039	0.273	8.502	0.000 *	1.319	0.758
R^2	0.691						
Adjustment R^2	0.689						
<i>F</i>	$F(3,396) = 295.842, p=0.000$						
D-W value	1.508						

Note: Dependent variable = Employee performance

* $p < 0.05$ ** $p < 0.01$

Regarding the collinearity diagnostics, the Variance Inflation Factor (VIF) values for all independent variables (HRMS, employee flexibility, and work engagement) are below 5, which indicates that multicollinearity is not a significant concern in this model. As a general rule, a VIF value greater than 10 may indicate problematic multicollinearity (Hair et al., 2010). The tolerance values for these variables are also acceptable, as they are above 0.1, suggesting that no multicollinearity issues exist. These results reinforce the validity of the regression model and the relationships examined in this study. Based on these steps, the regression analysis results for the independent variables, HRMS, employee flexibility and work engagement, and the dependent variable, employee performance, are summarized as follows:

$$\text{Performance} = 0.434 + 0.402 \cdot \text{HRMS} + 0.214 \cdot \text{flexibility} + 0.331 \cdot \text{engagement}$$

The R-squared value of 0.691 indicates that the model, which includes HRMS, employee flexibility, and work engagement, accounts for 69.1% of the variance in employee

performance. The F-test results ($F = 295.842$, $p < 0.05$) confirm that at least one of these variables significantly affects employee performance. The regression coefficients show that the HRMS has a significant positive impact on employee performance ($\beta = 0.402$, $t = 22.004$, $p < 0.01$), employee flexibility also positively influences employee performance ($\beta = 0.214$, $t = 9.904$, $p < 0.01$), and work engagement contributes significantly to employee performance ($\beta = 0.331$, $t = 8.502$, $p < 0.01$). Overall, the analysis reveals that HRMS, flexibility, and engagement each have a significant positive effect on performance.

3.2 Analysis of mediating role

In order to further explore the mediating role of flexibility and engagement and to obtain empirical results to test the research hypothesis, this paper takes these two variables as mediating variables and analyzes the mediating effect among them, and the results are shown in Table 3.

As can be seen from the above table, there are 4 models involved in the mediation effect analysis, which are as follows:

Model 1: Employee performance = $2.495 + 0.402 \cdot \text{HRMS}$

Model 2: Employee flexibility = $3.875 - 0.193 \cdot \text{HRMS}$

Model 3: Work Engagement = $3.729 + 0.125 \cdot \text{HRMS} + 0.155 \cdot \text{Employee flexibility}$

Model 4: Employee performance = $0.434 + 0.402 \cdot \text{HRMS} + 0.214 \cdot \text{Employee flexibility} + 0.331 \cdot \text{Work engagement}$

Table 3 Results of linear regression analysis

	Employee performance	Employee flexibility	Work engagement	Employee performance
Constant	** (30.635, 2.495)	** (24.396, 3.875)	** (42.322, 3.729)	** (2.974, 0.434)
HRMS	** (18.316, 0.402)	** (4.519, -0.193)	** (5.256, 0.125)	** (22.004, 0.402)
Employee flexibility			** (0.088, 0.155)	** (9.904, 0.214)
Work engagement				** (8.502, 0.331)
Sample size	400	400	400	400
R^2	0.457	0.049	0.065	0.691
Adjust R^2	0.456	0.046	0.063	0.689
F	$F(1,398) = 335.465$, $p=0.000$	$F(1,398) = 20.421$, $p=0.000$	$F(1,398) = 27.623$, $p=0.000$	$F(3,396) = 295.842$, $p=0.000$

* $p < 0.05$ ** $p < 0.01$

From the results in Table 3, it is clear that HRMS has a significant positive effect on employee performance ($\beta = 0.402$, $p < 0.01$), with a very high level of significance ($t = 22.004$). This shows that effective HRMS practices can substantially enhance employee performance. However, a noteworthy aspect is the negative relationship between HRMS and employee flexibility ($\beta = -0.193$, $p < 0.01$). This negative coefficient suggests that a more rigid or standardized HRMS implementation could limit employee flexibility. Despite the negative relationship with flexibility, HRMS still significantly impacts work engagement ($\beta = 0.125$, $p < 0.01$), indicating that HRMS can improve engagement, which is an important driver of performance.

Employee flexibility ($\beta = 0.214$, $p < 0.01$) and work engagement ($\beta = 0.331$, $p < 0.01$) both significantly mediate the relationship between HRMS and employee performance. The coefficients for these mediating variables are significant at the 1% level, confirming their crucial role in enhancing employee performance by improving both flexibility and engagement. The results show that when employees are more flexible and engaged, their performance improves significantly, thus reinforcing the importance of these mediating factors.

Overall, the regression results demonstrate that HRMS has a direct positive effect on employee performance, but it also has indirect effects through employee flexibility and work engagement. The analysis of the adjusted R^2 values further strengthens this conclusion. The R^2 value for employee performance is 0.691, indicating that 69.1% of the variation in employee performance can be explained by HRMS, employee flexibility, and work engagement. For employee flexibility and work engagement, the R^2 values of 0.049 and 0.065, respectively, suggest that while these factors are important, other variables not included in the model may also influence them. This finding suggests that higher implementation of HRMS is associated with reduced employee flexibility. Furthermore, the mediating effect of these two variables is highly significant. The specific influence path is illustrated in Figure 2:

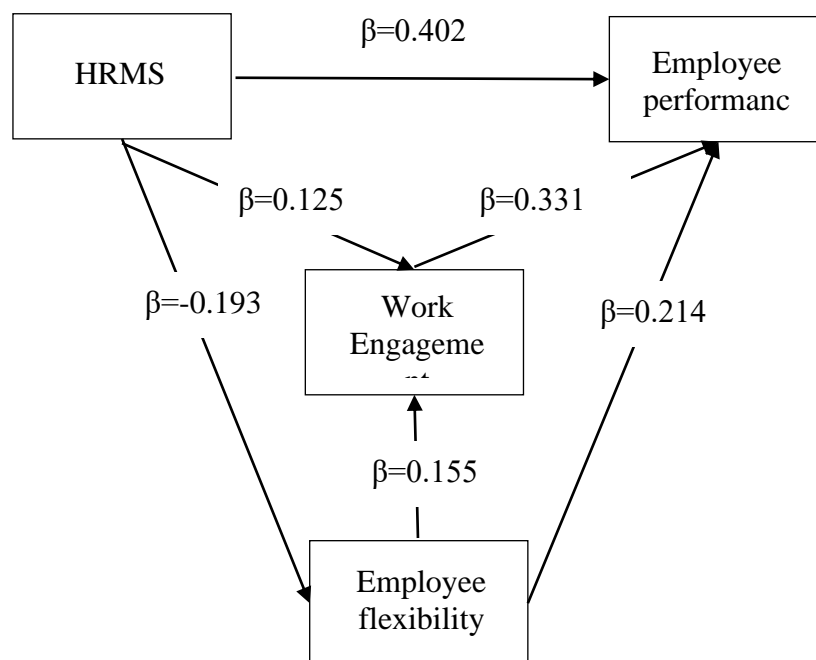


Figure 2 Influence path diagram of intermediary effect

In a competitive business environment, a robust human resource management system (HRMS) is crucial for enhancing corporate performance. While much research has focused on HRMS in the service industry, studies in the Express sector, particularly for ABC Express Company, are limited. This paper investigates how HRMS impacts employee performance at ABC Express, addressing key questions about the influence of HRMS on employee performance. Using a quantitative approach with data from 400 employees, the study finds that HRMS significantly improves employee performance ($r = 0.676$, $p < 0.01$), employee flexibility positively affects work engagement ($r = 0.354$, $p < 0.01$), and both employee flexibility and work engagement mediate the HRMS-employee performance relationship. The model explains 69.1% of the variance in performance ($R^2 = 0.691$).

Discussion

This study confirms that the Human Resource Management System (HRMS) positively impacts employee performance by enhancing recruitment, training, and performance management. This finding aligns with existing literature, such as Delery & Doty (1996), Li et al. (2016), and Jiang et al. (2024), which highlights the effectiveness of HRMS in boosting organizational performance. The study extends these findings by focusing on HRMS applications in the express delivery sector, particularly at ABC Express, offering empirical evidence where previous studies have been predominantly theoretical or cross-industry.

The research shows that employee flexibility significantly improves performance by enabling employees to adapt quickly to changes and challenges. This finding is consistent with study by Chatterjee et al. (2022) that underscore the role of flexibility in enhancing work performance. Unlike previous research, this paper quantifies the specific impact of flexibility and explores its mediating role between HRMS and performance, providing new insights for express enterprises. The results indicate a negative relationship between HRMS and employee flexibility ($\beta = -0.193$). This finding suggests that higher implementation of HRMS is associated with reduced employee flexibility. While this result differs from many previous studies that posit a positive relationship (Zhu et al. 2019; Xie & Dong, 2021), it may reflect unique organizational or contextual factors specific to ABC Express Company. For instance, the HRMS in this organization might focus on rigid standardization, formalized procedures, or centralized decision-making, which could limit employees' autonomy and adaptability. Furthermore, cultural or industry-specific factors might play a role, such as a preference for strict adherence to policies in logistics companies, which could inadvertently constrain employee flexibility. This unexpected result highlights the need for further exploration into the contextual dynamics of HRMS implementation and its impact on employee behaviors.

The study demonstrates that work engagement has a significant positive effect on performance, as engaged employees show higher satisfaction and loyalty, leading to better performance. This supports finding by Rameshkumar (2020) and Li (2019), who emphasize the role of engagement in boosting efficiency and organizational commitment. This research uniquely quantifies the impact of engagement in the express industry context and examines its role as a mediator between HRMS and performance, contributing a novel perspective to existing literature. To optimize the effectiveness of HRMS, it is crucial to first conduct detailed demand research to understand the specific needs of different departments. Based on this research, customize the HRMS features to address these needs effectively. Additionally, implement comprehensive training programs and internal promotional activities to ensure that employees are well-acquainted with the new system and are motivated to use it effectively (Dash & Mahapatra, 2016). Establishing a robust feedback mechanism will also be essential for continuously refining and optimizing the HRMS based on user experiences and evolving needs (Prastyaningtyas et al., 2023).

To enhance employee flexibility, develop clear policies that support flexible work arrangements, such as remote work options, to help employees adapt to changing work conditions (Weideman & Hofmeyr, 2020). Provide training focused on time management and emotional resilience to equip employees with the skills needed to handle job challenges effectively. Implement a mentorship program to support employees in adjusting to their roles and navigating changes (Tetzlaff et al., 2022).

Additionally, encourage independent learning by offering access to online resources and organizing knowledge contests to stimulate ongoing personal and professional development. Create personalized career development plans tailored to individual employee interests and career goals to enhance job satisfaction and performance. Develop a diverse

reward and recognition system that includes performance bonuses, stock-options, and promotional opportunities to motivate and retain employees. Maintain regular performance feedback and open communication channels to ensure employees feel supported and recognized for their contributions, which will further boost their engagement and commitment (Tate et al., 2021).

The limitations of this research should be considered in light of several factors. Firstly, the study was conducted within a single company, ABC Express, which may limit the generalizability of the findings to other organizations or industries. Future research could investigate how HRMS impacts vary across different industries beyond the express delivery sector. Comparing the effectiveness of HRMS in diverse contexts—such as manufacturing, technology, or healthcare—could provide deeper insights into industry-specific needs and best practices for HRMS customization and implementation. Conduct longitudinal studies to assess the long-term effects of HRMS implementation on employee performance and organizational outcomes. Such studies could track changes over time, providing insights into how HRMS impacts evolve and identifying factors that contribute to sustained improvements in performance and engagement.

Conclusion

This study explores the impact of the Human Resource Management System (HRMS) on employee performance at ABC Express Company, with a particular focus on the mediating roles of employee flexibility and work engagement. The findings reveal that HRMS has a significant positive effect on employee performance, accounting for 69.1% of the variance in performance outcomes. However, HRMS was found to have a negative effect on employee flexibility ($\beta = -0.193$), which is contrary to expectations and suggests that higher implementation of HRMS may limit employee adaptability. Despite this, employee flexibility positively influenced work engagement, highlighting the importance of fostering flexibility in promoting higher levels of employee involvement and commitment. The mediating roles of both employee flexibility and work engagement were significant. Specifically, work engagement mediated the relationship between HRMS and employee performance, reinforcing the importance of engaging employees to enhance overall performance. These results align with the research hypotheses and objectives, emphasizing the complex interplay between HRMS, employee flexibility, and work engagement, and providing valuable insights for enhancing performance at ABC Express Company.

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Brand Positioning Strategies for International Expansion: a Case Study of a New Energy Vehicle Company

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Abstract

This research aimed to 1) analyze the current development status, gaps, and challenges faced by Company A in achieving brand internationalization, 2) examine the strengths, weaknesses, opportunities, and threats (SWOT) of Company A during its internationalization process, and 3) propose brand positioning strategies to enhance Company A's international brand awareness. A case analysis approach was employed, combined with SWOT analysis, to examine Company A's internationalization practices, identify successful experiences, and pinpoint areas for improvement. In-depth interviews with key stakeholders, including executives, industry analysts, and consumer representatives, provided insights into critical aspects such as brand positioning, product differentiation, user experience, and brand communication. The data from these interviews, alongside documentary data (e.g., company reports, industry publications), were analyzed through content and thematic analysis to identify key themes and recurring patterns in Brand A's internationalization efforts.

The findings revealed that while Company A excelled in technological innovation and cost efficiency, it faced significant challenges, including inconsistent global positioning, insufficient infrastructure, and weak international brand recognition. These gaps, coupled with intense competition and geopolitical risks, hindered its global presence. However, opportunities existed in global green policies, increasing NEV demand in emerging markets, and advancements in autonomous technology. To enhance its international brand awareness, the study proposed that Company A adopt a multi-faceted brand positioning strategy. This included positioning itself as a high-end electric vehicle brand, emphasizing advanced technology and superior performance. Differentiating products through innovations like battery swap technology and offering tailored models for diverse markets could strengthen its competitive edge. Improving user experience through local service centers, expanded charging networks, and smart vehicle features, along with targeted brand awareness campaigns, would help build customer loyalty and strengthen global recognition.

Keywords: brand positioning strategies, international expansion strategies,
new energy vehicle

Introduction

The development of manufacturing technology and the expanding market share of new energy vehicles (NEVs) have firmly established them as pivotal players in the global automotive industry (Li, 2020). This momentum is driven by the pressing global energy crisis, further exacerbated by geopolitical events such as the Russia-Ukraine conflict. The depletion

of oil resources and the volatility of energy supplies have underscored the urgent need for a transition to sustainable, oil-independent industries, placing NEVs at the forefront of this transformation (Tan et al., 2023). In response, developed economies, including Europe, the United States, and Japan, have accelerated NEV development to address environmental challenges and secure a competitive edge in technological innovation. Meanwhile, the ASEAN region, with its rapidly growing economies and burgeoning demand for sustainable transportation, has emerged as a prime opportunity for NEV market expansion (Huang et al., 2023). Favorable government policies supporting green energy and the increasing acceptance of environmentally friendly products by ASEAN consumers make this region an attractive target for international NEV companies. Strategic penetration into this market not only enhances global competitiveness but also solidifies a firm's standing in the evolving global new energy sector.

Environmental concerns further amplify the urgency for transitioning to NEVs. Traditional fuel-powered vehicles remain major contributors to air pollution and health risks, releasing harmful emissions that align closely with the human breathing zone. Global agreements, such as the Kyoto Protocol, have intensified the focus on reducing greenhouse gas emissions, propelling NEVs into the limelight as low-carbon, energy-efficient alternatives. In this context, China's commitment to achieving “carbon peak” by 2030 and “carbon neutrality” by 2060 has made NEVs a critical pillar of its national development strategy (Guiyang & Xiaoming, 2023). This alignment with global climate goals has fostered robust policy support for the NEV industry, providing a fertile ground for innovation and growth.

China's NEV industry has achieved unprecedented milestones, reflecting the success of this strategic emphasis. By 2023, China had not only become the world's largest producer and consumer of NEVs but had also surpassed Japan as the largest automobile exporter. New energy vehicles played a pivotal role in this achievement, with leading domestic brands such as BYD and Geely spearheading the internationalization of Chinese NEVs (Ng, 2024). These companies have leveraged strong manufacturing capabilities, comprehensive supply chains, and favorable government policies to expand their reach. Among these emerging leaders, Brand A stands out as a representative of the new generation, gradually gaining prominence in the NEV sector.

Despite this progress, significant challenges remain. Chinese NEV brands, while gaining traction internationally, often rely heavily on cost-effectiveness rather than high-end brand positioning to compete. This reliance undermines their competitiveness in premium global markets dominated by established players like Tesla and Mercedes-Benz, whose brands are associated with cutting-edge technology and luxury (Kuru & Khan, 2020). Moreover, research on the internationalization of Chinese NEV brands remains fragmented, with limited systematic analysis of their branding strategies, especially in areas such as positioning, differentiation, and consumer engagement. Existing literature lacks a systematic exploration of brand positioning strategies in the context of international expansion for new energy vehicle (NEV) brands (Zhu et al. 2023). While studies have addressed various aspects of NEV development, such as government policies, technological advancements, and consumer perceptions, comprehensive analyses focusing on how NEV brands position themselves in global markets remain limited (Wang & Li, 2022). This gap highlights the need for a deeper understanding of strategic approaches to building brand identity, differentiation, and consumer engagement in diverse international markets.

To address these gaps, this study uses A company as a case study to explore the strategies behind its internationalization efforts. This research aims to contribute to the

understanding of how Chinese NEV brands can successfully navigate international markets while establishing a sustainable, high-value global presence.

1. Research Objectives

1.1 To analyze the current development status, gaps, and challenges faced by Company A in achieving brand internationalization.

1.2 To examine the strengths, weaknesses, opportunities, and threats (SWOT) of Company A during its internationalization process.

1.3 To propose brand positioning strategies to enhance Company A's international brand awareness.

2. Review of Related Literatures

2.1 Overview of strategic brand management

Brand awareness is a key element of brand equity, significantly influencing consumer trust, purchase decisions, and loyalty. Khurram (2018) highlights that brand awareness—the extent to which consumers recognize and recall a brand—directly impacts their preferences and purchasing behavior. Shariq (2018) expands on this by defining brand equity as a collection of values that includes brand loyalty, perceived quality, and brand associations, collectively enhancing competitiveness and delivering long-term economic benefits. Sivaram (2019) emphasizes the positive influence of high brand awareness and perceived quality on purchase intentions, with these factors fostering greater trust and willingness to buy. Effective strategies to build brand awareness and equity include brand identification, communication, experience, and monitoring (Beig, 2019). Regular evaluation and adjustment of these strategies, as Dumitriu (2019) points out, ensure sustainable brand development and competitiveness.

Brand positioning and market segmentation are critical for defining a company's unique role in the marketplace and targeting the right consumer groups. Tien (2019) asserts that successful positioning highlights a product's distinct value to a specific audience, enhancing loyalty and market retention. By dividing broad markets into segments with similar characteristics, companies can allocate resources more effectively, as Dolnicar (2022) explains. Heinberg (2020) notes that positioning should include functional benefits and emotional connections, as emotional resonance can deepen loyalty. Leijerholt (2019) stresses the importance of consistency in communicating brand values to build consumer trust and differentiation in competitive environments. Cultivating brand loyalty is essential for stable revenues and reducing marketing costs. Suhan (2022) describes loyalty as a long-term commitment from consumers, which ensures repeat purchases and attracts new customers through word-of-mouth. Key drivers of loyalty include brand trust, reliability, and emotional connection (Atulkar, 2020). Satisfied customers are more likely to develop favorable attitudes and long-term loyalty toward a brand (Dam & Dam, 2021). Companies can strengthen these connections by delivering high-quality products, engaging experiences, and responsive feedback systems.

2.2 Brand international expansion

Brand internationalization refers to the strategic expansion of a company's operations and market presence beyond domestic borders. Elliott et al. (2015) defines it as a process involving key decisions such as selecting target markets, determining entry strategies, and aligning global marketing efforts. Successful internationalization requires a unified global brand identity while adapting to regional cultural and consumer differences. Muchenje et al. (2023) emphasizes that companies must build unique brand personalities tailored to target

markets, addressing consumer expectations and achieving a balance between global consistency and local relevance.

Internationalization strategies rely on proprietary advantages, location benefits, and internalization opportunities. Proprietary advantages, such as technological innovation and intellectual property, differentiate brands in global markets (Campbel & Verbeke, 1994). Location advantages involve aligning resources with local consumer needs, while internalization benefits, such as supply chain integration, enhance operational efficiency and adaptability (Welch & Luostarinen, 1988). The Chinese government has supported "going out" strategies for domestic companies, offering financial incentives and infrastructure development to help them compete globally. However, international challenges like geopolitical risks, regulatory barriers, and cultural differences remain significant hurdles for expanding brands.

2.3 Related research on new energy vehicles

Research on new energy vehicles (NEVs) primarily focuses on the role of government policies and consumer perceptions in shaping market adoption. Government support, such as subsidies and tax incentives, has been instrumental in fostering NEV growth, especially in early development stages. Zhao et al. (2023) observed that aligning NEV brand communication with environmental policies enhances public acceptance. Wang et al. (2021) suggests that consistent investment in research and development is critical for advancing energy efficiency and expanding markets. Yang et al. (2021) demonstrated that economic incentives significantly drive NEV adoption, particularly in urban areas, where monetary policies are most effective.

Consumer perception also plays a pivotal role in NEV adoption. Wang et al. (2023) highlight those psychological factors, such as environmental awareness and lifestyle preferences, outweigh technical specifications in shaping purchase intentions. Similarly, Yang et al. (2020) found that values like social status and personal identity influence consumer preferences for NEVs. Addressing perceived risks, such as safety concerns, is essential for increasing adoption, as He et al. (2021) pointed out. However, existing research primarily focuses on domestic markets and fails to address cross-cultural differences, geopolitical risks, and the global branding challenges faced by NEV companies in international markets. This gap underscores the need for comprehensive strategies tailored to global expansion.

2.4 Conceptual framework

The conceptual framework (Figure 1) provides a theoretical foundation and guidance for the research, clarifying the key variables and their interrelationships. This study focuses on the current status and challenges of internationalization for Chinese new energy vehicle (NEV) brands, using Brand A as a representative case. In recent years, countries worldwide have been vigorously developing their NEV industries, and Chinese NEV brands have gradually emerged in the global market. However, they still face significant challenges in the internationalization process, such as low brand awareness, unclear brand positioning, insufficient brand communication, and a lack of differentiation in highly competitive markets. While Chinese NEV companies possess certain advantages in technology and cost, effectively establishing and managing their brands in international markets remains an urgent issue.

The analysis of Brand A's positioning divides it into four main aspects: market positioning, product differentiation, user experience, and brand awareness. Market positioning emphasizes Brand A's focus on the high-end electric vehicle market, aiming to attract quality- and technology-conscious consumers through high-quality, high-performance products. Product differentiation highlights the brand's use of advanced battery swapping technology and intelligent driving features to distinguish itself from competitors. These technological innovations not only enhance the user experience but also strengthen the brand's technological competitiveness. User experience focuses on service-oriented aspects, such as Brand A's

customer experience centers ("Brand A Homes") and mobile connectivity applications. Brand awareness centers on Brand A's recognition and reputation in international markets, analyzing the factors contributing to its market entry and consolidation globally.

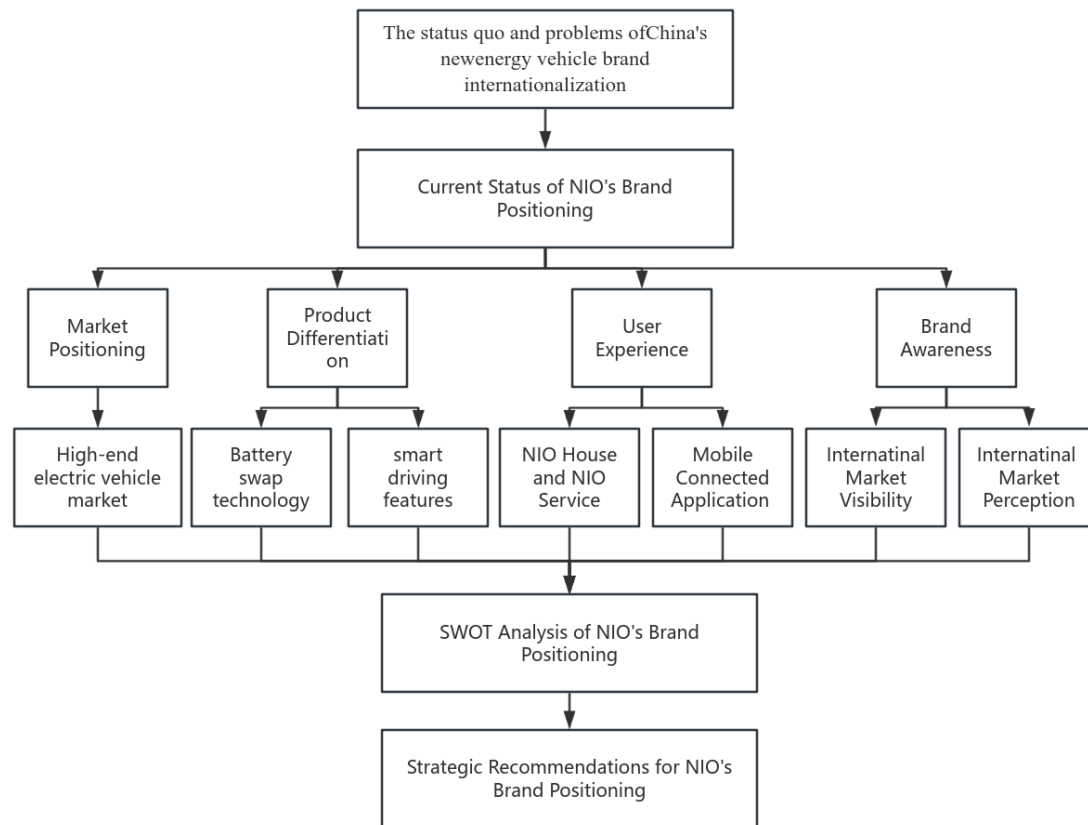


Figure 1 Conceptual Framework

Following this analysis, a comprehensive SWOT (Strengths, Weaknesses, Opportunities, and Threats) assessment of Brand A is conducted. SWOT analysis, as a classic strategic tool, helps identify key elements of the internal and external environment, providing a solid foundation for strategic decision-making. Based on the analysis and SWOT results, this study will propose management strategies to help Brand A establish and manage its brand more effectively in international markets, aiming to achieve its global development objectives.

Research Methodology

1. Research Design

The study employs a case analysis approach to examine Brand A's internationalization practices, identifying successful experiences and areas for improvement. Combined with the SWOT analysis method, the study evaluates Brand A's strengths, weaknesses, opportunities, and threats to provide a foundation for strategy optimization.

In-depth interviews with stakeholders (e.g., Brand A executives, industry analysts, and consumer representatives) are conducted to further explore key dimensions such as brand awareness, brand positioning, and brand communication. Semi-structured interview formats are adopted, and the interview data are integrated with the results from the earlier stages to propose actionable recommendations for enhancing Brand A's international brand influence.

The interview questions focus on key areas such as brand positioning, product differentiation, user experience, and brand awareness to gain multi-perspective insights.

2. Data Sources

2.1 Interview data

Obtain data through in-depth interviews with key stakeholders, including Brand A executives, industry analysts, and consumer representatives. The interviewees encompass internal management personnel from brand management, technical R&D, and marketing departments, as well as executives from major competing brands and international market analysts.

Table 1 Selection Criteria and Justifications for Interviewees

Key informants	Criteria	Rationale
Internal Management of Brand A	The selection of senior management ensures that the interviewees have a comprehensive and strategic view of A brand's internationalization efforts.	Senior management from different departments have strategic insights, providing multifaceted perspectives on A brand's internal strategies and challenges.
	Representatives from departments including technology R&D, comprehensive management, branding, and marketing provide a comprehensive view of various aspects of A brand's international strategy.	Through comprehensive understanding, personnel from technology, branding, and marketing departments can deeply understand how different aspects of A brand's operations promote or hinder its international brand image.
	Interviewees should have an in-depth understanding of A brand's internationalization strategy to provide detailed and relevant insights.	From a detailed perspective, they are directly involved in the decision-making process, ensuring that responses are informed and relevant.
Executives from competitor companies	The selection of senior management ensures that interviewees have the authority and knowledge to discuss company brand strategies and competitive positioning.	Insights from senior executives of major competitors provide valuable information about the competitive environment and comparisons of A brand's strategies.
	Including executives from major competitors such as Chang'an Automobile, KeXing, and BYD Automobile ensures a broad view of the competitive landscape.	Through strategic insights, executives can provide perspectives on industry trends, competitive strategies, and market positioning, which are crucial for understanding the challenges and opportunities faced by A brand.
	Interviewees should be directly involved in brand management to accurately understand how	In benchmarking, their opinions help compare A brand's strategies with those of major competitors.

	competitors position themselves in the market.	
Industry analysts	Selection of analysts from reputable consulting firms and authoritative data institutions ensures that interviewees have profound industry knowledge and analytical capabilities.	Analysts provide professional insights into market trends, industry developments, and consumer behaviors, which are essential for understanding the broader context of A brand's internationalization.
	Analysts should have a good track record in the new energy vehicle sector to provide informed insights.	Their expertise has strategic insights, with a meticulous understanding of brand strategies and competitive dynamics.
	Including both global and domestic analysts ensures a comprehensive understanding of market trends and brand strategies from different angles.	Analysts' abilities to interpret and analyze data help identify key trends and strategic opportunities for A brand.
Consumer representatives	Selection of consumers from different international markets ensures a representative sample of potential customers.	Insights from consumers help us understand the image of A brand in different international markets.
	Consumers should have experience with new energy vehicles to provide relevant feedback on their perceptions and evaluations of A brand.	Their feedback helps evaluate the effectiveness of A brand's brand communication and positioning strategies.
	Including consumers from different markets helps capture diverse consumer needs and preferences.	Diverse consumer perspectives ensure that the study considers a wide range of customer needs and expectations, which is crucial for developing effective international brand management strategies.

2.2 Documentary data

Collect annual reports, industry reports, academic literature, and media coverage related to Brand A and its competitors to systematically analyze the development trends and competitive landscape of the new energy vehicle industry.

3. Data Collection

The research data sources include company reports, academic literature, industry reports, media coverage, and interview records. Company reports comprise annual reports, market analysis reports, and brand promotional materials from A Brand and BYD Auto. Academic literature and industry reports include domestic and international research papers on brand internationalization and the new energy vehicle market, as well as reports from authoritative market research institutions. Media coverage from mainstream financial and automotive industry media provides insights into market reactions and brand awareness. The interview records involve senior management responsible for brand management and market development from companies like A Brand and BYD, experts in the new energy vehicle

industry, and consumer representatives from various international markets. Through in-depth interviews with these respondents, the research aims to comprehensively reveal multiple aspects of A Brand's brand internationalization strategy, including brand awareness, brand positioning, brand communication, and competitive environment. However, potential biases in data collection should be acknowledged, such as the reliance on company-provided reports, which may present a favorable view of their strategies and performance, and the subjective nature of interview responses, which could be influenced by respondents' roles, experiences, or personal interests (Abhayawansa et al., 2019). These limitations have been considered in the data analysis to ensure a balanced and objective interpretation of the findings.

4. Data Analysis

The data analysis for this study combined content analysis of documentary data and thematic analysis of interview data to understand Company A's brand internationalization and its challenges. Documentary data, including company reports, industry publications, and media coverage, were analyzed to identify key themes such as brand strategies and market trends. Interview data from executives, industry analysts, and consumers were coded to uncover recurring themes related to brand positioning and internationalization challenges. A SWOT analysis synthesized these findings, highlighting Company A's strengths, weaknesses, opportunities, and threats. The combined insights guided strategic recommendations to enhance Company A's global brand positioning and market presence.

Results

1. Current Status of Brand Positioning Strategies for A's New Energy Vehicles

1.1 Market positioning

Brand A positions itself as a premium electric vehicle brand in the global market, focusing on providing high-performance, high-quality new energy vehicles to mid-to-high-end consumers. Through in-depth analysis of market segmentation and target consumer groups, Brand A adopts a market positioning strategy centered on technology and user experience. The brand emphasizes product intelligence, environmental attributes, and superior services through precise marketing, appealing to tech- and eco-conscious consumers, particularly the younger generation and middle class. Additionally, Brand A is gradually establishing its international image by associating the brand with premium, smart, and sustainable development.

1.2 Product differentiation

Brand A achieves product differentiation through technological innovation, creating a significant competitive advantage. For instance, its battery-swapping technology significantly reduces consumers' charging time, while its intelligent driving system and vehicle connectivity features provide a safer and more convenient driving experience. Furthermore, Brand A pays attention to detail in vehicle design, incorporating elements aligned with international aesthetics, making its vehicles not only high-performing but also visually and stylistically appealing. These unique product features enable Brand A to distinguish itself from competitors and build a competitive product lineup.

1.3 User experience

Brand A places great importance on user experience and has established a comprehensive after-sales service system, including charging solutions, online service platforms, and user community activities. For example, the "NIO House" model provides owners with a space for socializing, relaxation, and experiencing the brand's value. These initiatives not only enhance consumer brand loyalty but also strengthen the emotional

connection between users and the brand. Additionally, Brand A leverages digital technology to optimize user experience, offering personalized services such as remote vehicle monitoring and maintenance scheduling through mobile applications, further catering to diverse consumer needs.

1.4 Brand awareness

While Brand A has achieved significant brand recognition in the domestic market, its international branding efforts are still in the early stages. Currently, the brand is gradually increasing its global visibility through multi-channel promotions, participation in international auto shows, and social media engagement. Simultaneously, Brand A emphasizes brand values centered on technological innovation and environmental sustainability, building its brand narrative and actively participating in social welfare initiatives to shape a brand image with international influence.

Table 2 Current status and challenges of brand positioning strategies for A’s new energy vehicles

Strategy Area	Specific Performance and Data
Market positioning	<ul style="list-style-type: none"> - Positioned as a high-end electric vehicle brand, targeting mid-to-high-end consumers. - Increase in global market share, for example, the global market share in 2023 is approximately 4.7%. - Emphasizes intelligence, environmental protection, and high-quality service to attract the younger generation and middle class. - Charging technology, average charging time is approximately 48 minutes, saving about 78% of the time compared to traditional charging.
Product differentiation	<ul style="list-style-type: none"> - Charging technology: average charging time is approximately 48 minutes, saving about 78% of the time compared to traditional charging. - Intelligent driving system, equipped with the latest AI driving assistance technology. - Design aesthetics, won multiple international design awards, enhancing brand design influence.
User experience	<ul style="list-style-type: none"> - Charging services, established over 320 charging stations. - "NIO House" model, approximately 48 locations opened worldwide, providing social and leisure spaces for users. - Digital services, mobile app downloads exceeded 1.05 million.
Brand awareness	<ul style="list-style-type: none"> - Domestic brand awareness is about 82%, and the international market is still in the expansion stage. - Participation in international auto shows, attends over 11 international auto shows annually to increase international exposure. - Social media follower growth, annual increase of about 29.7%, actively enhancing brand image through multi-platform interaction. - Participation in public welfare activities, invested millions of dollars in environmental public welfare projects to actively build a green brand image.

Source: Company A’s annual report, Gartner, IEA electric vehicle market statistics

2. Issues in A Brand's New Energy Vehicle Brand Positioning Strategy

2.1 Inconsistent global market positioning

A Brand’s global strategy aims at the premium segment but suffers from inconsistent implementation, leading to an unclear brand image. A brand manager noted:

“In Europe and the U.S., we emphasize luxury and technology, but in Southeast Asia, we focus on price competition. This helps short-term sales but risks long-term image blurring.”

Competitors and analysts agree that this inconsistency hinders A Brand’s ability to balance global goals with local needs, as its premium focus often misses affordability demands in emerging markets. A Southeast Asian consumer added:

“I like the design, but the prices are too high. Affordable options would work better here.”

2.2 Difficulty converting technical advantages into market appeal

Despite innovative features like battery swap technology, A Brand struggles to communicate these effectively. A product director admitted:

“Our technology leads the industry, but many consumers internationally aren’t aware of it.”

Insufficient infrastructure further limits practical adoption. A competitor executive remarked:

“Battery swap innovation depends on a strong infrastructure, which A Brand lacks in global markets.”

Analysts highlight that competitor like Tesla dominate in areas like intelligent driving, overshadowing A Brand’s technological edge.

2.3 Insufficient user experience adaptation

Community-driven models like "NIO House" succeed domestically but fail internationally. A service manager observed:

“In Europe, consumers prioritize functional services over social activities, but we lack sufficient repair centers and charging infrastructure.”

Competitors emphasized faster after-sales service as a critical factor. A European consumer shared:

“The app isn’t well-localized, and repair services are slow, which impacts my experience.”

2.4 Weak brand recognition in global markets

A Brand’s international recognition remains low, hindered by limited marketing investments. A brand manager stated:

“Many international consumers don’t know our technologies or brand story.”

Competitors noted that A Brand is often seen as a cost-effective Chinese brand without premium appeal. A Southeast Asian consumer added:

“It feels like just another Chinese company. I don’t see what makes it stand out.”

In summary, inconsistent positioning, weak differentiation, insufficient user experience adaptation, and low global recognition constrain A Brand’s international expansion efforts.

Table 3 Current status and challenges of brand positioning strategies for A’s new energy vehicles

Issue	Details
Inconsistent global market positioning and blurred brand image	<ul style="list-style-type: none"> - Inconsistent market positioning strategies across different regions, leading to a blurred brand image. - Emerging markets focus too much on price, overlooking the high-end brand image. - Lack of clear differentiation from competitors in mature markets.
Technical advantages difficult to translate into actual market appeal	<ul style="list-style-type: none"> - Technical innovations are not effectively conveyed to consumers. - Insufficient infrastructure limits the realization of technical advantages. - Emerging markets prioritize practicality and price, which conflicts with the technology-driven strategy.
Inadequate adaptation of user experience in international markets	<ul style="list-style-type: none"> - Service models have limited effectiveness when replicated in international markets. - Insufficient distribution of service centers and charging facilities. - Inadequate localization of digital services.
Weak brand recognition and influence in international markets	<ul style="list-style-type: none"> - Insufficient resources and investment in brand promotion, leading to low consumer awareness. - Brand stories are not deeply embedded in global communications. - Lack of a distinctive brand image, presenting a disadvantage compared to competitors.

3. SWOT Analysis of A Brand’s Internationalization Process

3.1 Strengths

A Brand demonstrates significant strengths in technological innovation, particularly in battery technology, intelligent driving systems, and overall vehicle design. Innovations like blade battery technology and battery swap solutions provide competitive advantages, enhancing both market appeal and consumer trust. Additionally, China’s complete NEV supply chain and strong government support (e.g., subsidies and infrastructure investments) enable A Brand to maintain lower production costs and greater market responsiveness. These factors position A Brand competitively in emerging markets, where cost efficiency is critical.

3.2 Weaknesses

A Brand faces challenges in brand recognition and influence in international markets, particularly in Europe and the U.S., where established competitors like Tesla dominate. Its limited international experience affects its localization strategies, cross-cultural management, and after-sales services. Furthermore, inadequate charging infrastructure in global markets,

compared to competitors like Tesla’s Supercharger network, significantly undermines user experience and limits its ability to replicate domestic success.

3.3 Opportunities

The rise of global green policies and incentives, such as tax rebates and subsidies in Europe and the U.S., presents favorable conditions for NEV adoption. Emerging markets in Southeast Asia, Africa, and South America also offer immense growth potential due to rising NEV demand and relatively low competition. Additionally, advancements in autonomous driving and battery technology create opportunities for A Brand to further differentiate its offerings and capture higher-value market segments.

3.4 Threats

Intensified global competition from established automakers (e.g., Mercedes-Benz, Tesla) and emerging brands (e.g., Rivian, Lucid Motors) complicates market entry. Trade barriers, geopolitical tensions, and supply chain risks (e.g., dependence on lithium and cobalt) further threaten cost stability and profitability. These external risks could hinder A Brand’s ability to scale effectively in international markets.

Table 4 SWOT analysis

Internal	Strengths		Weaknesses	
	Strong technological innovation		Low international brand recognition capability	
	Comprehensive supply chain and policy support		Lack of experience in international operations	
	Strong cost control ability		Insufficient infrastructure support	
External	Opportunities		Threats	
	Global push for new energy policies		Intense competition in international markets	
	Rapid growth of emerging markets		Trade barriers and geopolitical risks	
	Technological revolution providing differentiation opportunities		Supply chain uncertainties	

Company A's internationalization process leverages strengths such as strong technological innovation, a comprehensive supply chain, policy support, and effective cost control. These factors enable competitive pricing and operational stability in global markets. However, challenges include low international brand recognition, limited experience in global operations, and insufficient infrastructure support.

The company can capitalize on global trends like the push for new energy policies, emerging market growth, and technological advancements. Yet, it faces threats such as intense competition, trade barriers, geopolitical risks, and supply chain uncertainties. Addressing these weaknesses and threats is crucial for sustained success in international markets.

4. Brand Positioning Strategies to Enhance Brand A's International Brand Influence

4.1 TOWS matrix

To enhance Brand A's international brand influence, clear brand positioning strategies must be developed. These strategies need to combine internal resources with the external market environment. Through analyzing the TOWS matrix, key directions can be determined and specific measures implemented in market positioning, product differentiation, user experience, and brand recognition.

Table 5 TOWS matrix for international brand development of A company

Strategy combination	Description
SO Strategy (Leveraging strengths to seize opportunities)	Leverage technological innovation and policy support to penetrate emerging markets deeply. Strengthen differentiation through technological breakthroughs to establish a leading position in the international market.
WO Strategy (Using opportunities to overcome weaknesses)	Utilize the global push for new energy policies to enhance brand communication in overseas markets and improve international brand recognition. Address infrastructure shortcomings through strategic partnerships.
ST Strategy (Using strengths to counter threats)	Integrate supply chains and exercise cost control to address international competition. Use technological innovation to overcome supply chain uncertainties and geopolitical risks, ensuring operational stability.
WT Strategy (Reducing weaknesses and avoiding threats)	Establish a long-term internationalization plan, improve global supply chain layouts, enhance consumer satisfaction through localized market strategies, and reduce dependence on single markets or supply chains.

Based on the TOWS matrix, A company need to develop specific strategies in market positioning, product differentiation, user experience, and brand recognition to drive international development.

4.2 Strategies for international market expansion

4.2.1 Market positioning strategy

Brand A should position itself as a high-end electric vehicle manufacturer, emphasizing high performance, advanced technology, and premium design to attract quality-focused consumers. In Europe and the U.S., it should highlight environmental sustainability and cutting-edge technology, while in emerging markets like Southeast Asia, it must offer affordable, durable models tailored to local economic conditions. Localization is critical—adapting strategies to cultural and regulatory contexts, such as promoting sustainability in Europe and price benefits in Southeast Asia, can enhance market resonance. Collaborations with local dealers and partners will further strengthen market entry and trust.

4.2.2 Product differentiation strategy

Brand A should leverage technological innovation to achieve differentiation, focusing on standout features like battery swap technology and intelligent driving systems. Tailoring offerings to different markets—luxury models for developed markets and economical options for emerging ones—broadens its appeal. Highlighting sustainable practices, such as eco-friendly materials and recycling mechanisms, can attract environmentally conscious consumers. Value-added services like remote maintenance and personalized user analytics, combined with continued investment in cutting-edge technologies like solid-state batteries, will sustain differentiation and long-term competitiveness.

4.2.3 User experience strategy

Optimizing user experience is essential for building loyalty. Establishing local service centers and robust after-sales networks ensures timely and efficient support. Partnerships with charging network providers, like IONITY in Europe, can expand charging infrastructure coverage. Smart vehicle networking and app-based solutions, offering services like charging navigation and personalized recommendations, improve convenience. Community-focused

initiatives, inspired by the "NIO House" model, can enhance brand engagement. Efficient feedback mechanisms will ensure continuous product and service improvement.

4.2.4 Brand awareness strategy

To build international recognition, Brand A must communicate its values through global auto shows, mainstream and social media platforms like Instagram and YouTube, and strategic advertising campaigns. Crafting compelling brand stories around sustainability, innovation, and customer focus fosters emotional connections with consumers. Collaborations with international influencers or environmental projects can amplify brand influence. Tailoring messaging to regional cultures—emphasizing premium quality in Europe and affordability in Southeast Asia—ensures cultural resonance and enhances consumer affinity. Co-branding with global fashion or tech brands further diversifies its appeal and strengthens its global presence.

Discussion

Company A has made significant strides in internationalizing its brand as a premium electric vehicle (EV) provider, leveraging advanced technological innovations like battery-swapping and intelligent driving systems. These innovations, combined with a strong supply chain and cost-efficient production, position the company well for global expansion (Qadir et al., 2024). However, its global positioning strategy is fragmented, with a luxury focus in mature markets and price competition in emerging regions, potentially diluting its premium brand image (Thompson & Kumar, 2022). Brand coherence is essential to maintaining a strong international presence, and conflicting strategies can weaken brand recognition (Shocker et al., 1994; Hong et al., 2023).

While the company's technological innovations are advanced, their impact is hindered by inadequate infrastructure in international markets. The limited availability of charging stations and service centers, particularly for its battery-swapping technology, reduces its competitive edge (Zhao et al., 2020). The adoption of EVs heavily depends on the availability of infrastructure, and the lack of it remains a key barrier for international brands (Goncearuc et al., 2024). Additionally, models like "NIO House," designed to enhance user experience, have struggled internationally due to insufficient localization (Shankar et al., 2022).

Company A's weak international brand recognition, compounded by limited global marketing investments, has hindered its ability to differentiate itself from established players like Tesla in markets such as Europe and the U.S. (Saxena & Vibhandik, 2021). A cohesive narrative around its commitment to sustainability and innovation is needed to build emotional connections with consumers (Modliński & Pawlak, 2024). Strong brand storytelling and consistent communication are crucial in competitive global markets (Babatunde et al., 2024).

External threats such as intense competition, geopolitical risks, and supply chain vulnerabilities also jeopardize the company's internationalization efforts. The global EV market is increasingly competitive, with Tesla and other automakers intensifying their presence (Chen, 2023). Trade barriers and supply chain disruptions, particularly for critical materials like lithium, further complicate global expansion (Jones et al., 2023). Despite these challenges, Company A has numerous opportunities to strengthen its international position. Global green policies and rising demand for EVs in emerging markets create favorable conditions (Wu et al., 2021). Additionally, advancements in autonomous driving and battery technologies provide further differentiation opportunities (Schippl & Truffer, 2020). However, threats like competition from both established and emerging brands (Saxena & Vibhandik, 2021) and supply chain risks remain significant challenges.

To improve its international brand awareness, Company A should focus on a comprehensive brand positioning strategy that emphasizes its technological advancements and

sustainability. Research shows that high-tech features and environmental sustainability are key drivers for premium brand associations, particularly in developed markets (Borah et al., 2023). Tailoring product offerings for specific markets, along with investing in user experience improvements such as local service centers and expanded charging infrastructure, will enhance customer loyalty (Visaria et al., 2022). Additionally, leveraging digital tools and smart vehicle technology to engage customers and fostering brand awareness through global marketing campaigns will strengthen its international presence (Baddam, 2022).

Conclusion

Company A has strong technological innovation and cost advantages, positioning itself as a premium electric vehicle brand. However, its internationalization faces challenges, including inconsistent global market positioning, insufficient infrastructure to support its innovations, inadequate adaptation of user experiences abroad, and weak international brand recognition. Compounded by intense competition and geopolitical risks, these gaps hinder its ability to establish a cohesive and competitive global presence. Addressing these issues is critical for achieving successful brand internationalization.

Company A's internationalization process leverages strengths like advanced battery technology, cost efficiency supported by China's NEV supply chain, and government incentives, ensuring competitive pricing and innovation. However, it faces weaknesses in brand recognition, limited global experience, and inadequate charging infrastructure compared to competitors like Tesla. Opportunities arise from global green policies, growing NEV demand in emerging markets, and advancements in autonomous technology. Nevertheless, threats include intense competition, geopolitical risks, trade barriers, and supply chain challenges. Addressing these issues is critical for sustained international success.

To enhance its international brand awareness, Company A should adopt a multi-faceted brand positioning strategy. This includes positioning itself as a high-end electric vehicle manufacturer, emphasizing advanced technology, superior performance, and sustainable design. Differentiating its products through innovations like battery swap technology and tailored offerings for diverse markets—luxury models for developed regions and affordable options for emerging markets—is critical. Improving user experience through local service centers, expanded charging networks, and smart vehicle features can build customer loyalty. Additionally, targeted brand awareness campaigns leveraging global auto shows, social media platforms, and collaborations with influencers or co-branding opportunities will create emotional connections with consumers, ensuring cultural relevance and strengthening global recognition.

Future research could examine the role of infrastructure development, such as charging stations and service centers, on the international expansion of electric vehicle brands. This would include exploring how the availability of charging infrastructure influences consumer adoption of EVs in different regions and how brands can partner with local governments or other stakeholders to overcome these barriers. Research could also investigate the specific infrastructure needs for innovative technologies like battery-swapping. Another avenue for future research could explore the impact of product and service localization on consumer perception and brand loyalty in the electric vehicle industry. This study could investigate how companies like Company A can better tailor their offerings to meet the cultural, economic, and technological needs of specific international markets. It could also examine how localized marketing strategies, service adaptations, and product variations influence brand image and customer retention in diverse global contexts.

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Initiatives for enhancing employee performance of X company in China

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Abstract

The objectives of this research were: 1) to study the level of employee performance at X Company; 2) to identify the factors influencing employee performance at X Company; and 3) to propose initiatives for enhancing employee performance at X Company. A quantitative research approach was adopted, utilizing a sample of 154 employees at the Kunming North Star Center, selected through simple random sampling from a population of 250 employees. Data were collected using a structured questionnaire, which demonstrated a content validity of 0.961 and a reliability coefficient of 0.846. Data analysis included descriptive statistics (percentages, means, and standard deviations) and inferential statistics (correlation and regression analysis).

The findings revealed: 1) Employees exhibited high task performance (mean: 3.975), reflecting competence, efficiency, and adaptability through training and talent management, and high contextual performance (mean: 3.981), highlighting teamwork, adaptability, and organizational alignment. 2) Both intrinsic and extrinsic rewards significantly influenced performance. Extrinsic rewards, like bonuses and benefits, showed a moderate positive impact, with gifts contributing 26% and 30.7% of the variance in task and contextual performance, respectively. Intrinsic rewards, such as recognition and growth opportunities, explained 21.2% and 24% of the variance, with recognition and responsibility being key motivators. Together, rewards accounted for 42.5% and 44.5% of the variance in task and contextual performance, balancing immediate and long-term impacts. 3) Initiatives included personalized rewards, bonuses, and family benefits, alongside intrinsic strategies like meaningful tasks, empowerment, and career-linked responsibilities. Management support through mentorship and feedback aligned efforts with organizational goals, fostering performance and sustainable growth. These initiatives aimed to balance short-term performance improvements with long-term sustainable growth and employee satisfaction.

Keywords: Employee performance; Extrinsic rewards; Intrinsic rewards; Task performance; Contextual performance

Introduction

Amidst accelerating globalization and technological disruption, the electric vehicle (EV) sector has emerged as a critical battleground for sustainable innovation. X Company's meteoric rise from a 2003 startup to an industry leader—with revenue surging 80% from \$53.82 billion to \$96.77 billion (2021–2023) and vehicle deliveries reaching 1.8 million units in 2023 (Statista, 2024) exemplifies the strategic importance of human capital optimization in

technology-driven industries. the company's augmented market share and the efficacy of its commercial methods.

However, despite its remarkable growth, X Company faces persistent challenges in sustaining innovation momentum within its highly specialized workforce. While its 40% year-over-year (YoY) delivery growth (2022–2023) reflects operational excellence, traditional performance management frameworks validated primarily in either conventional manufacturing (Bai et al., 2021) or pure technology environments (Kim & Park, 2020) struggle to address the unique hybrid nature of the new energy vehicle sector. This industry demands both engineering rigor and Silicon Valley-style agility, requiring an adaptive approach to employee motivation and performance management.

A critical issue in this context is the design of reward systems. Existing research largely bifurcates into financial incentive studies in capital-intensive industries and psychological motivation studies in knowledge-based sectors (Deci & Ryan, 2020; Gerhart & Fang, 2021), leaving a gap in understanding how to synthesize these approaches for sustainable innovation ecosystems. In China's rapidly evolving EV landscape, where technology iteration cycles are 68% faster than in traditional automotive manufacturing (Zhang & Wang, 2022), conventional compensation models risk misalignment with employees' dual needs—protecting against skill obsolescence while recognizing breakthrough innovation.

To address this gap, this study integrates Herzberg's Two-Factor Theory with the specific challenges of the new energy vehicle industry to develop a dynamic motivation framework. Through a three-pronged investigation into (1) skill obsolescence anxiety in fast-evolving technical roles, (2) cross-functional collaboration barriers in matrix organizations, and (3) equity perception in hybrid compensation models, this research aims to identify key factors influencing employee performance and propose targeted initiatives for improvement.

Ultimately, this study advances a balanced reward system that aligns short-term performance metrics with long-term talent development, fostering both employee satisfaction and sustainable innovation in the electric vehicle sector. By bridging extrinsic and intrinsic reward mechanisms, this framework provides actionable strategies to enhance workforce motivation, strengthen organizational resilience, and maintain X Company's competitive edge in the global.

1. Research Objectives

- 1.To study the level of employee performance at X Company.
- 2.To identify the factors that influence of X Company's employee performance.
- 3.To propose the initiatives for enhancing employee performance of X Company.

2. Review of Related Literatures

2.1 Concept of Employee Performance

It was imperative to implement performance management to encourage employees to operate at elevated levels. Nevertheless, it was deemed inadequate. Pulakos (2009) emphasized the necessity for performance management systems to be aligned and continuously improved. Performance management was identified as a critical tool for motivating employees to perform at their best, with the ultimate goal of creating value for both shareholders and customers (Cokins, 2009). To enhance the overall output of employees, it was essential to understand job responsibilities and performance evaluation processes, as well as to address existing gaps (Richard, 2003).

Indicators of employee performance include work quality, customer satisfaction, and speed at which the tasks are performed (Njanja et al., 2013). According to Locke and Latham (2002), performance improvement depends on the goals being set to be specific and

challenging. Employee performance is normally divided into task performance and contextual performance. Task performance refers to performance of job-specific duties, including aspects such as work quantity, quality, and efficiency (Campbell, 1990). On the other hand, contextual performance includes behaviors that support the organization, such as teamwork and collaboration. According to Borman & Motowidlo, 1997, both components are important in terms of giving an accurate view of employee contributions toward organizational success.

2.2 Rewards and Employee Motivation

Rewards play a pivotal role in motivating employees through both extrinsic and intrinsic incentives (Camilleri, 2002). Extrinsic rewards, such as salaries and bonuses, provide external recognition for employee efforts (Mahaney & Lederer, 2006). Intrinsic rewards, such as job satisfaction and opportunities for personal growth, fulfill psychological needs and foster long-term motivation (Meyer & Allen, 1984). Effective reward systems aligned with organizational goals can enhance employee performance and retention (Armstrong, 2009). A balance between extrinsic and intrinsic rewards is essential to maintain motivation and improve productivity (Ali & Akram, 2013).

According to Sansone and Harackiewicz (2000), motivation is the intrinsic force that promotes the efficiency and performance of employees. Robbins and Coulter (2014) have elucidated motivation as a mechanism that aids individuals in accomplishing organizational objectives. Diverse motivational theories concentrate on the factors that influence human behavior. Based on the arguments of Seiler et al. (2012), incentives may be presented as either intrinsic or extrinsic components. Islam and Ismail (2008) underscored the importance of a supportive work environment, job security, and high compensation as powerful motivators. Motivation can be classified into financial (extrinsic) and non-financial (intrinsic) factors, which have a significant impact on organizational success and employee engagement (Al-Alawi, 2005). Research indicates that employees are more productive and committed when they feel empowered and supported (Allen et al., 2015). Deci and Ryan (1985) developed the self-determination theory, which underscores the importance of intrinsic and extrinsic motivation in enhancing performance. Maslow and Herzberg's theories also suggest that growth and development are powerful motivators. (Chintallo & Mahadeo, 2013).

Herzberg's Motivation-Hygiene Theory (1959) distinguishes between motivators and hygiene factors. Herzberg (1966) posits that hygiene factors, such as salary and job security, prevent dissatisfaction but do not directly increase motivation. Conversely, motivators like achievement and recognition result in increased job satisfaction and performance. Herzberg's theory posits that performance can be significantly improved by enhancing intrinsic motivators. Ryan and Deci (2000) underscore the significance of intrinsic rewards in performance enhancement, as evidenced by empirical studies. Additionally, this theory has been expanded to posit that intrinsic rewards, including the opportunity for development and a sense of responsibility, are critical factors in employee performance (Herzberg, 1968).

2.3 Rewards and Employee Performance

Extrinsic rewards—such as bonuses, promotions, and material incentives—have been widely shown to enhance employees' task performance by increasing work effort, boosting job satisfaction, and stimulating creativity (Danish & Usman, 2010; Ajmal et al., 2015). Research also emphasizes that fair and transparent compensation practices are critical for fostering knowledge sharing and psychological empowerment (Ghazanfar et al., 2011; Sulistiyani et al., 2018).

H1a: Extrinsic rewards have a significant positive impact on task performance.

Moreover, extrinsic rewards influence behaviors that extend beyond core job tasks. Studies indicate that material incentives and recognition not only promote individual effort but

also encourage teamwork, collaboration, and overall organizational citizenship (Ajmal et al., 2015; Bari et al., 2019). The positive effects of extrinsic rewards on contextual performance are most pronounced when the reward system is perceived as equitable and well aligned with organizational goals (Gkorezis & Petridou, 2012; Shahab et al., 2018).

H1b: Extrinsic rewards have a significant positive impact on contextual performance.

Intrinsic rewards—such as recognition, career growth opportunities, and the provision of meaningful work—fulfill employees’ fundamental psychological needs for autonomy, competence, and relatedness. Early studies by Deci (1971) and further research by Ryan and Deci (2000) have established that intrinsic motivation is a powerful driver of enhanced task performance, as it encourages innovative problem-solving and a deep commitment to work quality (Amabile, 1993; Lin, 2007).

H2a: Intrinsic rewards have a significant positive impact on task performance.

In addition, intrinsic rewards contribute to improved contextual performance by fostering a strong sense of purpose and encouraging prosocial behaviors that support teamwork and a positive organizational culture (Deci & Ryan, 1985; Gagné & Deci, 2005). By promoting long-term engagement and commitment, intrinsic rewards help create a work environment where employees are more willing to go beyond their formal responsibilities (Cerasoli et al., 2014; Amabile, 1993).

H2b: Intrinsic rewards have a significant positive impact on contextual performance.

2.4 Conceptual Framework

Conceptual framework as show in Figure 1.

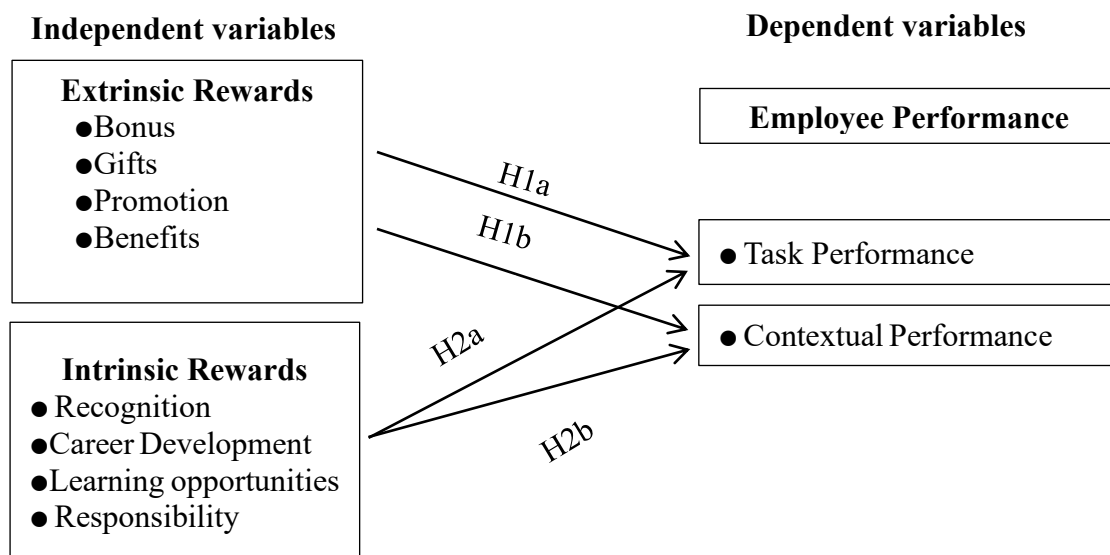


Figure 1 Conceptual framework

This conceptual framework delineates the study's variables, comprising two independent variables: extrinsic rewards (bonuses, gifts, promotions, benefits) and intrinsic rewards (recognition, career development, learning opportunities, responsibility), with employee performance (task performance, contextual performance) as the dependent variable. Extrinsic and intrinsic incentives affect employee performance.

Research Methodology

This research used a quantitative methodology to analyze the correlations between rewards and employee performance. Multiple regression analysis was used to examine the relationships between two categories of independent variables extrinsic and intrinsic rewards and a dependent variable, employee performance, which was categorized into task performance and contextual performance. The research followed these stages: 1) Designing a questionnaire based on the framework and literature review; 2) determining the sample size using Slovin’s formula; 3) conducting a survey to collect data; 4) performing descriptive and regression analyses using statistical tools; 5) interpreting the findings to test the hypotheses.

Kunming North Star Center was chosen as the research site due to its geographic and economic importance. The center is home to many businesses and employees, providing a representative sample. The diverse employee population allows the results to be applied across different company types. The center's organizational culture and performance management system also provide rich data for exploring the impact of rewards on employee performance.

The study used Slovin’s formula to determine the sample size: $n = 250 / (1 + (250 \times 0.05^2)) = 154$ respondents (Yamane, 1967). Slovin’s formula is efficient and suitable for determining sample sizes without detailed population data. A sample of 154 respondents adequately represents the employee population at Kunming North Star Center.

For reliability and validity, the questionnaire was evaluated using Cronbach's Alpha and the Index of Item-Objective Congruence (IOC). The reliability analysis showed an overall Cronbach's Alpha of 0.846, with all dimensions scoring above 0.7, indicating good internal consistency. The IOC evaluation by three experts resulted in a score of 0.961, exceeding the 0.5 threshold. This confirms the questionnaire's strong reliability and validity as a measurement tool for future research.

Results

Table 1 outlines the key variables used in the analysis. The independent variables include extrinsic rewards (x1)-bonuses (x11), gifts (x12), promotions (x13), and benefits (x14)- and intrinsic rewards (X2)-recognition (x21), career development (x22), learning opportunities (x23), and responsibility (x24). The dependent variable (Y) represents employee performance, further divided into task performance (Y1) and contextual performance (Y2). Significance levels are indicated as * ($p < 0.05$) and ** ($p < 0.01$), providing insights into the relationships between rewards and performance outcomes.

Table 1 Correlation Analysis of Independent and Dependent Variables

	x_1	x_11	x_12	x_13	x_14	x_2	x_21	x_22	x_23	x_24	Y	Y_1	Y_2
x_1	1												
x_11	0.878 **	1											
x_12	0.901 **	0.769 **	1										
x_13	0.891 **	0.766 **	0.790 **	1									

	x_1	x_11	x_12	x_13	x_14	x_2	x_21	x_22	x_23	x_24	Y	Y_1	Y_2
x_14	0.875**	0.713**	0.781**	0.737**	1								
x_2	-0.054	-0.023	-0.092	-0.054	-0.090	1							
x_21	-0.102	-0.068	-0.113	-0.093	-0.106	0.877**	1						
x_22	-0.070	-0.031	-0.084	-0.057	-0.088	0.866**	0.749**	1					
x_23	-0.098	-0.056	-0.107	-0.083	-0.126	0.871**	0.755**	0.737**	1				
x_24	0.015	0.070	-0.037	0.034	-0.012	0.845**	0.701**	0.710**	0.711**	1			
Y	0.576**	0.559**	0.585**	0.513**	0.491**	0.521**	0.446**	0.452**	0.453**	0.538**	1		
Y_1	0.502**	0.490**	0.514**	0.438**	0.425**	0.456**	0.393**	0.405**	0.413**	0.451**	0.906**	1	
Y_2	0.538**	0.523**	0.546**	0.491**	0.465**	0.482**	0.415**	0.414**	0.407**	0.523**	0.904**	0.639**	1

Significance levels: $p < 0.01$: Marked as ** (highly significant); $p < 0.05$: Marked as * (significant).

Source: Prepared by the authors themselves.

This study empirically validates hypotheses H1a, H1b, H2a, and H2b, confirming that both extrinsic and intrinsic rewards significantly enhance employee performance. As shown in Table 1, extrinsic rewards (bonuses, gifts, promotions, and benefits) positively correlate with task performance (mean correlation: 0.514) and contextual performance (mean correlation: 0.546), with gifts demonstrating the strongest impact. Similarly, intrinsic rewards (responsibility, recognition, career development, and learning opportunities) exhibit significant positive effects, with responsibility showing the highest correlation with task (0.451) and contextual performance (0.523).

Additionally, the weak negative correlation between extrinsic and intrinsic rewards ($r = -0.054$) suggests their relative independence. Some negative correlations may stem from substitution effects, role-based differences, or design flaws in the reward system. The study highlights the need for an optimized reward structure, emphasizing dynamic alignment, compatibility between reward types, and continuous performance evaluation to enhance the synergy between extrinsic and intrinsic incentives, ultimately maximizing employee performance.

Table 2 Regression Analysis of Task and Contextual Performance in Relation to Intrinsic and Extrinsic Rewards

Variable	Intercept	Coefficient (a/b)	Standard Error	Beta	t	VIF	R ²	Adjusted R ²	F	P
Task (Extrinsic)	2.365	0.411	0.152	0.515	7.407	1.265	0.265	0.260	54.867	< 0.001*
Contextual (Extrinsic)	2.252	0.441	0.147	0.558	8.298	1.312	0.312	0.307	68.849	< 0.001*
Task (Intrinsic)	2.535	0.367	0.157	0.466	6.498	1.200	0.217	0.212	42.223	< 0.001*
Contextual (Intrinsic)	2.469	0.386	0.154	0.494	7.014	1.250	0.245	0.240	49.198	< 0.001*

Source: Statistics Software

Note: ** indicates statistical significance at the 0.01 level.

Table 3 Correlation coefficients for the impact of intrinsic and extrinsic rewards on employee performance

	x_1	x_11	x_12	x_13	x_14	x_2	x_21	x_22	x_23	x_24
Y_1	0.490	0.514	0.438	0.425	0.502	0.393	0.405	0.413	0.451	0.456
Y_2	0.523	0.546	0.491	0.465	0.538	0.415	0.414	0.407	0.523	0.482

This study begins by highlighting key statistical findings from the correlation analysis, which reveal that extrinsic rewards (x1) are positively correlated with task performance (Y1) and contextual performance (Y2) with correlation coefficients of 0.502 and 0.538, respectively. Similarly, intrinsic rewards (x2) are positively correlated with task performance and contextual performance with correlation coefficients of 0.456 and 0.482. These findings indicate a significant positive relationship between rewards and employee performance, with extrinsic rewards showing slightly higher correlations.

Building on these findings, multiple linear regression analysis further confirms the significant impact of extrinsic and intrinsic rewards on employee performance. The regression equation for task performance is $Y = 2.365 + 0.411x_1 + 0.367x_2 + E$, while the equation for contextual performance is $Y_2 = 2.252 + 0.441x_1 + 0.385x_2 + E$. The regression coefficients indicate that extrinsic rewards have a stronger impact on task and contextual performance (0.411 and 0.441, respectively) compared to intrinsic rewards (0.367 and 0.385, respectively). The adjusted R² values show that extrinsic rewards explain 26.0% of the variance in task performance and 30.7% in contextual performance, while intrinsic rewards explain 21.2% and 24.0%, respectively.

In conclusion, the results demonstrate that both extrinsic and intrinsic rewards have a significant positive impact on employee performance, validating hypotheses H1a, H1b, H2a, and H2b. Notably, extrinsic rewards exert slightly greater influence, providing valuable insights for organizations to develop effective reward mechanisms to enhance employee performance.

Conclusion

This study analyzed employee performance at X Company, revealing high task (3.975) and contextual performance (3.981), driven by competence, teamwork, and adaptability. Regression results confirmed that extrinsic rewards (e.g., gifts, bonuses) significantly influenced performance, explaining 26.0% of task and 30.7% of contextual performance variance, while intrinsic rewards (e.g., recognition, responsibility) accounted for 21.2% and 24.0%, respectively. Together, they explained over 40% of performance variance, validating the study's hypotheses. To enhance performance, the study recommends a balanced approach integrating tailored incentives, career growth opportunities, and both short-term extrinsic and long-term intrinsic motivation.

Discussion

The discussion emphasizes the important role of both extrinsic and intrinsic rewards in improving employee performance. The results show that extrinsic rewards, such as bonuses, gifts, promotions, and benefits, have a significant positive impact on task performance and contextual performance, explaining 26.0% and 30.7% of their variance, respectively. This supports the argument that monetary and tangible incentives play a crucial role in motivating employees to achieve immediate performance goals (Ihemereze et al., 2023).

Similarly, intrinsic rewards, including recognition, career development, learning opportunities, and responsibility, also have a significant positive effect, accounting for 21.2% and 24.0% of the variance in task and contextual performance, reinforcing the notion that non-monetary incentives foster sustained engagement and employee satisfaction (Altassan, 2024). These findings validate the hypotheses (H1a, H1b, H2a, H2b) and reveal that extrinsic rewards provide immediate motivation through tangible benefits, while intrinsic rewards promote long-term engagement and satisfaction. The observed high levels of task and contextual performance at X Company reflect the effectiveness of its workforce's competence, teamwork, and adaptability. These factors are integral to modern organizations as they enhance both individual and collective productivity (Omachi & Ajewumi, 2024). The findings suggest that fostering a balanced rewards system is key to maintaining high performance. For instance, tailored incentives can address diverse employee needs, while career growth opportunities contribute to long-term engagement and motivation (Quader, 2024).

The synergy between extrinsic and intrinsic rewards ensures a balanced approach to motivating employees, addressing both short-term productivity and sustained performance. The study highlights the importance of aligning reward systems with organizational objectives to maximize their effectiveness and suggests implementing personalized and meaningful rewards to meet the diverse needs of employees (Fulmer & Li, 2022). Moreover, this study highlights the importance of adopting a strategic perspective on rewards management. Short-term extrinsic rewards are effective in driving immediate performance improvements, whereas intrinsic rewards cultivate a sense of ownership and alignment with organizational goals over the long term. This balance ensures a sustainable performance management system that benefits both employees and the organization (Amjad et al., 2021). These insights provide a valuable framework for X Company to optimize its reward policies, enhance employee motivation, and improve overall organizational performance.

Recommendations

1. Practical Recommendations

To enhance employee performance, X Company should integrate AI- driven performance tracking, real-time feedback, and personalized training programs. Clear career progression, flexible work policies, and strong recognition programs can boost engagement. Performance-based incentives and continuous managerial support through mentorship and feedback will sustain long-term productivity.

2. Limitations

This study has several limitations. First, the sample was limited to X Company employees, restricting generalizability to other industries. Second, the reliance on self-reported data may introduce bias; future research should incorporate objective performance metrics. Third, the cross-sectional design captures employee perceptions at a single point, limiting insights into long-term effects. Lastly, external factors such as economic conditions and company policies were not considered, which may also influence employee motivation and performance.

3. Future Research Suggestions

Future studies should test reward systems in real business environments, examine leadership styles' impact on engagement, and explore AI- driven employee motivation strategies. Longitudinal research is needed to assess how changing reward structures influence performance and retention over time.

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A review of Local Community Participation in Community-Based Tourism Development in Vietnam from Theory to Practice: Case Studies in Two Mountainous Areas of Thua Thien Hue Province, Vietnam

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Abstract

Community-based tourism (CBT) not only helps build the local economy but also promotes the preservation of traditional values and natural landscapes. This study aims to i. synthesize local community participation in community-based tourism, ii. develop a model of local community participation in community-based tourism in Vietnam, and iii. examine the current status and lessons learned from local participation in community-based tourism in the mountainous areas of Thua Thien Hue province (Nam Dong and A Luoi), Vietnam. The sequential explanatory mixed methods research, consisting of a quantitative systematic review and a qualitative case study, reveals important findings that include: i. a lack of clear and specific orientation and strategy for developing CBT in Vietnam; ii. current difficulties faced by CBT due to a lack of critical knowledge in business and administration, digital marketing, and market access; iii. insufficient concern from local government regarding budget allocation for improving infrastructure and enhancing human resource capacity; iv. mismatches among different stakeholders in implementing projects and policies issued by local governments, leading to low community motivation to participate in the decision-making process of CBT. The study proposes several policy implications to deepen the understanding of local community participation in CBT.

Keywords: Tourism and Development, community-based tourism, sustainability, community participation

1. Introduction

Tourism is a rapidly expanding economic industry that is progressively contributing to the growth and development of numerous cities, countries, and regions around the globe. The United Nations 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) were ratified in 2015, and tourism was designated as a vital aspect in achieving the SDG goals. The important role of tourism was formalized in the declaration of the International Year of Sustainable Tourism for Development 2017. Tourism has long been

viewed as a sector that helps poor countries accomplish their long-term development goals (Scheyvens and Laeis, 2019). Tourism has been linked to sustainable development in numerous studies. Studies have focused on tourism's potential contributions to poverty reduction (Saarinen and Rogerson) and environmental conservation (Edgell, 2019); yet, tourism's far-reaching negative consequences are also generally recognized (Caton et al., 2014).

In recent years, community-based tourism has become a prominent tourist concept that is seen to be suited for tourism-based sustainable development. Despite its recent development in Europe, America, and Australia in the 1980s of the twentieth century, community participatory tourism has attracted travelers from all over the world. Community-based tourism has a wide range of applications and can be used in a variety of ways. Community-based tourism is projected to contribute to sustainable development goals in poor nations, particularly in the aim of widespread community-based tourism as a means of promoting biodiversity and heritage conservation, as well as combining livelihoods with biodiversity protection while reducing rural poverty (Kiss and Bank, 2004). By empowering local communities to manage their own resources, create jobs, and support capacity building and cultural preservation, community-based tourism contributes to social sustainability. It's a new approach to tourist development that emphasizes community involvement in all stages of the process, from concept generation to planning, execution, management, monitoring, evaluation, and sharing benefits (Schott and Nhem, 2018). When it comes to economic, socio-cultural, and environmental factors, CBT is similar to sustainable tourism (Dangi and Jamal, 2016). As a result, community tourism is seen as a worthwhile experience.

According to recent studies, community-based tourism plays a vital role in enhancing the localization of economic connectedness, which lowers economic leakage (Manyara and Jones, 2007; (López-Guzmán, Sánchez-Cañizares, et al., 2011; Lapeyre, 2010). Community-based tourism is also considered as a positive motivator, promoting local engagement, empowerment, and decision-making while enhancing local infrastructure such as healthcare, transportation, and communication (Duffy, 2002). Communication benefits the community in a practical way (Manyara and Jones, 2007).

The Vietnamese government has recognized the critical importance of tourism in the economy and declared the objective of expanding tourism into the country's primary economic sector. Vietnam is a country with significant assets and tourist growth potential, as well as numerous benefits in terms of geographic position, climate, and natural conditions. Vietnam also features a wealth of natural wonders, historical sites, and different landscapes. Along with it, there is the highly rich and distinctive culture, history, and cuisine that has been recognized around the world. Many models and forms of community-based tourism have been implemented in some localities with initial positive results, such as Lac village (Mai Chau - Hoa Binh of Thai people); Elephant Stream, Loc Tien Commune (Phu Loc - Thua Thien Hue); Pac Ngoi (Tay) and Bo Lu (Dao) villages in Ba Be National Park..., all of which have made significant contributions to economic development, poverty alleviation, and environmental protection.

Recognizing the potential, benefits, and advantages of community-based tourism, the government has developed several rules and solutions to encourage the growth of this new approach. However, the development of community-based tourism in Vietnam is not commensurate with current resources and potential, and it still has numerous limitations. In particular, the quality and diversity of tourism products, the quality and consistency of the infrastructure system, the quality and uniformity of human resources in the tourism industry, and the administration of tourism operations are all still missing. In comparison to other nations in the region, the interaction - connectivity between players engaging in community based tourism is poor, and community based tourism's tourism products lack originality and

competitiveness of community based tourism in Vietnam is highlighting important concerns in terms of sustainable development includes (i) Community-based tourism's growth rate and stability are still low; (ii) community-based tourism's contribution to Vietnam's tourism industry is still low; (iii) community-based tourism activities have many negative impacts on tourism resources, the natural and social environment, and the economy. (iv) CBT has an impact on the preservation and promotion of tangible cultural values, as well as intangible cultural values. The constraints and flaws mentioned above have had a direct impact on the long-term growth of community-based tourism in Vietnam. In this context, it is critical to conduct research and suggest solutions to help Vietnam grow community-based tourism.

Several studies on CBT have been published in Vietnam, including those by Bui Thanh Huong and Nguyen Duc Hoa Cuong (2007), Nguyen Quyet Thang and Nguyen Van Hoa (2012), Lich & Thu, 2019,... This research has highlighted issues such as: community-based tourism experiences in Vietnam; identifying and evaluating groups of motivating elements and impediments to community engagement in tourist activities; and developing sustainable community-based tourism. However, these studies are limited to a specific location or geographical area, and no comprehensive study on the local community participation in community-based tourism in Vietnam has yet been completed. Hence, the study's overall goal is to provide and systematize theoretical and practical issues about local community participation in community-based tourism in Vietnam, thereby contributing to the nation's valuable cultural heritage values being preserved and promoted, as well as promoting and introducing unique culture to domestic and international tourists.

Research Objectives, the objectives of this study are to 1) synthesize the local community participation in community-based tourism and 2) develop a model of local community participation in community-based tourism in Vietnam 3) Examine current status and lesson learned of community participation in community-based tourism in mountainous areas, Vietnam.

2. Materials and Methods

The sequential explanatory mixed methods research consists of quantitative systematic review to synthesized the local community participation in CBT and develop a model of local community participation in CBT in Vietnam. After that, it conducted a qualitative case study to explain the lesson learned of a community participation in community-based tourism in mountainous areas – Thua Thien Hue province, Vietnam.

2.1. Quantitative design

The systematic review which is comprehensive high-level summary of primary research on CBT that attempts to identify, select, synthesize, and appraise all high-quality evidence to provide valid and reliable conclusions that can inform future research studies, practice or policy (Cochrane collaboration, 2020). It consisted of 5 steps include 1) inclusion and exclusion criteria 2) search for study 3) selection and critical appraisal 4) data extraction and synthesis 5) interpretation of findings and policy recommendations.

Inclusion and Exclusion Criteria. The inclusion criteria to select literatures are (a) any literatures focus on community-based tourism with not specific to any population group or geographic region. (b) published in Web of Science TM Core Collection (WOS) and Scopus (SCO) databases including peer-review journals, books, and reports, (c) published between 2011-2021 (d) Research papers, articles, or reports written in English and Vietnamese language. Exclusion Criteria Studies were excluded when the subject of the study did not match the objective of this review article. The outputs were successively filtered, until we had only

peer-reviewed articles. Unreliable sources of publications and non-scholarly documents were excluded.

Search for study. The keywords used for the three separate searches were community-based tourism, local community participation, sustainable tourism development. The search process was begun with an initial search of major databases—namely, Emerald Management, Science Direct, Taylor & Francis Online: Sport, Leisure & Tourism. Review database due to the scarce results that appeared when using the terms mentioned earlier. This integrative review included quantitative, qualitative, mixed methods research. The search targeted articles published between 2011-2021.

Selection and Critical Appraisal. The first author reviewed research published in peer-review journals. Then, two authors read the topic, the abstract, the content to the same number of articles independently. For the items that either author evaluated against another author, the third authors assist to reach a consensus. The process was continued until three authors agreed on the number of the included articles. Of in the beginning, 125 articles were chosen based on the analysis of titles, abstracts, and keywords. These articles were studied in detail and finally, there were 15 pieces of literature in types of academic journals, books, reports were selected as the basic ground for further analysis.

Data Extraction and Synthesis. The concepts assessed were comprises content on the theoretical foundation of community-based tourism, presenting the ideas of community-based tourism and studies on community tourism, and thus offering a research model on community-based tourism. The parts that follow describe the research methodology, the current state of community-based tourism development, and community-based tourism lessons learned for Vietnam.

2.2. Qualitative Design

2.2.1. Research setting

Case studies on community-based tourism on mountainous areas in Thua Thien other Vietnamese cities, has a lot of potential for tourism development, thanks to its proximity to the sea, forests, natural beauty, and numerous historical, cultural, and intangible heritage sites. Furthermore, Thua Thien Hue has a long cultural tradition and history, many traditional craft villages, many customs and habits in spiritual life as well as in production, all of which are treasures that must be preserved. This provincial government has launched and implemented the idea of turning new rural villages into tourism products based on the results obtained during the process of building a model new rural residential area.

2.2.2. Data Collection

This study combines the collection of various primary data sources for research purposes. Source 1: from service providers in the two districts of Nam Dong and A Luoi. Local Government: The research team will conduct in-depth interviews with 20 experts, divided equally between the two districts. Each district will include 2 district-level officials and 8 commune-level officials, including leaders of associations and organizations. Additionally, the study will organize 2 Focus Group Discussions. In addition, homestay Business Owners: The research team collected data from households running homestay services to calculate indicators on the effectiveness of this tourism type, as well as assess guest flow, peak, and off-peak periods. To explore the key informants' real-life experience with community-based tourism, open-ended and probing questions focus on key informants, such as: “Do you talk or help customers?”; “Do you or your family members participate in tourism activities?”; “Does tourism help you increase your income?”; “Are you satisfied with your income from participating in community tourism?”; “This is the first time you travel here?”; “Do you want to come back here? Why?”. The in-depth interviews will take one hour while focus group

discussion will about three hours. All interviews and focus groups were recoded and transcribed verbatim in English.

Secondary data is gathered from a variety of sources to produce theoretical and synthetic reports, including newspapers, periodicals, brochures, social media, and electronic media.

2.2.3. Data Analysis

The content from both interviews and focus groups were analyzed. Considering the expecting themes in light of the literature, interviews, and focus groups, the researcher will be able to combine a deductive review of the literature with an inductive approach to coding that allowed data from the specific context to emerge.

3. The synthesize of local community participation in community-based tourism

3.1. The concept of Community based tourism

Community based tourism is a unique type of tourism with different characteristics from mass tourism. Murphy introduced the concept of community-based tourism, which has been explored since 1985 and has resulted in several research studies on the exploitation and development of this type of tourism. The opinions, solutions, and principles of community-based tourism have been described as the perspectives, solutions, and principles of sustainable tourism development (Polnyotee and Thadaniti, 2015).

CBT is described as “a type of tourism in which the local community plays a major role in controlling and relating to tourism activities,” according to the World Wide Fund for Nature - WWF. The community owns the creation and management of tourism, as well as a percentage of the remaining benefits.”

Clause 15, Article 3 of the Law on Tourism 2017 explicitly states: "Community tourism is a type of tourism produced on the basis of the community's cultural values, by the local community." manage, organize, profit from, and gain from.” (Vietnam Tourism Law 2017)

CBT is frequently described as a type of tourism that, in developing nations, replaces mass tourism and supports rural communities through grassroots development, local engagement, and empowerment (Isaac; Dangi and Jamal). Because of its context-dependent nature, experts cannot agree on a definition of CBT, but the core distinguishing characteristics of CBT can be summarized as an ownership of the place approach to development projects, strong local community involvement in all phases of project development, and meaningful interactions between hosts and guests (Goodwin & Santilli, 2009). Economic benefits include contributing to rural development and poverty elimination (Salazar, 2012; Müller et al., 2020); preserving and developing locally cultural traditions (Lenao et al., 2015; Musa et al., 2010); empowering rural communities (Salazar, 2012); enhancing cross-cultural interaction (Regmi and Walter) and conservation of biodiversity (Newsome et al., 2012; Reimer et al., 2013). CBT approach has long been advocated as an important part of sustainable tourism development because it aims to achieve economic, cultural, social, and environmental goals, while the goal is to improve the community's capacity to meet the conditions for tourism development by lowering costs and thus increasing tourism benefits (Okazaki; Kunjuraman). CBT products, according to Benur et al.(2015), mix a wide range of tourism activities, local food and beverage, and lodging services. Trekking, camping, and strolling are common outdoor tourism activities, whereas inside activities tend to focus on village activities such as cooking, weaving, and other traditional activities. (Jugmohan, Spencer, & Steyn, 2016)

As a result, CBT can be defined as a type of tourism in which the local community participates directly in the planning, construction, implementation, and management of tourism activities for community development, conservation, and sustainable exploitation of tourism resources, while also receiving the majority of the profits from tourism.

3.2. Community-based Tourism Research

The notion of CBT can be found in Murphy's (1985) work, which examines issues of tourism and local community development, as well as a research published in 2004 by the same author (Murphy, 2004). This notion unlocks new research areas and the prospect of tourism development, as well as other alternative ways such as Pro-Poor Tourism (PPT) and Community-Based Tourism Initiatives (CBTIs) (Simpson, 2008). CBT projects can be found in many parts of the world, including Africa (Lepp; Manyara and Jones, 2007), Asia (Okazaki, 2008; Musa et al., 2016), Oceania (Dyer et al., 2007), and Latin America (Romão et al., 2016).

Actors participating in community-based tourism. Community involvement, according to Haywood (1988), is a process that involves all stakeholders, including local government officials, people, architects, developers, business people, and planners, in order to share decision-making. CBT also agrees that proper tourist development should be accompanied by community participation and stakeholder collaboration (Timothy, 1999; Kibicho, 2008; Murphy, 2013; Reed et al., 2006; Timothy, 1999; Yang, Ryan, & Zhang, 2013). As a result, the primary benefits of CBT have a direct impact on household economics, contributing to socio-economic development (Manyara and Jones, 2007).

Many scholars believe CBT is an excellent and practical paradigm for enhancing local communities' socioeconomic well-being while reducing negative impacts (Moscardo, 2008; Ruiz-Ballesteros & Hernández-Ramírez, 2010). According to Hausler and Strasdas (2003), there are three major CBT models: Model 1: The project involves the entire community. Model 2: Project participants are members of the community or family. Model 3: A joint venture between members of the community or some members of the community and commercial partners (Hausler and Strasdas (2003)). “Many organizations generally favor Model 1 due to the high degree of participation,” Hausler and Strasdas (2003) write, “but experience suggests that Model 3 is more successful.” The authors also propose that depending on the area, the extent to which community people participate in tourism can vary substantially. Furthermore, Cioce et al. (2007) promote intimate connection between the local population and visitors as a critical component in the creation of tourism products.

Jugmohan et al. (2016); Giampiccoli and Mtapuri (2017) have all documented a number of CBT concepts, characteristics, prerequisites, and obstacles. CBT's long-term success is heavily reliant on the stakeholders' abilities. As a result, capacity building should begin as early as possible in a CBT initiative. For the purpose of proposing a CBT classification system, Giampiccoli and Mtapuri (2017) give a list of CBT principles. Endogeneity, environment (particularly community-based ecotourism - CBET), education, empowerment, equity, development, sustainability, entrepreneurship, ethics, externality, exclusivity, experience, enjoyment, and ethnicity are also some of the themes that CBT must consider. These "endogenous" principles address concerns of control and ownership in CBT, indicating the appropriate level of endogenous ownership and control. “Control issues” are also mentioned in Saayman and Giampiccoli's research (2016). According to Telfer and Sharpley (2008), the topic of CBT control and advantages is a crucial concern in CBT, and it helps us understand whether control and profit remain in local communities or belong to local elites or outsiders.

Local community participation in community-based tourism. Local communities are seen as a valuable asset in tourism development since it occurs where they live and work, and they have a thorough grasp of the resources, strengths, and shortcomings of the area. Local communities are the primary actors in tourist development (Haukeland; Jamal and Stronza) as their interests impact or are influenced by planners' policymaking and implementation decisions (McCool). Without local participation, CBT's developer-related goals and activities would be difficult to attain. According to Gunn (1988), there should be linkage and resemblance between government and corporate levels, with the manager's role in overseeing

the CBT program/project playing a significant role. In tourism, communities are frequently the least benefited and empowered group. However, Gray, (1985) underlined the necessity for methods to empower citizens as well as training programs to develop capacity and abilities so that they can participate in CBT activities. In fact, communities frequently lack knowledge regarding the CBT process, including how, when, and what tasks can be performed (Joppe, 1996).

Many development projects now incorporate all stakeholders, not just because of the effectiveness and equity of programs, donor leverage, and the demands of local communities, but also because of the initiatives' long-term viability and efficacy. As a result, in order to encourage community participation, an enabling environment must be created, particularly for local populations who are vulnerable to the negative effects of tourism. Recently, the local community has been able to join in CBT initiatives and initiatives by donating shares or partnering with tourism enterprises in a variety of ways, including providing travel services, lodging services, and experiencing life in the countryside (Songorwa). This encourages local communities to take part in decision-making and express their involvement in CBT activities. However, if the local government does not provide the soft infrastructure, such as a legal framework, policy system, and special mechanisms to support and encourage community participation, the actual decentralization of the community to CBT will be difficult to achieve the expected success (Tosun, 2000; Wang and Wall, 2005).

CBT research, according to Briedenhann & Wickens (2004), should focus on how the entire community contributes in the development of the place as a tourism attraction. Local community perceptions and assessments of CBT potential (environment, infrastructure, and traditional cultural events); study models/methods of people's participation in CBT in the neighborhood; and the impact of tourism planning on CBT are some of the research topics. Tosun (2000) puts the barriers to CBT participation into three categories: executive level constraints, management decentralization limits, and cultural and cognitive limits. This is also the reason why residents are hesitant to participate in CBT.

Community based tourism's advantages. Hatton (1999) concluded that, while the implementation and outcome of CBT differ, there are common ground issues: economic benefits, leadership, empowerment, and employment, based on a larger study encompassing a series of rural tourism, community-based tourism, and ecotourism cases in several countries in the Asia-Pacific region. However, economic gains are not the only advantages of CBT practice: overall socioeconomic improvement and long-term lifestyle diversification are two of its outcomes (Rastegar; Manyara and Jones, “Community-Based Tourism Enterprises Development in Kenya: An Exploration of Their Potential as Avenues of Poverty Reduction”). Furthermore, according to George et al., (2007), major benefits to communities include: decreasing the impact of mass tourism on both culture and the environment; poverty alleviation and job creation; and money to maintain and restore community cultural assets.

To attain these objectives, government agencies, non-governmental organizations (NGOs), private businesses, and the local community must come together and collaborate. One of the primary restrictions that local communities confront while executing tourist initiatives, according to Nyaupane et al., (2006), is that, in addition to a lack of financial resources, infrastructure, or experience, conflicts between different state administrative authorities are a possibility. As a result, CBT becomes an effective technique to coordinate and implement various policies in order to minimize disputes between various tourism stakeholders and establish synergies based on the exchange of knowledge, analysis, and competence across all community members (Kibicho, 2008).

On the other hand, defining the amount and types of tourists appropriate for each community in order to minimize negative consequences of tourism such as loss of cultural

identity or tourism natural resource deterioration is one of the most contentious areas of the research study (Teye et al., 2002). In this regard, Nyaupane et al. underline that accepting a small number of tourists allows for more exposure to local culture and society, eliminating the risk of tourists trespassing on private parts of local culture while also producing disadvantages and depleting economic resources. The restricted number of visitors, on the other hand, decreases the economic benefits of tourism. As a result, the formation of cooperatives that allow communities to self-manage tourism resources is seen as a critical aspect (Lepp, 2007; Kaufmann et al., 2014). However, there are also drawbacks to the development of tourism products, such as the possibility of connection between large visitor numbers, sex and alcohol, loss of cultural identity, and the possibility of natural resource deterioration (Teye et al., 2002). We must remember that if tourism is handled solely as another tourist attraction with the goal of quick regional development, it has the potential to modify (or destroy) local culture.

3.3. Proposed model of local community's participation in community based tourism for Vietnam

This article discusses the community-based tourism models that have been researched, as well as their application in the Vietnamese context. Model selection criteria are based on resemblance to current conditions in Vietnam. In the investigations of Mtapuri and Giampiccoli (2016), there are various CBT models that have been enhanced. Ndlovu et al., (2003) discuss concerns of community tourism project ownership and management, whereas Zapata et al. (2011), Häusler and Strasdas (2003) all provide community tourism models based on the level and intensity of community members' participation in community tourism initiatives. Giampiccoli & Mtapuri (2021) suggest four tourist concepts for Vietnam, with Hanoi as the focus. The models include community-owned CBT, CBT personally owned, luxury downtown area, and 'Albergo Diffuso' (scattered hotels).

However, due to their popularity and relevance to the contemporary conditions and context of Vietnam, models 1 and 2 continue to be the most popular models in consideration of selection. Mtapuri and Giampiccoli (2013) claim that this is a single, community-owned structure, such as a community guesthouse and many micro and small companies organized under the direction of a company, when comparing models 1 and 2. (Mtapuri and Giampiccoli 2013). Although Model 1 is more effective at a community level, Mtapuri and Giampiccoli (2013) argue that Tourism Model 2 is more beneficial in terms of increasing the income level of individuals directly involved in CBT, particularly in areas such as accommodation, food (meal service), or tourism activities, cultural experiences, or local production.

Furthermore, the proposed CBT study approach must be considered in the context of trauma. Market shocks, cultural risks, seasonal influences, and regulatory policy risks are all factors that affect vulnerability situations (DFID, 2002). The global impact of the Covid 19 outbreak is a noteworthy example related to the vulnerability setting that may be mentioned.

Furthermore, tourism in Vietnam is undergoing a rapid and significant digital transition. Many digital transformation projects involving the government, local governments, and enterprises are underway to aid the promotion process, give additional conveniences, and create new products. Because the situation with the Covid-19 outbreak is still problematic around the world, digital transformation is one of the most important strategies for changing the tourism industry's model and operations in order to adapt and achieve sustainable development. A novel finding in the general model is the examination of the effectiveness of digital transformation in community-based tourism in Vietnam.

The author presents a research model suitable for the conditions in Vietnam, based on Oliver Mtapuri & Andrea Giampiccoli's (2014) research model on community tourism.

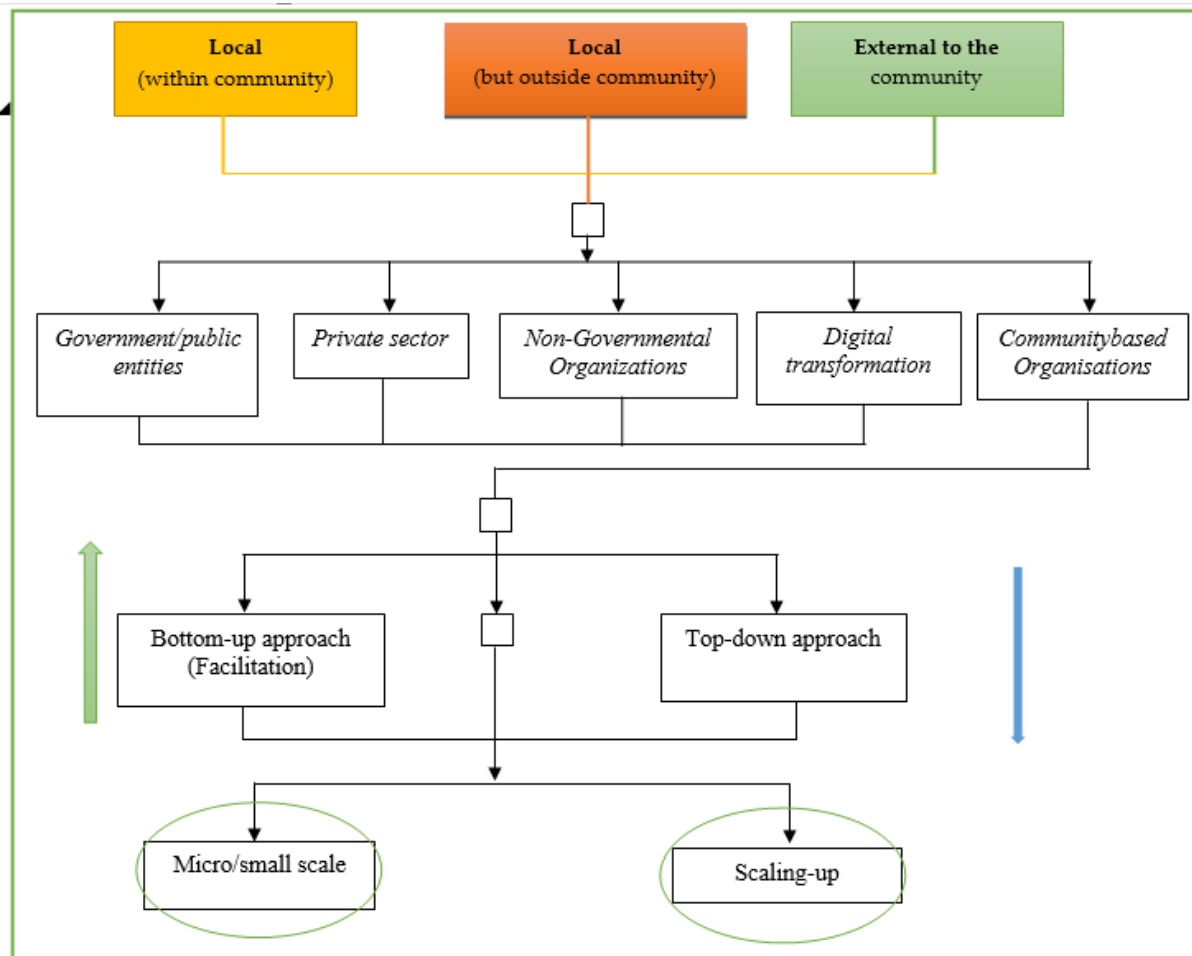


Figure 1. Proposed model to study Vietnamese community-based tourism
(Source: compiled from the author's research)

3.4. Developing community-based tourism in Vietnam at a glance

Until date, Vietnam has established itself as a desirable tourist destination for international visitors, having been recognized with major regional and worldwide prizes by major international organizations and the press. According to statistics from Vietnam's tourism agencies, the number of domestic tourists increased 85 times from 1 million in 1990 to 85 million in 2019. Along with the development of the country in the opening period, with international integration, Vietnamese people's lives are increasingly improved, the demand and ability to travel is increasing, contributing to improving the spiritual life and promoting economic activities in the country. Regarding international tourists, if in 1990 there were only 250,000 international arrivals to Vietnam, then only 5 years later it has increased more than 4 times, reaching over 1.3 million; reached the milestone of 5 million visits in 2010 and more than 18 million turns in 2019 – an increase of 72 times compared to 1990. The annual growth rate usually reaches double digits, especially in the period 2015-2019 reaching 22.7 % per year - ranked among the highest in the world by the World Tourism Organization. The CBT model is quickly evolving in line with the overall tourism industry development trend. Vietnam has benefited from community-based tourism in terms of exploitation, introduction, and preservation of its distinct natural and cultural characteristics. The traditional culture, living habits, and daily lives of ethnic minorities have become an enticing aspect for international tourists to explore and experience thanks to community-based tourism.

CBT has been present in various Vietnamese provinces and cities since 1997, including Hoa Binh, Lao Cai, and Quang Nam... Community tourism Dong has now grown to all three regions of Vietnam after more than 20 years of development. In particular, as the number of international tourists participating in community-based tourism has increased dramatically around the world, community-based tourism activities have become more exciting and appealing in many places, including Son La, Dien Bien, Lai Chau, Cao Bang, Bac Kan, Yen Bai, Thai Nguyen, Lang Son, Ha Giang, Nam Dinh, Ninh Binh, Nghe An, Quang Ninh, Thua Thien Hue, Dong Thap, Tien Giang, Ben Tre, Vinh Long, Can Tho, Hau Giang, An Giang, Lam Dong, Dak Lak, Kon Tum, Binh Dinh, Phu Yen, Khanh Hoa,... and even major cities like Hanoi, Da Nang, and Hai Phong. Indeed, community-based tourism provides numerous economic and social benefits to local residents by establishing jobs and increasing wages. Indeed, community-based tourism provides numerous economic and social benefits to local residents by establishing jobs and increasing wages.

According to the Vietnam National Administration of Tourism's (VNAT) 2020 report, there are approximately 300 villages throughout the country with community tourism activities; there are more than 5,000 homestays with a capacity of nearly 100,000 guests, of which more than 2,000 have been designated as standard. However, because localities have not paid attention, tourism has failed to connect the community and retain cultural identity, and infrastructure is poor and poor, hygienic conditions, unsafe environment, unfair competition...the practical implementation of CBT in Vietnam continues to encounter numerous challenges.

3.5 Current status of community-based tourism in Thua Thien Hue's mountainous regions and the lessons

3.5.1 Model of community-based tourism in "new rural" areas in mountainous areas

In comparison to prior locations, Thua Thien Hue's community-based tourism strategy takes a different path. If single houses and individuals drive community-based tourism in Quang Binh, a new model rural residential area has emerged in this province. The idea of turning new rural villages into tourism goods was proposed by the leaders of Thua Thien Hue province and is currently being implemented based on the achievements acquired in the process of developing a model new rural residential area, a model garden.

The households renovated and refurbished the house premises, home gardens, and fully supplied necessary products to satisfy the personal needs of visitors at the end of 2017, after being selected as a destination to welcome tourists to visit, rest, and enjoy village life. Tourists can relax in attractive, airy, clean, and completely furnished rooms provided by the houses. Following a review of the village's requirements and capacities, a core group of families were chosen as tourist accommodations.

3.5.2. The results of community tourism models

However, in mountainous regions of Thua Thien Hue, community-based tourism operations did not produce the intended results for both the government and the locals involved. Households became regular tourist attractions during the initial year of implementation, but the number of tourists has steadily decreased over time, with no tourists recorded in 2019. When the manager examined the situation more attentively, he noticed that the number of people staying was quite limited. Realizing that providing community tourist services is ineffective, participating households progressively departed to work elsewhere, and activities such as homestays, art performances, and so on were eventually closed.

People believe that the difficulty of attracting tourists to stay is due to the monotony of local manufacturing industries, thus most present homestays only fulfill demand as a stopover; nevertheless, the desire to explore and experience the productive life of working people is nearly difficult to meet. Furthermore, there is no relationship with travel companies to create

tours of the area. They are not regular and unprofessional when it comes to cultural and creative products for tourists. According to the findings of Key Informer Interviews (KII), Folklore, the commune folk art team is currently active in the form of movements and activities. Members are drawn together mostly by a shared enthusiasm; the community does not provide any special treatment to members. As a result, having a commitment and professionalism in performing and serving tourists is extremely tough.

“This is also a typical challenge of localities in promoting community-based tourism in the countryside,” said by other KII. As in mountainous areas in Thua Thien Hue province, there is currently no truly systematic community tourism business model; everything is extremely new, and everyone is learning as they go. The community's financial assistance is still limited, serving merely as a source of encouragement rather than motivation.

There is no close coordination between relevant departments, regional linkages, or cooperation in tourism development at home and abroad. Tourism promotion with propaganda programs is still in its infancy, limiting itself to providing information, introducing, and promoting the local tourism potential, specific to each product. The province's tourism marketing initiatives lack a distinct market orientation, particularly for the foreign tourist industry, due to a lack of investment work for marketing initiatives. At the same time, there is still a lack of understanding of the role and value of tourism promotion, advertising, and propaganda at all levels of management and businesses.

4. Discussions

Many lessons may be learnt from the implementation of CBT in Thua Thien Hue's mountainous regions for local authorities and persons involved in the organization of CBT.

To begin, this province is a community with the potential to build community-based tourism by leveraging natural tourism characteristics. According to the findings of the interviews and field observations, tourism resources in the community serve a purpose for CBT because they are located in the community and attract tourists all year. According to (Tamir et al.), the locational advantages of a region being close to a popular tourist destination are presented as an opportunity for CBT development. It may be convenient for tourists to visit multiple destinations and CBT sites at the same time. However, Ha Tinh must first identify genuine resources and design a specific plan to build community-based tourism in the appropriate location. To exploit and promote tourism, the community must do a good job of planning; design thorough plans of community tourist attractions to conserve house architecture, customs, cultural identity, and traditional occupations of indigenous people.

Second, the most visible feature in Thua Thien Hue's community-based tourism is that individuals rush to create homestays and eco-tourism gardens without a clear direction or development strategy, despite the fact that the products and services are identical. It's difficult to attract clients when everything looks the same. In agro-rural tourism, a destination recession in a relatively short period of time is a worrying issue that must be addressed. CBT projects are frequently plagued by a lack of financial sustainability. It is primarily due to a lack of business expertise, knowledge among members (Kontogeorgopoulos et al.), and market access. The goal of developing a larger economy is the first major concern when CBT is developed based on community assets. Marketing notable community products and introducing special offers may become a priority, but what tourists will buy may be overlooked. In this sense, products should be designed with market demand in mind. Findings from interviews and field observations indicated the need for superior products owned locally by the community as a solution to financial sustainability. According to Häusler (2005), communities should conduct a market analysis to identify their strengths and weaknesses and then identify business opportunities. Furthermore, products should be developed through collaboration in which they can assist in

providing necessary skills and market access (Dodds and Ali, 2018), and marketing strategies can be more successful if a communication plan is built based on tourist motivation and involvement (Priporas et al., 2018).

Third, the local government has not prioritized the development of tourism infrastructure and human resources in the tourism industry... As a result, these districts must establish and implement preferential policies for infrastructure and facility investment. Create a method for households in potential tourism development sites to participate in tourism service operations (public restrooms, parking lots, minimum equipment for guests). To have resources to support infrastructure, occupational skills training, and community-based tourist development, it is vital to combine capital-funded programs such as new rural programs, poverty reduction support programs, and non-governmental projects. Furthermore, people's awareness is still low, and many are unwilling to participate in community-based tourism. Local governments must invest in training and human resource development. To improve service and communication quality, business households must actively participate in training classes, fostering professional knowledge, skills, communication skills, and foreign languages; raising community awareness about preserving national cultural identity, and protecting environmental resources for tourism development.

Fourth, Interviews and field observations revealed a distinct lack of local involvement. Notably, the project on community-based tourism is launched from the level of local government, limiting the ability of the community to participate in the decision-making process of the CBT project. Group solidarity is essential in developing tourism communities where group cohesion is required to gain decision-making advantages and tourism integration (Mitchell and Eagles, 2001). As a result, management decisions must be made in close collaboration with community members, who have a better understanding of the situation and will benefit from management decisions administration (Thaman et al., 2016). It has been suggested that because tourism management sometimes necessitates quick decisions (Murphy, 1985), it is difficult to ensure that all voices are heard in the process. the decision-making procedure (Nault and Stapleton, 2011). However, in order to achieve maximum project efficiency, it is necessary to fully consult with all project participants.

5. Conclusions and recommendations

5.1. Conclusions

Community based tourism is a reasonably sustainable tourism strategy based on the benefits of proximity and pleasant attachment to the human living environment, which includes both the natural and social environments. As a result, CBT not only aids in the achievement of the tourism industry's overall purpose, but also directly aids in the long-term growth of Vietnam and the rest of the world. More importantly, by shifting their livelihoods from agriculture to tourism services, CBT has helped local people steadily improve their living conditions and alleviate poverty. Research on community engagement in tourism activities in the direction of sustainable tourism, with the goal of forming a community of action that will participate more actively in tourism activities.

Although community-based tourism has had positive results in Vietnam, due to small-scale activities, spontaneity, a lack of professionalism, lack of systematic investment, and a lack of specific support mechanisms from management agencies, community-based tourism is unlikely to grow. People who work in community-based tourism still rely on travel businesses and guides for their income.

The lack of competence in arranging and inadequate foreign language ability to convey the information of local attractions to tourists is the most concerning and hindering factor for

local populations wanting to participate in tourism. Furthermore, local community participation in decision-making and planning tourism activities is still passive and formal. Despite being the subject of community-based tourism, the majority of locals are only temporary workers when travel agencies bring visitors, only engaged in some simple jobs such as boating, serving meals, porters, etc., while the main tasks such as guiding tourists to visit, creating menus with specific regional characteristics, or designing sightseeing programs are under the responsibility of travel agencies.

5.2. Recommendations

For the community

The local community must be extremely concerned about assuring the quality of tourism items for tourists. The kind approach, considerate greeting, and understanding of the natural and human surroundings contribute to visitors' positive feelings. The correct and intelligible presentation of information is effective in the process of communication between visitors and the community. As a result, while implementing activities to welcome international tourists, the language barrier must be overcome via the efforts of the people themselves. Local communities must be acutely conscious of conserving, conserving, and implementing cultural habits in daily life, not a cultural performance, in order to generate true cultural values. Furthermore, it is required to modernize and repair the conditions of facilities in order to provide the bare minimum of daily living conditions for guests, while avoiding total renewal, which would jeopardize traditional resources.

For the agents of tourism

Travel agencies serve as a link between visitors and the community. As a result, travel businesses must increase their promotion in order to attract community-based travelers. The promotional information, on the other hand, must be clear and truthful in order to avoid excessive marketing abuse that leaves visitors unsatisfied when they access products that are not true to what is advertised. At the same time, travel enterprises must provide possibilities for local communities to profit from current conditions.

For the government

The government is critical in assisting the local community and tour operators in completing and implementing tourist projects. Furthermore, the government must aggressively strengthen relationships between CBT actors, link supply services to produce tourism products, and link destinations and markets.

At the macro level, authorities at all levels must continue to develop and organize the implementation of legal documents, policies, and regulations on management of CBT activities, from the National Administration of Tourism to provinces and cities with CBT development and development capacity, with a focus on promoting community-based tourism to domestic and international tourists, and strengthening CBT development and development capability.

At the micro-level, authorities must coordinate in measuring and accurately analyzing communities' capacity to categorize and identify quality on a regular and fair basis using an appropriate set of criteria. On the other hand, it is necessary to assist participants in developing CBT in accordance with the model of one community, one product in order to avoid duplication of CBT products and, at the same time, to assist in diversifying types of CBT products.

Finally, in order to attract investment funding for CBT development, the government must actively integrate and collaborate worldwide. However, CBT investor selection must take into account the natural environment, cultural identity, and community in the investment region; avoid fragmented investment, snatching, and profit-driven investment.

Because the study was designed to lay the groundwork for CBT in Vietnam, it did not approach the model with realistic settings for analysis. Later applied studies will conduct a more in-depth investigation of application models.

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The Relationship of Airline Service Quality, Brand Image, Loyalty Program Perceived Value, and Customer Loyalty: A Case Study of an International Airline in Cameroon

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Abstract

Customer loyalty is the goal that airline strive to achieve. Airline service quality and brand image are likely to be critical factors boosting customer loyalty. Nonetheless, loyalty program perceived value is also expected to enhance customer loyalty. This study objectives are 1.) to evaluate the impacts of airline service quality, brand image, and loyalty program perceived value on customer loyalty, 2.) to evaluate the impacts of airline service quality on brand image. This study used a quantitative approach with a self-administered questionnaire on 271 passengers who had experiences with the selected international airline in Cameroon. Regression analysis showed that airline service quality and brand image have positive impact on customer loyalty while loyalty program perceived value does not have significant impact on customer loyalty. This study also found that airline service quality is statistically significantly impacted on brand image. The study found that airline service quality has a greater impact on customer loyalty than brand image. Hence, improving service quality with streamlining operations would improves the customer experience and increase customer loyalty.

Keywords: Airline Service Quality, Brand Image, Loyalty program perceived Value, Customer Loyalty

Introduction

The aviation industry in Cameroon, much like in many other African countries, has experienced both challenges and opportunities due to factors such as economic conditions, infrastructure limitations, regulatory frameworks, and global trends (Tolcha et al., 2023). Cameroon's strategic location in Central Africa makes it a potential hub for regional air travel, connecting neighboring countries and contributing to economic growth. The country boasts rich cultural and natural diversity, making it a potential destination for tourism. Developing air travel infrastructure can boost tourism revenue (Manjong et al., 2021). Cameroon's aviation sector has expanded dramatically because of favorable weather conditions and increased low-cost flight alternatives, which encourage air travel and position low-cost airlines for key positions in global transportation by increasing competitiveness and consumer loyalty (Samunderu, 2023). Between 2010 and 2022, Cameroon's aviation industry saw steady growth in passenger traffic due to economic expansion, a rising middle class, and enhanced airport infrastructure, particularly at Douala and Yaoundé airports. However, despite Camair-Co's role in expanding connectivity, the industry faced challenges like financial constraints, regulatory

issues, and impacts from the COVID-19 pandemic, prompting government initiatives for sectoral reform and private investment to bolster resilience (Tolcha et al., 2023).

Service quality in airlines is critical because it connects customer expectations with actual experiences, influencing loyalty, competitive positioning, and profitability; Parasuraman, Zeithaml, and Berry's SERVQUAL framework, which includes dimensions such as tangibility, reliability, responsiveness, assurance, and empathy, remains a useful tool for evaluating this (Daskalaki et al., 2020). Brand image is critical in the aviation industry for fostering customer trust, satisfaction, and loyalty because it shapes public perception, influences customer experiences, and increases competitiveness, with strategic branding playing an important role in maintaining a positive reputation and ensuring customer satisfaction (Hendrawan & Agustini, 2021).

Customer loyalty is critical for airlines to remain competitive, increase profitability, and achieve long-term stability, with loyalty programs playing an important role in customer retention and lowering the cost of gaining new ones (Lakshman & Faiz, 2021). Loyalty programs' perceived value has grown critical in the aviation sector, progressing from basic point systems to comprehensive schemes that improve customer satisfaction, reduce switching, and secure long-term profitability by encouraging repeat business and brand loyalty (Agarwal & Gowda, 2021).

Although previous study has investigated the impact of service quality and customer orientation, little has been done to precisely investigate how airline service quality, brand image, and loyalty program perceived value influence customer loyalty as well as the impact of airline service quality on brand image.

1. Research Objectives

- 1.1 To evaluate the impacts of airline service quality on customer loyalty.
- 1.2 To evaluate the impacts of brand image on customer loyalty.
- 1.3 To evaluate the impacts of loyalty program perceived value on customer loyalty.
- 1.4 To evaluate the impacts of airline service quality on brand image.

2. Review of Related Literatures

Service Quality Concept

Service quality in the airline industry is a multi-dimensional concept focused on meeting or exceeding customer expectations to gain a competitive edge, with influential models like SERVQUAL and AIRQUAL being widely used to measure its components (Medberg & Grönroos, 2020). The SERVQUAL model evaluates service quality through dimensions such as tangibility, reliability, responsiveness, assurance, and empathy, although it has faced critiques for its applicability and adaptability across different industries (Masumbuko, 2021; Wu et al., 2020). Alternative approaches, like the AIRQUAL scale, have emerged to address these limitations by including more tailored dimensions like in-flight services, employee behavior, and branding, all aimed at enhancing customer satisfaction and loyalty in the airline sector (Setiawan et al., 2020).

Brand Image Concept

The brand image of an airline is a critical, intangible asset that influences customer loyalty and competitive advantage, built through a deliberate combination of quality, service, and brand positioning efforts (Triatmanto et al., 2021). Signaling theory plays an important role in this process, enabling airlines to strategically communicate their strengths, thereby reducing information asymmetry and fostering customer trust (Nyagadza et al., 2021). The brand image, shaped by cognitive, sensory, and emotional elements, establishes the airline's credibility, making it challenging for competitors to replicate, while also allowing the airline

to effectively manage consumer perceptions and maintain a loyal customer base (Jahanvi & Sharma, 2021).

Customer Loyalty Concept

Customer loyalty has become a crucial area of research in the airline industry due to its significant influence on marketing strategies, sales, and profitability (Joshi and Dowpiset, 2021). It is defined by customers who consistently choose a specific airline, promote its services positively, and maintain favorable attitudes, with loyalty manifesting through both behavioral and attitudinal dimensions (Jiddi, 2021). The psychological (attitudinal) perspective focuses on the customer's commitment to the airline despite competitive offers, while the behavioral perspective emphasizes repeated purchases and the duration of customer relationships, highlighting the need for airlines to understand and manage these dimensions to retain loyal customers effectively (Shammout, 2020).

Perceived Value Concept

Customer loyalty programs perceived value have become essential for airlines, offering competitive advantages and fostering long-term relationships with travelers amid ongoing industry changes (Law et al., 2022). The perceived value of these programs significantly influences customer engagement and loyalty, as it encompasses aspects such as reward relevance, ease of attainment, and emotional connection (Koo, Yu & Han, 2020). By aligning rewards with customer preferences and ensuring transparency, airlines can enhance the perceived value of their loyalty programs, leading to improved customer satisfaction and sustained profitability (Chen et al., 2021).

Hypotheses development

Chen et al. (2023) explored the effects of AI chatbot service quality on customer loyalty, identifying nine key quality attributes. Based on data from 459 respondents, they found that chatbot quality enhances loyalty by boosting perceived value, trust, and satisfaction. High chatbot reliability, responsiveness, assurance, empathy, and tangibility foster emotional attachment and brand loyalty. Meanwhile, Venkatakrishnan et al. (2023) studied e-service quality's influence on satisfaction and loyalty, focusing on the moderating roles of web design and trust. Their findings suggest that high-quality e-services drive loyalty, especially when customers perceive strong value for the price. Therefore, this study proposed that

Hypothesis 1: Airline service quality has significant relationship with customer loyalty

Ab-Hamid et al. (2023) explored factors shaping corporate brand image and customer loyalty in Malaysia's Islamic banking sector, examining functional, emotional, and spiritual brand attributes. Analyzing survey data from 281 Islamic banking customers via Partial Least Squares-Structural Equation Modeling, they found that brand attributes significantly influence corporate brand image, promoting loyalty. Emotionally connected customers tend to make repeat purchases and are less inclined to switch. Similarly, Setyorini et al. (2023) showed that brand image and customer relationships drive loyalty among Al-Ulum Primary School parents, highlighting trust as a key loyalty factor. Therefore, this study proposed that

Hypothesis 2: Brand image has significant relationship with customer loyalty

Loyalty programs are crucial for customer retention, with perceived value driving loyalty (Mainardes & de-Freitas, 2023). Kolte et al. (2023) found that loyalty program benefits, such as discounts and exclusive offers, significantly impact store patronage and loyalty behavior. Their study, using convenience sampling and survey analysis via SmartPLS, confirmed that customers value both monetary and non-monetary rewards, boosting retention. Similarly, Pappachan (2023) examined the effects of airline service quality (ASQ), loyalty programs, and perceived value on loyalty and word-of-mouth (WOM) among 554 passengers. ASQ was found to impact WOM, particularly for domestic travelers, with perceived value strongly influencing loyalty across all customers. Therefore, this study proposed that

Hypothesis 3: Perceived value has significant relationship with customer loyalty.

Rachmad et al. (2023) explored how service quality and marketing strategies influence brand image, gathering data from 100 Jakarta residents with repeat purchases from Geprek Bensu. Path analysis showed that high service quality enhances brand image, which in turn affects buying decisions. Consistent, reliable service fosters a positive brand perception. Similarly, Tirtayasa et al. (2024) studied 384 Shopee users and found that e-service quality positively impacts brand image, with e-satisfaction mediating this effect. This research highlights that strong service quality significantly boosts brand image and customer loyalty. Therefore, this study proposed that

Hypothesis 4: Airline service quality has significant relationship with brand image.

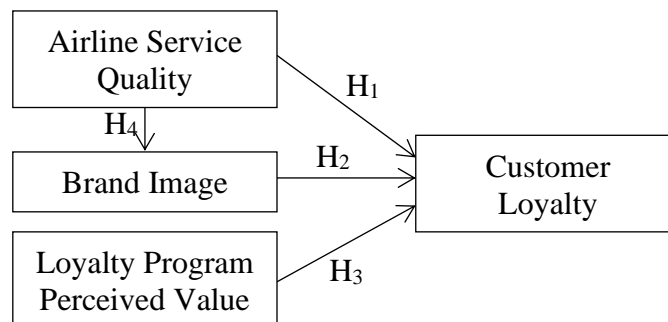


Figure 1 Research Model

Research Methodology

1. The Research Procedure

1.1 To study the impact of airline service quality, brand image, and loyalty program perceived value on customer loyalty as well as the impact of airline service quality on brand image.

1.2 To analyze the data obtained from the 1 step through hypotheses testing with regression analysis

1.3 To design the research using the quantitative approach employing self-administered questionnaire.

1.4 To develop the research instrument from the previous literature. The measurement items are in 5-point Likert scale.

1.5 To collect the data, a total of 1,000 questionnaires were randomly distributed to passengers of a selected airline in Cameroon.

2. Research Instrument

The current study employed self-administered questionnaire for data collection. The measurement items for airline service quality, brand image, loyalty program perceived value, and customer loyalty were on a five-point Likert scale (1 for Strongly Disagree and 5 for Strongly Agree).

2.1 Airline service quality: It contains 22 items adopted from Randheer et al. (2011), It was measured in five dimensions: Reliability (5 items), Responsiveness (4 items), Tangibles (4 items), Assurance (4 items), and Empathy (5 items), For example, "When you have a problem, XXX flight staffs shows a sincere interest in solving it."

2.2 Brand image: It contains 21 items adopted from Russell et al. (2015). It was measured in three dimensions: Mystery (6 items), Sensuality (6 items), and Intimacy (9

items), For example, "This XXX flight comes to mind immediately when I want to purchase any Airline Services."

2.3 Loyalty program perceived Value: It contains 4 items adopted from Yi and Jeon (2003). For example, "The proposed rewards by XXX flight have high cash value."

2.4 Customer loyalty: It contains 4 items adopted from Chaudhuri and Holbrook (2001). It was measured in two dimensions: Purchase loyalty (2 items) and Attitudinal loyalty (2 items), For example, "I will buy from the XXX flight the next time I wish to buy an airline ticket."

2.5 Validity and Reliability Test

The study found that the loading value of measurement items of all constructs is above 0.5 confirming validity (Nunnally & Bernstein, 1994). In addition, the composite reliability (CR) and Cronbach's alpha of variables exceeded 0.7, showing internal consistency for reliability.

3. Target Group / Populations and Samples

3.1 Populations were passengers of a selected world-class airline in Cameroon. The population number is unknown.

3.2 Samples were 271 Nigerian respondents over the age of 20 who had experience with the airline's services. The study utilized a non-probability sampling method.

4. Statistics for Data Analysis The statistics used for analyzing data were mean, percentage, standard deviation, and t-test (Dependent Sample).

Research Results

The study collected the data from 271 respondents. As shown in table 1, of those, 58% are female and 42% are male. Most of them are in the age of 26 – 40 years old.

Table 1 Respondent information

		Freq.	%			Freq.	%
Gender	Female	156	58	Occupati on	Student	67	25
	Male	115	42		Employed part time	60	22
Age	26-30 years old	98	36		Business owner	51	19
	31-40 years old	87	32		Retired	49	18
	41-50 years old	44	16		employed full time	28	10
	18-25 years old	42	16		others	16	6
	79,001-99,000CFA	77	28	Education	Graduate	90	33
Monthl y income	30,001-59,000CFA	57	21		Postgraduate	70	26
	59,001-79,000CFA	54	20		Undergraduate	57	21
	99,001CFA and	48	18		Beyond post	40	15
	Under 30,000CFA	35	13		Less than undergrad	14	5

This study employs linear regression to test all four hypotheses in 2 models. Model 1 of this study tested hypothesis 1, hypothesis 2, and hypothesis 3 and found a multiple regression model confirmed that service quality ($\beta = 0.738$) and brand image ($\beta = 0.416$) statistically significant impact on customer loyalty while perceived value ($\beta = -0.019$) is not statistically significant impact on customer loyalty at a 95% confidence level as a p-value of the model is

less than .05 ($F(3,267) = 330.433$, $p\text{-value} = 0.000$). Therefore, hypothesis 1 and hypothesis 2 were supported, while hypothesis 3 is not supported.

The regression analysis of Model 2 of the current study tested hypothesis 4 and indicated that service quality ($\beta = 1.028$) statistically significant impact on brand image at a 95% confidence level as a $p\text{-value}$ of the model is less than .05 ($F(1,269) = 4687.903$, $p\text{-value} = 0.000$). Therefore, hypothesis 4 was supported.

Table 2 Hypotheses Testing

Variable	Model 1		Model 2	
	B	β	B	β
Service Quality	.738*	.559	1.028*	.972
Brand Image	.416*	.333		
Perceived Value	-.019	-.018		
R ²	.788		.946	
Adj. R ²	.785		.946	
F	(3,267)		(1,297)	
	330.433***		4687.903***	
P	.000		.000	

Note: * $p < .05$. ** $p < .01$ *** $p < .001$

a. Model 1 Dependent Variable: Customer Loyalty

b. Model 2 Dependent Variable: Brand Image

Discussion and conclusion

Only three of the four hypotheses of the current study are confirmed. The study found that hypothesis 1 is supported where service quality significantly impacts on customer loyalty ($\beta = 0.738$) with 95% confidence level with a $p\text{-value}$ less than 0.05. The analysis reveals a positive significant impact of service quality on customer loyalty, supported by Octaviani et al. (2023) observed that Lion Air passengers prioritize high-quality service in handling failures over the occurrence of failures themselves, linking satisfaction to loyalty and positive word-of-mouth. Chao et al. (2023) showed that, in ocean freight forwarding, small business customers prioritize professionalism and damage claim handling, while large customers focus on punctuality. Personalized, empathetic service fosters strong customer loyalty by creating an emotional bond.

The study found that hypothesis 2 is supported where brand image significantly impacts on customer loyalty ($\beta = 0.416$) with 95% confidence level with a $p\text{-value}$ less than 0.05. Setyorini et al. (2023) supported that brand image and customer relationships significantly impact customer loyalty, with satisfaction as a mediator. A positive brand image builds trust, making customers more loyal by reinforcing confidence in the brand's quality and reliability. Similarly, Mulyono and Pasaribu (2021) demonstrated that mobile service quality and brand image positively affect customer loyalty through satisfaction. When customers align with a brand's values, they feel a connection that strengthens loyalty, as seen in customers committed to brands reflecting personal values, like environmental responsibility.

The study found that hypothesis 3 is not supported where perceived value not significantly negatively impacts on customer loyalty ($\beta = -0.019$) with 95% confidence level with a $p\text{-value}$ higher than 0.05. This finding is contrast with Paulose & Shakeel (2022) that study in India's hotel industry and found that perceived value and service experience significantly boost guest satisfaction and loyalty, especially during COVID-19, with satisfaction mediating this effect. This is aligned with Bilal and Achmad (2023) that suggested

for Cold'N Brew coffee consumers indicated that service quality, brand trust, and perceived quality increase loyalty, with satisfaction mediating the effect of service quality and perceived quality. High perceived value strengthens satisfaction, which is essential for loyalty. However, Umboh et al (2024) found that perceived value is not significantly influence on customer loyalty among ESSE cigarettes brand users in Manado. Similarly, Maghembe and Magasi (2024) asserted that customer perceived value nor brand trust significantly correlated with customer loyalty in their study of the three-star hotels in Dodoma City, Tanzania.

The study found that hypothesis 4 is supported where brand image significantly impacts on service quality ($\beta = 1.028$) with 95% confidence level with a p-value less than 0.05. Lin et al. (2021) supported that a social enterprise's social mission enhances service quality and brand image, fostering consumer concern and support. High service quality creates a positive brand perception by providing reliable and attentive service. Similarly, Chatchawnchanchanakij & Arpornpisal (2024) showed that digital marketing and service quality positively impact the brand image of processed agricultural products in Thailand. Consistent, high-quality service builds brand trust and credibility, encouraging favorable word-of-mouth, which strengthens the brand's reputation and public image.

This study finds that service quality ($\beta = .559$) has a stronger effect on customer loyalty than brand image ($\beta = .333$). This is consistent with Chen et al (2017) that confirmed that a tourist's perceived service quality boosts the airlines brand image through the perceived value in which induce customer loyalty. Wang, X. (2023) also studied on airline enterprises and found that service quality ($\beta = .45$) has stronger impact on customer loyalty than brand image ($\beta = .38$).

Managerial implication

This study finds that service quality has a stronger influence on customer loyalty than brand image. Therefore, to enhance loyalty, the airline should focus on advanced customer service training for frontline staff, emphasizing empathy, communication, and cultural sensitivity. Improving the website, mobile app, and timely service also enhances perceived value. Efficient boarding, baggage handling, comfortable seating, and personalized in-flight amenities boost satisfaction. The airline should also use real-time updates, post-flight surveys, and robust service recovery mechanisms to address issues and demonstrate customer care effectively. International airlines should enhance their quick service by streamlining operations, reducing wait times, and improving staff coordination. Multiple feedback channels, like suggestion boxes, online surveys, and social media, should be provided. Regularly reviewing customer feedback and promptly addressing concerns will help identify improvement areas and elevate overall service quality.

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The Impact of Airline Service Quality and Sustainability Reputation on Customer Satisfaction and Customer Loyalty: A Case Study of a World-Class Airline in Nigeria

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Abstract

Aviation industry intensively emphasis on the sustainability solutions to improve the business. This study focuses on the impact of airline service quality and sustainability reputation on customer satisfaction and on customer loyalty of a world-class airline in Nigeria. The study objectives are to explore impacts of airline service quality on customer satisfaction and on customer loyalty as well as the impact of customer satisfaction on customer loyalty, to analyze the effect of sustainability reputation on customer satisfaction, and customer loyalty. This study used a quantitative approach with a self-administered questionnaire on 321 customers who had experiences with the selected world-class airline in Nigeria. The data was analyzed using regression analysis. The hypotheses showed that airline service quality and sustainability reputation have positive statistically significant impact on customer satisfaction and on customer loyalty. In addition, customer satisfaction has positive impact on customer loyalty. This study also found that sustainability reputation has stronger impact on customer satisfaction and on customer loyalty than airline service quality. Therefore, the airline should also improve sustainability by conducting annual environmental audits and increasing renewable energy use. Additional steps could involve transitioning to Sustainable Aviation Fuel, using electric ground vehicles, and powering facilities with renewable energy. Still, the airline should continue to enhance airline service quality by improving airline cleanliness and onboard amenities, eco-friendly toiletries, ergonomic seating, and high-quality materials for passenger comfort. These measures not only strengthen service quality and environmental responsibility but also build trust and loyalty among passengers.

Keywords: Airline Service Quality, Sustainability Reputation, Customer Satisfaction, Customer Loyalty

Introduction

The service delivery industry, particularly in sectors like airlines, faces challenges in sustaining high customer loyalty by delivering excellent service. Service quality is key to achieving competitive advantage, as it directly influences customer satisfaction, loyalty, and positive behavioral outcomes like retention and advocacy (Setiawan, 2020; Kossmann, 2006). Although much research has explored service quality determinants, studies covering a comprehensive range across industries remain limited, leaving questions about how well current services meet diverse customer needs (Marhamat, Zali & Rezvani, 2018). The airline sector, for instance, has made strides by focusing on customer and employee engagement,

providing training in technical and interpersonal skills essential for quality support. Despite positive feedback, companies like a world-class airline still find areas for improvement in enhancing customer loyalty through service quality. This study aims to analyze how airline service quality and sustainability reputation influence customer satisfaction, underscoring their critical role in today's competitive business landscape.

The airline industry is vital to global economic growth, facilitating the rapid transport of people and goods worldwide. Airlines are increasingly focusing on customer satisfaction and loyalty through branding, personalized services, and competitive strategies, with service quality playing a crucial role in shaping reputation and retention. The world-class airline exemplifies this commitment, growing from a regional airline to a globally recognized brand known for exceptional service. However, it faces strong international competition and must innovate to maintain its position. In Nigeria, deregulation has boosted industry growth, yet limited research exists on how service quality affects loyalty. This study uses the SERVQUAL model to assess a world-class airline's service quality and customer loyalty in Nigeria, aiming to guide future improvements.

Airline service quality is crucial in the airline industry, where customer satisfaction hinges on seamless experiences across processes like check-in, baggage handling, and interactions with frontline staff (Guernsey et al., 2017; Grönroos, 2001). Since airlines offer intangible services rather than products, customers assess quality based on how experiences align with their expectations. Recognizing service gaps, such as the disparity between management's perception and travelers' actual expectations, is essential for improving service quality (Gourdin & Kloppenborg, 1991). Meeting customer expectations is key in this competitive environment, as positive service quality strengthens customer loyalty and an airline's competitive edge (Park, Robertson & Wu, 2004). Factors like flight schedules, ticket prices, onboard amenities, and staff attitudes significantly shape passengers' perceptions and influence their airline choices (Cunningham et al., 2002).

The airline industry wields significant economic influence, especially in tourism and aircraft manufacturing, yet faces scrutiny for its environmental impact and challenges in balancing sustainability with profitability (McManners, 2016). Cost-effective strategies that minimize environmental harm are crucial for financial stability (Forsyth, 2011). Corporate Social Responsibility (CSR) and a strong reputation play key roles in building customer loyalty and market share, as modern consumers prioritize ethical practices and may pay more for socially responsible companies (Sarnacchiaro et al., 2018). However, unethical actions can quickly erode trust, emphasizing the need for transparent and responsible practices (Green & Peloza, 2014).

Customer satisfaction is crucial in the airline industry, as meeting and surpassing customer expectations fosters loyalty and profitability. High-quality service and effectiveness help airlines stay competitive, with satisfied customers more willing to pay premium prices and remain loyal, benefiting airlines through positive word-of-mouth and repeat business (Haryono et al., 2020). Loyalty, influenced by service quality and reliability, is reinforced by effective loyalty programs and consistent service, making it essential for long-term success. Regular assessments of service quality and strategic adjustments are vital for sustaining customer loyalty and securing a competitive edge in the industry (Hayati et al., 2020).

1. Research Objectives

1.1 To explore impacts of service quality on customer satisfaction and customer loyalty as well as the impact of customer satisfaction on customer loyalty.

1.2 To analyze the effect of sustainability reputation on customer satisfaction, and customer loyalty.

2. Review of Related Literatures

Concept of Sustainability Reputation

Sustainability reputation is now vital to corporate reputation, reflecting a company's commitment to social, environmental, and economic responsibilities within its operations. Through corporate social responsibility (CSR), businesses gain competitive advantages, improve performance, and build customer loyalty (Abratt & Kleyn, 2023). Sustainable practices offer both tangible benefits, like revenue growth, and intangible benefits, such as a stronger reputation and stakeholder trust. Reputation is measured through multi-faceted models that assess product quality, social responsibility, and workplace environment (Lee et al., 2020). As sustainability and CSR continue to gain importance, their impact on reputation and customer perceptions remains a key focus for businesses and researchers alike (Baumgartner et al., 2019).

Concept of Airline Service Quality

Service quality refers to customers' evaluations of their experiences in relation to their expectations, impacting factors like loyalty and financial performance. The SERVQUAL model proposed by Parasuraman et al. (1998) assesses service quality through five dimensions—tangibility, assurance, responsiveness, reliability, and empathy—but has limitations in the airline industry, leading to the creation of the AIRQUAL model Nadiri et al. (2008), which addresses airline-specific factors such as onboard services and terminal conditions. The expectancy disconfirmation theory further explains customer satisfaction by highlighting the gap between pre-consumption expectations and actual performance, which influences feelings of satisfaction or disappointment. Overall, the interplay between service quality, expectations, and customer satisfaction is complex and multifaceted, prompting various theories and models for analysis.

Concept of Customer Satisfaction

Customer satisfaction, represents the overall assessment of a customer's experience with a product or service over time. It refers to a consumer's response to the evaluation of the perceived discrepancy between prior expectations and the actual performance of the product as perceived after its use (Suhartanto and Noor, 2012). It involves feelings of pleasure or disappointment stemming from the comparison of perceived performance against prior expectations. This concept is particularly important in marketing for service-oriented organizations, where achieving customer satisfaction is more complex than in product sales. High service quality enhances satisfaction, which is influenced by perceived value and individual customer relationships. Satisfied customers bolster an organization's reputation and profitability through positive word-of-mouth and loyalty, ultimately reducing marketing costs. In competitive sectors like airlines, customer satisfaction is vital for retaining clients and defending against competitors, linking it closely to the disparity between expectations and actual performance while being shaped by both cognitive and emotional factors.

Concept of Customer Loyalty

Customer loyalty is a key predictor of repurchase behavior, stemming from customer experiences with a service or product provider, including relationships and emotional engagement. Shifting focus from satisfaction to loyalty can improve customer retention and reduce advertising costs. Research shows that loyalty enhances market and financial performance by linking repeat purchases to customer attitudes (Zainuddin et al (2024). Factors influencing loyalty include employee loyalty, service quality, and customer satisfaction, especially in high-contact industries. Loyalty evolves through cognitive (attitude), conative (intention), and behavioral (action) stages, driven by positive experiences (Oliver, 2010). Additionally, trust, commitment, loyalty programs, and product quality further impact customer loyalty.

Hypotheses development

Idros et al (2020) examined web-based services in Malaysia's airline industry, and found that responsiveness, data quality, tangibility, and trust significantly enhance customer loyalty, reinforcing the connection between service quality and customer satisfaction. Meanwhile, Sezgen, et al (2019) highlighted the ambiguous definition of customer experience and its importance in ensuring satisfaction during all interactions with airline brands. A review of data from 18,567 passengers across 15 major airlines showed that traveler satisfaction, reliability, and promotion are vital for improving the customer experience, while crew satisfaction and in-flight services also play key roles in fostering loyalty. Therefore, this study proposed that

Hypothesis 1: Airline service quality has a positively significant effect on customer satisfaction.

The concept of sustainability reputation is viewed as a valuable intangible asset that offers organizations a competitive edge, regarded as a critical strategic resource (Ghosh, 2020). It is increasingly recognized as a driver of organizational performance and has attracted academic interest (Sidek, Mohamad & Wan, 2019). A study by Wikhamn (2019) on Swedish companies found that sustainable HR practices significantly influence the relationship between innovation and customer satisfaction. Companies engaged in sustainable HR practices showed that both innovation and ethical HR practices positively impact customer satisfaction, with their interaction enhancing overall satisfaction. The findings underscore the connection between sustainability reputation, innovation, and customer satisfaction. Therefore, this study proposes

Hypothesis 2: Sustainability reputation has positive impact on customer satisfaction

Satisfaction and loyalty are distinct yet interconnected concepts; satisfaction refers to meeting customer needs, while loyalty signifies a customer's ongoing preference for a service or product (Oliver, 2010). Research by Izogo et al. (2021) indicates that satisfied customers in Nigeria are more likely to become loyal, highlighting the inadequacy of viewing satisfaction and loyalty as entirely independent. Marketing analysts should prioritize understanding satisfaction to grasp loyalty behaviors, as satisfaction significantly influences loyalty (Wahyuni & Ihsanuddin, 2019). While satisfied customers often become loyal, the relationship is complex; satisfied customers may not always remain loyal, and loyal customers may experience dissatisfaction (Kwak et al., 2022). Continuous satisfaction is vital for fostering loyalty, as organizations need to offer attractive services to retain customers. Therefore, this study proposes

Hypothesis 3: Customer satisfaction positively effects on customer loyalty.

Tabrani et al. (2021) argue that a brand's impact on consumer decisions and loyalty is reflected in its service recognition and perceived quality. Service quality as the ease of use aligned with customer needs, emphasizing its role in fulfilling customer requirements and enhancing brand loyalty. Amba et al. (2022) found a positive relationship between perceived service quality and brand loyalty in the railway and airline sectors. Additionally, research by Chiu-Yiong-Lim et al. (2022) indicates that dimensions of service quality, such as reliability and empathy, significantly influence customer loyalty, as supported by studies in the banking sector and among low-cost airline passengers in Thailand. Therefore, this study proposes

Hypothesis 4: Airline service quality has a positive impact on customer loyalty.

Organizations that prioritize corporate social responsibility (CSR) enjoy numerous benefits, including reduced liabilities, lower security costs, increased sustainability, and enhanced brand reputation. CSR is now recognized as a crucial element in building brand status and can significantly bolster customer support, ultimately contributing to profitability (Bhattacharya et al., 2020). Research shows that consumers are more likely to purchase from

companies engaged in social initiatives, preferring sustainable organizations over irresponsible ones. Positive CSR associations lead to favorable perceptions, while negative ones create adverse effects. Scholars suggest that CSR directly enhances customer loyalty, as positive perceptions of CSR drive favorable consumer behaviors (Starr et al., 2019). Therefore, this study proposes

Hypothesis 5: Sustainability reputation positively affects customer loyalty.

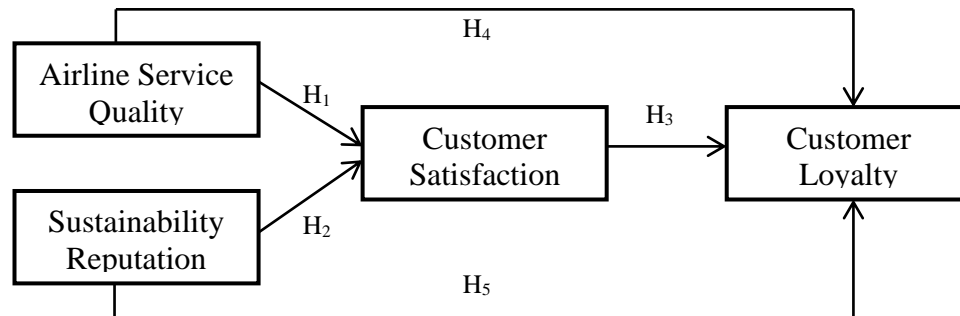


Figure 1 Research Model

Research Methodology

1. The Research Procedure

1.1 To study the impact of airline service quality and sustainability reputation on customer satisfaction and on customer loyalty

1.2 To analyze the data obtained from the 1 step through hypotheses testing with regression analysis

1.3 To design the research using the quantitative approach employing self-administered questionnaire.

1.4 To develop the research instrument from the previous literature. The measurement items are in 5-point Likert scale.

1.5 To collect the data, a total of 1,000 questionnaires were randomly distributed to passengers of a selected world-class airline in Nigeria.

2. Research Instrument

The current study employed self-administered questionnaire for data collection. The measurement items for airline service quality, sustainability reputation, customer satisfaction, and customer loyalty were on a five-point Likert scale (1 for Strongly Disagree and 5 for Strongly Agree).

2.1 Airline service quality: It contains 24 items adopted from Nadiri et al. (2008). It was measured in five dimensions: airline tangibles (6 items), personnel (8 items), empathy (7 items), and image (3 items), For example, "The XXX has high quality of catering served in plane", "The XXX operates with an effective consistency of ticket prices with given service", and "The XXX operates with an effective availability of health personnel during the flights".

2.2 Sustainability reputation: It contains 12 items adopted from De Leaniz et al., (2013) and Chen et al., (2020). It was measured in four dimensions: Economic dimension (4 items), Social dimension (6 items), Environmental dimension (7 items), Product Sustainability (Kianpour, Jusoh and Asghari 2014) (3 items) and Service Sustainability (Han, Yu & Kim, 2019) (3 items), For example, "The XXX exploits renewable energy in a productive process compatible with the environment", " The XXX online seller uses recycled

packing materials for delivery", and "The XXX provides training and promotion opportunities to their employees".

2.3 Customer satisfaction: It contains three items adopted from Cronin et al. (2000). For example, "Your choice to purchase this XXX service was a wise one".

2.4 Customer loyalty: It contains 12 items adopted from Caruana (2002). For example, "You will always encourage friends and relatives to do business with this XXX", and "To you, this XXX is clearly the best to do business with.

2.5 Validity and Reliability Test

The study found that the loading value of measurement items of most of the constructs are above 0.5 confirming validity (Nunnally & Bernstein, 1994). In addition, the composite reliability (CR) and Cronbach's alpha of variables exceeded 0.7, showing internal consistency for reliability.

3. Target Group / Populations and Samples

3.1 Populations were passengers of a selected world-class airline in Nigeria. The population number is unknown.

3.2 Samples were 321 Nigerian respondents over the age of 18 who regularly utilized the airline's services, ensuring they had a clear understanding and evaluation of the service quality provided. The study utilized a non-probability sampling method.

4. Statistics for Data Analysis The statistics used for analyzing data were mean, percentage, standard deviation, and t-test (Dependent Sample).

Research Results

The study collected the data from 321 respondents. As shown in table 1, of those, 69% are female and 31% are male. Most of them are in the age of 26 – 40 years old.

Table 2 Demographic Information

		Freq.	%		Freq.	%
Gender	Female	221	69	Business owner	109	34
	Male	100	31	Student	103	32
Age	26-30 years old	112	35	Skilled labor	52	16
	31-40 years old	108	34	Retired	48	15
	18-25 years old	51	16	Gov. official	9	3
	US\$751 –	97	30	Business owner	109	34
Monthly income	US\$1001 or	64	20	Bachelor degree	108	34
	US\$251 –	63	20	Master degree	83	26
	US\$500	59	18	Higher National	65	20
	US\$501 –	38	12	Diploma (HND)	47	15
	US\$250-and	97	30	Doctoral	18	5
	US\$751 –			Secondary		

This study used regression analysis to test five hypotheses in four models. Model 1 of this study found a multiple regression model confirmed that service quality ($B = .179$) and sustainability reputation ($B = .952$) statistically significant impact on customer satisfaction at a 95% confidence level as a p-value of the model is less than .05 $F(2, 318) = 207.763$, $p\text{-value} = .000$). Therefore, hypothesis 1 and hypothesis 2 were supported.

The regression analysis of Model 2 of the current study indicated that customer satisfaction ($B = 0.278$) statistically significant impact on customer loyalty at a 95% confidence level as a p-value of the model is less than .05 ($F(1, 319) = 25.398$, $p\text{-value} = .000$). Therefore, hypothesis 3 was supported.

Regression analysis of Model 3 indicated that service quality ($B = 0.357$) statistically significant impact on customer loyalty at a 95% confidence level ($F(1, 319) = 6.053$, $p\text{-value} = .000$), while Model 4 indicated that sustainability reputation ($B = 0.550$) statistical significant impact on customer loyalty at 95% confidence level ($F(1,319) = 65.663$). Hence, hypothesis 4 and hypothesis 5 were supported.

Table 3 Hypotheses Testing

Variable	Model 1		Model 2		Model 3		Model 4	
	H ₁ &H ₂		H ₃		H ₄		H ₅	
	B	β	B	β	B	β	B	β
Service quality	.179*	.070*			.357**	.136**		
Sustainability reputation	.952**	.732**					.550**	.413**
Customer satisfaction			.278**	.272**				
R ²	.566		.074		.019		.171	
Adj. R ²	.564		.071		.016		.168	
F	(2,318)		(1,319)		(1,319)		(1,319)	
P	.000		.000		.000		.000	

Note: * $p < .10$. ** $p < .05$ *** $p < .01$

Discussion and conclusion

All five hypotheses of the current study are confirmed. The study found that hypothesis 1 is supported where airline service quality significantly impacts on customer satisfaction ($\beta = 0.070$) with 90% significant level with a p-value less than 0.05. The analysis reveals a positive significant impact of airline service quality on customer satisfaction, supported by Sani et al. (2024) who found that high service quality positively impacts customer satisfaction, aiding competitive advantage and loyalty. Conversely, poor service harms perceptions and retention. Khan et al. (2024) showed that technology service quality in Bangladeshi banks, especially during the pandemic, significantly affects e-customer satisfaction, with mixed results for responsiveness and empathy. Both studies affirm service quality's critical role in customer loyalty and satisfaction.

The study found that hypothesis 2 is supported where sustainability reputation significantly impacts on customer satisfaction ($\beta = 0.732$) with 95% significant level with a p-value less than 0.05. Nasser et al. (2023) supported this, found that a strong sustainability reputation enhances customer satisfaction by building trust and perceived product quality, especially for new customers. Opoku et al. (2023) also showed that sustainability reputation positively impacts brand performance through customer satisfaction, appealing to values-driven consumers and strengthening brand loyalty.

The study found that hypothesis 3 is supported where customer satisfaction significantly impacts on customer loyalty ($\beta = 0.272$) with 95% confidence level with a p-value less than 0.05. Panday & Nursal (2021) support this, found that service quality and customer satisfaction significantly boost loyalty among McDonald's customers, emphasizing the importance of fast service and quality improvements. Similarly, Supriyanto et al. (2021)

showed that while service quality indirectly supports loyalty through satisfaction, high satisfaction reduces churn, building lasting brand loyalty.

The study found that hypothesis 4 is supported where service quality significantly impacts on customer loyalty ($\beta = 0.136$) with 95% confidence level with a p-value less than 0.05. Juwaini et al. (2022) support this, found that e-service quality significantly boosts e-loyalty, though it has a limited effect on e-satisfaction. Muharam et al. (2021) also showed that e-service quality and trust positively impact loyalty, mediated by satisfaction. Quality service strengthens loyalty, encouraging advocacy and reducing customer churn.

The study found that hypothesis 5 is supported where sustainability reputation significantly impacts on customer loyalty ($\beta = 0.413$) with 95% significant level with a p-value less than 0.05. Astono (2021) support this, found that sustainability reputation and competence influence customer loyalty, with trust acting as a mediator. A strong sustainability reputation fosters trust, driving loyalty. For Nigerian airlines, Rebollo and Pacana (2023) showed that service quality—comfort, reliability, and punctuality—is paramount in building loyalty, while sustainability plays a secondary role.

Managerial implication

This study suggested that sustainability reputation has a greater impact on customer satisfaction ($\beta_{\text{Sustainability}} = .732$, $\beta_{\text{Service Quality}} = .070$) and customer loyalty ($\beta_{\text{Sustainability}} = .413$, $\beta_{\text{Service Quality}} = .136$) than airline service quality. Customers are more inclined to stay loyal to airlines that align with their values, especially those committed to eco-friendly practices. While customer satisfaction also promotes loyalty, it may require an added distinguishing factor like sustainability to secure ongoing patronage. Though service quality is essential, it may be seen as a baseline expectation rather than a primary loyalty driver. Sustainability reputation ($\beta = .732$) also significantly impacts customer satisfaction more than service quality ($\beta = .070$), suggesting that sustainable initiatives, such as carbon offsetting and waste management, strongly enhance satisfaction. Customers may perceive a sustainable airline as more innovative and reliable, while expecting service quality from a top-tier airline as a given. To increase loyalty, the airline should focus on customer satisfaction by meeting and exceeding expectations across all interactions while promoting sustainability. This dual approach could cultivate a loyal customer base in a competitive market. Consistently, the airline may focus on sustainable service quality as Dananjoyo et al (2022) proposed to apply on the residential housing industry that includes sustainable service quality elements which are sustainability construction, reliability, assurance, tangible, empathy, responsiveness since they were significantly and directly impact on customer satisfaction which led to improve customer loyalty.

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From “brown” to “green” The effect of authentic leadership on green creativity behavior and the mediating role of psychological green climate – A study in the banking sector in Vietnam

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Abstract

In the context of global commitments to sustainable development and the goal of achieving net-zero emissions by 2050, this study explores the role of Authentic Leadership (AL) in fostering Green Creative Behavior (GCB) among employees in the Vietnamese banking sector. The research highlights the mediating role of Psychological Green Climate (PGC) in this relationship. Using a sample of 207 employees from various banks in Vietnam, the study employs structural equation modeling to test the proposed hypotheses. The findings indicate that AL significantly influences GCB, both directly and indirectly through PGC. This study contributes to the literature by extending the application of AL and PGC theories to the banking sector, providing insights into how leadership can promote environmental sustainability and innovation. Practical implications suggest that banks should cultivate authentic leaders and foster a green psychological climate to enhance green creativity among employees.

Keyword: Authentic Leadership, Green Creative Behavior, Psychological Green Climate, Banking sector, Vietnam

Introduction

Currently, commitments to sustainable development and combating climate change, particularly the goal of achieving net-zero emissions by 2050, are being strongly promoted. To limit global warming to 1.5°C, CO₂ emissions must reach net zero by 2050, alongside significant reductions in other greenhouse gases. Credible emission reduction pathways need to be developed at both the organizational and economic levels. The primary driving force comes from the credibility and ambitions of governments, with 127 countries (accounting for 63% of global emissions), including major economies such as the UK, EU, Japan, China, and the US, pledging to achieve net-zero (Climate Action Tracker (CAT), 2020). Finance plays a pivotal role in this transition. The 2015 Paris Agreement explicitly set the goal of “making financial flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development” (UNFCCC, 2021). Many countries and financial institutions have adopted green strategies, while central banks and financial regulators have adjusted policies to support net-zero goals. In Vietnam, the commitment to achieving net-zero emissions by 2050 was first announced at COP26 and integrated into the National Strategy on

Climate Change through 2050 (Nguyễn Hoàng, 2024). In addition to emission reduction measures, the carbon market serves as an effective tool to achieve this objective.

The banking and financial sectors are under pressure to integrate sustainability policies into their business operations as natural disasters and climate change pose global threats. Investing in environmentally friendly projects not only brings long-term economic benefits but also demonstrates social responsibility. However, to foster green creativity behaviors, banks need to transform their organizational culture, focusing on Authentic leadership a style emphasizing transparency, sincerity, and consistency between words and actions. This approach builds employee trust and promotes creativity behaviors, including green creativity behaviors (Ribeiro et al., 2020).

Although numerous studies have been conducted on Authentic leadership and Green creativity behavior, the field remains limited, especially in the banking sector, where empirical studies are scarce (Gardner et al., 2011). The psychological mechanisms through which Authentic leadership influences employee outcomes are not yet well understood (Gardner et al., 2011; Rego et al., 2014). Recent research has highlighted the role of psychological capital and perceived organizational support as potential mediating factors (Penger & Černe, 2014; Rego et al., 2012). However, further exploration of other mechanisms and processes is needed, particularly in the banking sector, where green financial flows can significantly impact the global economy (Dikau S et al., 2021).

This study proposes that the “Psychological green climate”—employees' perceptions of their organization’s commitment to environmental sustainability (Norton et al., 2012) - serves as a mediator between Authentic leadership and Green creativity behavior. Employees with a clear perception of a green climate are more likely to engage in positive environmental behaviors (Dumont et al., 2017; S. Zhou et al., 2018), whereas low perceptions lead to reduced green performance (Luu, 2019).

This research contributes to the literature by: Firstly, expanding the study of green innovative behavior into the banking sector in Vietnam, introducing authentic leadership as a new predictor. Secondly, clarifying how authentic leadership impacts green innovative behavior through the mediating role of the green psychological climate. Thirdly, employing social exchange theory to propose a model tailored to the banking industry, which differs significantly from manufacturing or tourism sectors.

1. Research Objectives

- 1.1. To develop a theoretical framework that explores the relationship between Authentic leadership and Green creative behavior within the banking sector.
- 1.2. To try out empirical testing of the mediating role of the Psychological green climate in the relationship between Authentic leadership and Green creative behavior among employees in Vietnamese banks.
- 1.3. To study how Authentic leadership influences Green creative behavior by integrating Social exchange theory for the unique context of the banking industry.

2. Literature Review

2.1. Green creative behaviors

Driven by increasing pressure for organizations to adopt environmentally friendly practices to achieve sustainable competitive advantages, alongside rapid urbanization, depletion of natural resources, and rising global carbon emissions, organizations are forming creative teams to protect the environment through creative methods. These include reducing paper and water usage, developing rainwater collection systems, and recycling water.

According to (Amabile, 1988), creative behavior involves generating novel and practically useful ideas or solutions. Green creative behavior, as a specific form of creative behavior, refers to an individual’s ability to develop unique ideas or solutions for conserving or improving the environment. These ideas can be applied to green processes, products, or services within organizations (Chen & Chang, 2013; Li et al., 2020). Similarly, Mittal & Dhar, 2016 define green creative behavior as the development of innovative ideas related to green products, services, processes, or practices that are original, novel, and useful. These ideas aim to enhance environmental efficiency and minimize an organization’s negative environmental impact (Chen & Chang, 2013).

2.2. Authentic leadership

Leadership is the process of influencing and guiding the behaviors of a group or organization to achieve goals. Effective leadership not only involves the use of power but also motivates, builds trust, and fosters the personal growth of employees (Neider & Schriesheim, 2011). Leadership theories have evolved to reflect a shift in perception of a leader’s role, from control toward promoting sustainable development for organizations and their members. The need to improve leadership quality and mitigate unethical behavior in organizations, exacerbated by scandals and declining trust in leaders, has increased demands for transparency and ethics in management. This has led to the emergence of authentic leadership as a promising approach to restoring employee trust and fostering a positive organizational culture (Neider & Schriesheim, 2011).

Authentic Leadership (AL) is founded on ethical qualities, integrity, and consistency between leaders’ principles, words, and actions. Developed by Luthans & Avolio, 2003 and later expanded by Walumbwa et al., 2008, AL is a leadership behavior model that promotes positive psychological outcomes, such as an ethical climate, heightened self-awareness, and intrinsic moral perspective. These factors enhance balanced information processing and transparency in leader-follower relationships, ultimately fostering the positive development of followers (Semedo et al., 2017). Based on prior theoretical and research (Avolio et al., 2004; Avolio & Gardner, 2005; Gardner et al., 2005; Walumbwa et al., 2008), AL consists of four key components:

1. Self-awareness: Leaders understand their strengths, weaknesses, values, and emotions, enabling meaningful and appropriate decision-making that builds employee trust.
2. Transparency: Authentic leaders demonstrate sincerity, openly and honestly sharing information, thereby fostering trustworthy relationships with others.
3. Balanced processing: Leaders objectively evaluate information, avoiding bias, and make decisions based on all available facts, even when they are unfavorable.
4. Ethical/Moral: Leaders act based on personal ethical values and principles rather than external pressures.

2.3. Psychological green climate

The psychological climate has become a topic of interest among management scholars, although it gained attention later than the organizational climate (Kataria et al., 2013). In the context of increasing ecological degradation and global climate change, organizations are focusing more on adopting sustainable policies to promote employees’ environmentally friendly behaviors. In management psychology, the Psychological green climate is considered an important contextual factor, reflecting employees’ attitudes and behaviors (Kang et al., 2016; Norton et al., 2014). Psychological green climate is defined as employees’ shared perceptions of organizational processes, policies, and practices related to the environment that promote green values and environmental sustainability (Dumont et al., 2017; Norton et al., 2014; S. Zhou et al., 2018).

According to Norton et al., 2014, the Psychological green climate is viewed from two perspectives:

From the organizational perspective, it reflects employees' perceptions of the policies and actions the organization takes to support and protect the environment. These perceptions represent "prescriptive norms," which are the values endorsed and expected by the organization from its employees.

From the peer perspective, it refers to employees' perceptions of how their colleagues behave in matters related to environmental protection. These perceptions reflect "descriptive norms," or the behaviors commonly observed among coworkers within the organization.

2.4. Social Exchange Theory

Social Exchange Theory (SET) is a key framework for explaining behavior and relationships within organizations. SET posits that social relationships are built through interactions in which parties exchange resources and create obligations. Relationships are sustained when the benefits received are perceived as proportional to the contributions made (Blau, 1964; Cropanzano & Mitchell, 2005). SET has its roots in the works of Blau, 1964; M Mauss, 1925; Malinowski, 1922, with further developments by Homans, 1958. High-quality relationships develop by adhering to the "exchange rules," which include reciprocating positive actions, building trust, and fostering commitment (Cropanzano & Mitchell, 2005). The "norm of reciprocity" is central to SET, reflecting mutual dependence, cultural trust, and ethical standards (Gouldner, 1960). For instance, when employees feel supported by their organization, they are more likely to commit and enhance their performance.

The resources exchanged in SET include economic benefits (e.g., salaries) and social benefits (e.g., respect). Foa & Foa, 1974 categorized these resources into six types: love, status, information, money, goods, and services. Sustained exchanges of these resources foster stable relationships, enhance trust and commitment, and encourage effective work behaviors (Blau, 1964).

In Authentic leadership, SET explains how leaders encourage employees through mutual trust and respect. Leaders demonstrate transparency and fairness, motivating employees to contribute more (Du et al., 2022). For example, studies by Du et al., 2022; Teng & Yi, 2022 show that Authentic leadership enhances job engagement, promotes creative behaviors, and reduces employees' intention to quit. By fostering supportive and trustworthy relationships, Authentic leadership improves performance and reduces negative outcomes such as fatigue, burnout, and turnover intentions (Ribeiro et al., 2020).

2.5. Hypothesis development and Research model

Authentic leadership enhances employees' intrinsic motivation, a key factor driving creative behavior. This motivation enables employees to be flexible, persistent, and willing to take risks for creativity (Amabile, 1997; J. Zhou & Ren, 2011). Studies by Černe et al., 2013; Rego et al., 2012 demonstrate that Authentic leadership not only directly but also indirectly fosters Green creative behavior through employees' perceptions of support for innovation and their psychological capital. Semedo et al., 2017 emphasize the role of leaders' authenticity and transparency in fostering commitment and promoting individual creativity. Authentic leadership strengthens relationships with teams, thereby enhancing ecological effectiveness and encouraging green creative behavior (Kohnen, 2005; Rego et al., 2012; Walumbwa et al., 2011). Thus, the hypothesis is proposed:

H1: Authentic leadership is related to employees' Green creative behavior.

The Psychological green climate is defined as employees' shared perceptions of organizational environmental policies and practices (Dumont et al., 2017; Norton et al., 2014). According to componential theory of creativity, leadership influences employees' emotions and perceptions, as well as how they evaluate the psychological climate within the organization

(Afridi et al., 2023). Given that organizational behavior is largely driven by leaders (Bass, 1960), they are capable of fostering a psychological environment that encourages pro-environmental thinking (Ones & Dilchert, 2012).

Leaders often shape how employees perceive and interpret organizational policies and practices (Rabiul et al., 2022). They can translate strategies into guidelines and train employees on green outcomes and expected creative behaviors, thereby promoting positive perceptions of the organization's Psychological green climate through the establishment of green policies and practices. Thus, the hypothesis is proposed:

H2: Authentic leadership is related to the green psychological climate.

In a study by Tahir et al., 2020, the positive impact of the Psychological green climate on employees' green behaviors at the workplace was confirmed. Similar findings were reported by Dumont et al., 2017; Norton et al., 2015, establishing that the Psychological green climate is a strong predictor of employees' related behaviors. Extending this discussion, Khan et al., 2019 argue that positive perceptions of the Psychological green climate enhance employees' pro-environmental behaviors, such as waste recycling, energy conservation, and efforts to minimize waste. Conversely, if employees perceive that organizational policies and processes do not support ecological behaviors and responsible environmental protection, they are less likely to engage in green behaviors (Luu, 2019).

Since Green creative behavior is a specific manifestation of employees' green behaviors (Mittal & Dhar, 2016), positive perceptions of the Psychological green climate within the organization, particularly in the banking sector, are expected to positively influence employees' green creative behavior. Based on empirical evidence and theoretical support, the following hypotheses are proposed:

H3: The Psychological green climate is related to employees' green creative behavior.

H4: The Psychological green climate mediates the relationship between Authentic leadership and employees' green creative behavior.

Figure 1 shows the hypothesis research model:

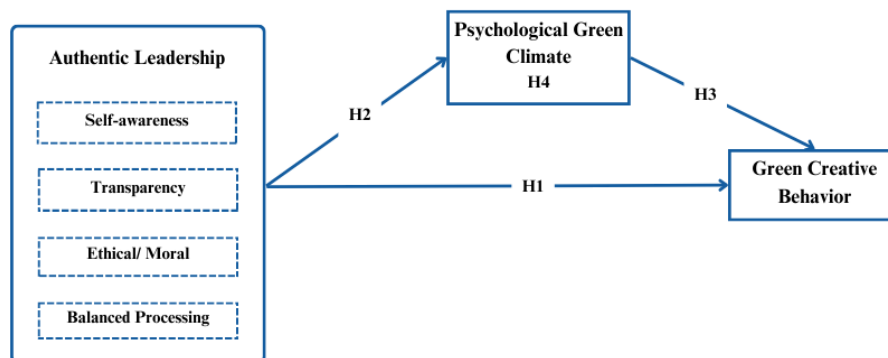


Figure 3 Research Model

Research Methodology

1. Participants and procedure

The sample for this study comprised employees and managers from Vietnamese banking institutions implementing green policies and strategies. A design was utilized for data collection. A total of 207 questionnaires were distributed online to bank employees and their managers, targeting those working in banks with environmental sustainability initiatives in Vietnam. Data were collected during the period from September to December 2024.

The sampled organizations were selected to represent various types of banks actively engaged in sustainability, ensuring the diversity of participants' roles and experiences. The questionnaire was developed based on validated scales from prior studies, ensuring contextual relevance by following a translation-back-translation process and an expert review. The responses were analyzed using SPSS and SmartPLS to explore the relationships among Authentic leadership, Psychological green climate, and Green creative behavior.

In total, 290 responses were collected from the distributed questionnaires, of which 83 were discarded due to extreme responses or employees indicating uncertainty about their bank's participation in green or sustainable strategies. The final sample for the study consisted of 207 employees, where employees assessed their immediate supervisor's authentic leadership and their own perceptions of the psychological green climate and green creative behavior.

Participants were also asked to provide demographic information, including gender, age, education level, job position, and organizational tenure. Regarding sample characteristics, there were 81 males and 126 females, with 89.9% holding a bachelor's degree, 8.7% holding a master's degree, and the remaining having other qualifications. In terms of age, 42.5% of the respondents were below 30 years old, 49.3% were between 31–40 years, and 8.2% were above 40 years. A majority (36.1%) had worked with their current organization for 8-15 years, while 25.1% had tenure from 3-8 years, 29.5% below 3 years. In terms of organizational hierarchy, 28.5% of respondents were in middle management positions and the remaining were employees.

2. Research Instruments

Participants provided their responses to the scale items using a five-point Likert scale ranging from 1 = "strongly disagree" to 5 = "strongly agree," unless stated otherwise. The scale items were translated into Vietnamese using the back-translation procedure to ensure accuracy (Iarossi, 2006). The measurement items for all research constructs are detailed in **Table 2** of the appendix.

2.1. Authentic leadership

This construct was assessed using 4-item authentic leadership inventory by Bruce J. Avolio, William L. Gardner, & Fred O. Walumbwa. Bank employees were invited to rate the frequency of authentic leadership behaviors demonstrated by their immediate supervisors on a 5-point scale (1 = never, 5 = almost always).

2.2. Psychological green climate

Bank employees were asked to rate on a 5-point scale (1 = never, 5 = almost always) using nine items adapted from Norton et al., 2014.

2.3. Green creative behavior

Bank employees were invited to rate the frequency of their behaviors on a 5-point scale (1 = never, 5 = almost always) using six items adapted from (Chen & Chang, 2013).

Results

1. Evaluation of measurement models

As presented above, the proposed theoretical framework includes the constructs: Authentic Leadership (AL), Psychological Green Climate (PGC), and Green Creative Behavior (GCB). Specifically, Psychological Green Climate (PGC) and Green Creative Behavior (GCB) are identified as reflective measurement constructs. Authentic Leadership (AL) is conceptualized as a formative measurement construct. Therefore, this section will discuss the procedures for evaluating both types of measurement models as a foundation for presenting the data analysis results in this study.

Table 7 First measurement model result

	Outer Loading	Cronbach's Alpha	rhoA	rhoC	AVE
PGC- Psychological Green Climate		0.936	0.938	0.946	0.663
PGC1	0.774				
PGC2	0.835				
PGC3	0.716				
PGC4	0.869				
PGC5	0.869				
PGC6	0.806				
PGC7	0.813				
PGC8	0.778				
PGC9	0.856				
GCB- Green Creative Behavior		0.879	0.886	0.910	0.629
GCB1	0.792				
GCB2	0.859				
GCB3	0.629				
GCB4	0.778				
GCB5	0.880				
GCB6	0.795				

The results indicate that the observed variable GCB3 has an outer loading below the recommended threshold of 0.708 (Hulland, 1999). Therefore, this variable was removed from the model, and a second analysis was conducted, yielding the results shown in the table below:

Table 8 Second measurement model result

	Outer Loading	Cronbach's Alpha	rhoA	rhoC	AVE
PGC- Psychological Green Climate		0.936	0.937	0.946	0.663
PGC1	0.777				
PGC2	0.836				
PGC3	0.720				
PGC4	0.867				
PGC5	0.866				
PGC6	0.808				
PGC7	0.814				
PGC8	0.774				
PGC9	0.854				
GCB- Green Creative Behavior		0.889	0.891	0.919	0.694
GCB1	0.778				
GCB2	0.837				
GCB4	0.817				
GCB5	0.876				
GCB6	0.853				

The second analysis shows that all indicators have outer loadings above the recommended threshold of 0.708 (Hulland, 1999), indicating strong influence on latent variables and high quality for further measurement. Cronbach's Alpha and composite reliability (rhoC, rhoA) were then assessed, with all values exceeding recommended thresholds: Cronbach's Alpha > 0.7 (DeVellis, 2003) and rhoA, rhoC within 0.7–0.9 (Dijkstra & Henseler, 2015; Jöreskog, 1971). Convergent validity, evaluated using Average Variance Extracted (AVE), was confirmed as all AVE values exceeded 0.5, meeting the criteria for latent variable explanation (Hair Jr et al., 2021; Hock et al., 2010).

Finally, the author assessed the discriminant validity of the scale using the HTMT (Heterotrait-Monotrait) ratio. Henseler et al., 2015 recommend an HTMT threshold of 0.9,

beyond which latent variables are not clearly distinct and may measure the same concept. The analysis yielded an HTMT value of 0.784, confirming that the variables in the model meet the criteria for discriminant validity.

The evaluation of the formative measurement construct of AL is given in the following table.

Table 9 Formative measurement results

	VIF	Outer Weight (p-value)
AL- Authentic Leadership		
AL1	1.607	0.004
AL2	1.535	0.003
AL3	1.706	0.000
AL4	1.937	0.000

To ensure no multicollinearity, a VIF threshold of less than 5 is recommended. The VIF for AL meets this criterion, confirming no multicollinearity issues in the formative model. Next, Outer weight was assessed via Bootstrapping. Per Hair et al., 2020, a p-value below 0.05 indicates significance at the 95% confidence level. If not, the Outer loading should be checked; a p-value below 0.05 allows the variable to be retained. The analysis shows the Outer weight of AL is statistically significant, validating its suitability for structural model evaluation.

2. Structural model evaluation

In experimental research, high correlations between independent variables are generally undesirable as they can significantly affect the accuracy of data analysis results. Therefore, the VIF index is examined to assess the level of multicollinearity in the model. The VIF values were 2.240, 1.000, and 2.240, all below the threshold of 5. Thus, it can be concluded that the risk of multicollinearity in the model has been eliminated. According to Hair et al., 2019, a VIF exceeding 5 indicates a high likelihood of multicollinearity issues.

The results of the hypothesis testing are summarized in **table**. All proposed hypothesis (H1, H2, and H3) were accepted, as their respective p-values were below the 0.05 threshold. Specifically:

H1 (AL → GCB): The path coefficient was 0.641, with a t-value of 8.149 and a p-value of 0.000, indicating strong support for the hypothesis.

H2 (AL → PGC): The path coefficient was 0.744, with a t-value of 16.085 and a p-value of 0.000, further supporting the hypothesis.

H3 (PGC → GCB): The path coefficient was 0.241, with a t-value of 3.187 and a p-value of 0.001, confirming the hypothesized relationship.

Table 10 Bootstrapping results

Hypothesis	Relationship	Original sample (O)	t-value	p-value	Test result
H1	AL → GCB	0.641	8.149	0.000	Accepted
H2	AL → PGC	0.744	16.085	0.000	Accepted
H3	PGC → GCB	0.241	3.187	0.001	Accepted

The adjusted R^2 for GCB (Green Creative Behavior) is 0.697, meaning AL (Authentic Leadership) and PGC (Psychological Green Climate) explain 69.7% of its variance. Similarly, the adjusted R^2 for PGC is 0.551, with AL explaining 55.1% of its variance. Both values, being close to 1, indicate strong explanatory power.

The f^2 statistic measures the impact of an exogenous latent variable on an endogenous variable when the exogenous variable is removed from the model (Hair et al., 2017). According to Cohen, 1988, $f^2 \geq 0.35$ indicates a large effect, $0.15 \leq f^2 \leq 0.35$ a medium effect, and $0.02 \leq f^2 \leq 0.15$ a small effect. AL has a strong impact on GCB ($f^2 = 0.612$) and PGC ($f^2 = 1.240$), while PGC has a weak effect on GCB ($f^2 = 0.087$).

For predictive accuracy, the Q^2 values for GCB (0.661) and PGC (0.532) exceed 0.5, showing high out-of-sample predictive capability (Geisser, 1974; Stone, 1974). The q^2 for AL is 0.422, indicating a strong predictive effect on GCB, as $q^2 \geq 0.35$ (Cohen, 1988).

3. Analysis of mediating effects

The table below presents the mediating effect of PGC in the relationship between AL and GCB. The results indicate a statistically significant indirect effect, confirming the mediating role of PGC.

Table 11 Impact of the mediator variable

	Original sample (O)	t-value	p-value
AL → PGC → GCB	0.180	2.893	0.004

The indirect effect (AL → PGC → GCB) is significant with a p-value of 0.004 (< 0.05), and the t-value of 2.893 exceeds the critical threshold (1.96 for 95% confidence). This confirms that PGC serves as a mediator in the relationship between AL and GCB.

Discussion and Conclusion

1. Discussion of research findings

The analysis of 207 valid responses confirmed the research hypotheses. Authentic Leadership (AL) significantly impacts Green Creative Behavior (GCB) ($\beta = 0.641$, $p < 0.05$, $f^2 = 0.612$), demonstrating its strong positive influence. This aligns with Social Exchange Theory (SET) and prior studies (Černe et al., 2013; Ribeiro et al., 2020), emphasizing how sincerity, transparency, and ethics in leadership foster employee creativity, particularly in environmental initiatives. AL also strongly shapes Psychological Green Climate (PGC) ($\beta = 0.744$, $p < 0.05$, $f^2 = 1.240$), supporting theories (Dumont et al., 2017; James et al., 2008) that leaders play a pivotal role in creating green-supportive work environments. PGC positively influences GCB

($\beta = 0.241$, $p < 0.05$), though the effect is weaker ($f^2 = 0.087$). Mediation analysis reveals that PGC partially mediates the relationship between AL and GCB ($\beta = 0.180$, $p < 0.05$), highlighting its role as a bridge while suggesting further research on additional mediators. These findings expand the application of leadership and environmental theories to the banking sector, emphasizing AL's ability to inspire green creativity and shape sustainable workplace climates.

2. Contributions of the study

This study expands the application of Authentic Leadership (AL) theory to Vietnam's banking sector, where creativity is often constrained by rigid processes. It confirms that AL positively influences Green Creative Behavior (GCB) and highlights the mediating role of Psychological Green Climate (PGC) in transforming leadership values into employee creativity. These findings enrich Social Exchange Theory (SET) by emphasizing the role of leadership in shaping employees' environmental perceptions. Additionally, the study extends AL and PGC theories to the financial sector, differing from prior research focused on manufacturing or technology, and provides valuable insights for banks facing sustainability pressures.

Practically, the research suggests that Vietnamese banks should prioritize cultivating authentic leaders characterized by self-awareness, transparency, and ethics to foster a sustainable workplace and encourage creativity. Building a psychological green climate is essential to promoting green innovation, alongside implementing flexible policies such as eco-friendly financial products, resource optimization, and internal incentives. These insights enable Vietnam's banking sector to lead in sustainability efforts and enhance its global competitiveness.

3. Research limitations and future direction

To address these limitations, future research should expand the survey scope to cover northern and southern Vietnam, enhancing representativeness and generalizability. Incorporating additional mediators, such as intrinsic motivation, work engagement, green self-efficacy, or organizational commitment, could further elucidate how AL influences green creative behavior.

Additionally, interdisciplinary studies could offer comparative insights by applying this model to other industries like manufacturing or technology, where green innovation plays a core role. This would help organizations design management strategies better aligned with the global green transformation.

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The Impact of Organizational Culture on Employees’ Intrinsic and Extrinsic Motivation in Vietnamese Enterprises

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Abstract

This study aims to examine the impact of organizational culture on both intrinsic and extrinsic motivation of employees in Vietnamese enterprises. The characteristics of organizational culture are examined using Denison's Organizational Culture Model. Survey data were collected from 625 employees currently working in various businesses in Vietnam. Utilizing a quantitative approach, this study employs Structural Equation Modeling (SEM) to develop the research model, refine measurement scales, and analyze data. The findings indicate that organizational culture has a strong influence on extrinsic motivation in Vietnamese enterprises. However, its impact on intrinsic motivation appears to be more limited. Notably, cultural traits such as adaptability and mission, as defined in Denison's model, do not significantly affect intrinsic motivation. The study contributes to a deeper understanding of the relationship between organizational culture and employee motivation in a developing country with distinct socio-cultural characteristics like Vietnam. Furthermore, the findings provide practical insights for business leaders in developing effective organizational culture strategies to enhance employee motivation through cultural alignment.

Keywords: Organizational Culture, Denison Model, Intrinsic Motivation, Extrinsic Motivation.

Introduction

In the context of Industry 4.0 and the rapidly evolving business environment, enterprises are facing unprecedented opportunities and challenges for innovation and growth. In this new landscape, human resources are gradually becoming the most critical asset, replacing traditional factors such as financial capital and raw materials in determining an organization's competitive advantage. Humans are the key drivers of capital creation, technological innovation, and the generation of new ideas, increasingly becoming the most valuable asset of any organization (Khan et al., 2010). Numerous factors influence employee productivity, among which work motivation is considered the most significant, directly impacting an organization's overall performance (Kuranchie-Mensah & Amponsah-Tawiah, 2016). Employees lacking high motivation will fail to invest their hearts and minds into their tasks, customer satisfaction, or organizational goals. They will lack ambition, enthusiasm, dedication, and focus, operating like *"soulless bodies"* within their organizations. Creating

motivation among employees is the most crucial condition for achieving high performance and organizational objectives (Devadass, 2011). In business management, the most critical task is to accurately identify the factors that drive employee motivation, serving as the foundation for adjusting and refining motivation policies accordingly (Kovach, 1995).

To date, research findings consistently demonstrate that organizational culture influences all aspects of business operations, with a particularly strong impact on employee motivation (Yusof et al., 2016; Matkó & Takács, 2017). When examining the influence of organizational culture on motivation, many contemporary studies approach motivation through Maslow's Hierarchy of Needs Theory (1943), Herzberg's Two-Factor Theory (1959), or the Goal-Setting Theory by Edwin Locke (1960). These theories emphasize the intrinsic nature of needs, the internal factors driving motivation, and the satisfaction of those needs as key elements in fostering motivation. However, such theoretical perspectives tend to obscure the nuanced impact of organizational culture on the distinct components of motivation, specifically intrinsic and extrinsic motivation. This lack of clarity often results in motivation policies derived from organizational culture lacking specificity and targeted effectiveness. Therefore, a more refined approach is needed to better capture the relationship between organizational culture and the multifaceted nature of employee motivation.

To further deepen the understanding of the impact of organizational culture on motivation, this study adopts Denison's Organizational Culture Model. According to this model, organizational culture is composed of four dimensions: involvement, consistency, adaptability, and mission. Employee motivation is examined through the lens of Self-Determination Theory (SDT) proposed by Ryan and Deci, which distinguishes between intrinsic and extrinsic motivation. This study explores how each dimension of organizational culture influences these two specific components of employee motivation.

The research utilizes data collected from 625 employees working in various enterprises in Vietnam. The Denison Organizational Culture Scale has been adapted to align with the socio-cultural characteristics of Vietnam. Through this approach, the study aims to provide a clearer and more in-depth understanding of the relationship between organizational culture and the distinct components of employee motivation. The findings offer a solid foundation for enterprises to enhance their organizational culture and refine motivation policies, ultimately fostering a more engaged and high-performing workforce.

1. Research Objective

1.1 To examine the influence of the four dimensions of organizational culture (involvement, consistency, adaptability, and mission) on the two distinct components of employee motivation (intrinsic and extrinsic motivation) as outlined by Self-Determination Theory (SDT) in the context of Vietnamese enterprises.

2. Review of Related Literatures

2.1 Theoretical Framework

This study is grounded in two key theoretical frameworks: Self-Determination Theory (SDT), proposed by Edward L. Deci and Richard M. Ryan, and Expectancy Theory, developed by Vroom (1964). These theories provide a robust foundation for understanding how organizational culture influences intrinsic and extrinsic motivation among employees.

Self-Determination Theory (SDT)

Self-Determination Theory (SDT) posits that individuals have an innate tendency to grow, develop, and realize their full potential. To achieve this, the surrounding environment must satisfy three fundamental psychological needs: autonomy, competence, and relatedness. When these three needs are met, individuals are more likely to experience strong intrinsic

motivation, achieve higher performance, and experience a sense of well-being. SDT emphasizes that the environment plays a pivotal role in shaping individual motivation. It serves as a powerful framework for understanding and applying strategies to foster employee motivation, particularly through the development of organizational culture. When an organizational culture supports autonomy, competence, and relatedness, employees not only develop strong intrinsic motivation but also feel a deeper sense of commitment and belonging to the organization. Moreover, SDT provides a critical theoretical foundation for understanding the relationship between organizational culture and employee motivation. While SDT primarily focuses on intrinsic motivation, it also offers insights into how organizational culture can influence extrinsic motivation. However, the core argument of SDT remains that a supportive organizational culture, which fulfills these three psychological needs, will significantly enhance intrinsic motivation. In the context of modern organizations, SDT serves as an essential theoretical lens for both research and practice in human resource management, highlighting the importance of fostering a positive organizational environment that supports autonomy, competence, and relatedness to drive sustained employee motivation and engagement.

Expectancy Theory

Expectancy Theory, proposed by Vroom (1964) and later refined by scholars such as Porter and Lawler (1968), posits that employee motivation depends on their expectations regarding task performance and the rewards associated with successful task completion. According to this theory, employees are motivated when they clearly perceive a connection between their efforts, performance outcomes, and rewards. Organizational culture plays a crucial role in reinforcing these perceptions by ensuring that employees have sufficient resources, training, and support to believe that their efforts will lead to effective performance outcomes. Additionally, a transparent organizational culture fosters employee confidence that their performance will be recognized and rewarded appropriately. Conversely, if rewards are inconsistent, opaque, or perceived as unfair, the perceived link between effort and reward (instrumentality) weakens, ultimately diminishing motivation. Expectancy Theory primarily focuses on explaining extrinsic motivation, emphasizing how individuals act based on their belief that effort will lead to performance and performance will result in meaningful rewards. In this regard, organizational culture plays a pivotal role in strengthening extrinsic motivation by creating a clear and credible connection between effort, performance, and reward systems while ensuring that rewards are valuable and aligned with employees' needs and expectations.

However, Expectancy Theory does not directly address intrinsic motivation. Its influence on intrinsic motivation is more indirect, operating through feelings of achievement and competence derived from successful performance outcomes. Therefore, supporting intrinsic motivation requires integrating complementary theories, such as Self-Determination Theory (SDT).

Combining Expectancy Theory and Self-Determination Theory (SDT) offers a comprehensive theoretical framework for examining the impact of organizational culture on both intrinsic and extrinsic motivation. This integration leverages the strengths of each theory, providing a holistic explanation of how organizational culture shapes motivation dynamics, addressing both the internal psychological needs of employees and their external expectations of reward and recognition.

2.2 Research Concepts

Organizational Culture

Organizational culture is a multidimensional concept for which no universally accepted definition currently exists (Tharp, 2009). The diversity in definitions arises from the complex components and varying mechanisms employed by researchers to explain this concept..

Schein posits that “*Organizational culture consists of the underlying assumptions, values, and beliefs shared by members within an organization*” (Schein, 1985). Similarly, Denison (1995), another prominent scholar in organizational culture, offers a closely aligned perspective, stating that “*Organizational culture is the deep structure of organizations, rooted in the values, beliefs, and assumptions shared by organizational members*” (Denison & Neale, 2000). Despite variations in wording and emphasis, these definitions share a common understanding that organizational culture is fundamentally composed of shared values and beliefs (O’Reilly et al., 1991). In this study, organizational culture is approached through the lens of shared values and beliefs among organizational members, consistent with the perspectives of Denison (1995), Schein (1985), and Chatman (1991). It is viewed as a collection of core values and fundamental beliefs selected, shared, and collectively agreed upon by members of the organization. These shared values and beliefs form the organization's core identity and guide the behaviors of its members. The rationale for adopting this approach lies in the stability and sustainability of shared values within organizations, which reflect the interaction between individuals and the organization. These interactions subsequently give rise to behavioral patterns that express and embody the organization's culture.

Researchers have proposed numerous theoretical models for understanding organizational culture values, with notable contributions from Trompenaars (1998), O’Reilly, Chatman & Caldwell (1999), Cameron and Quinn (2006), Hofstede (1980), and Denison & Neale (2000). Each model possesses its own strengths and limitations. In this study, we adopt the Organizational Culture Model proposed by Denison & Neale (2000) as the foundation for developing our research hypotheses. According to Denison (1995), organizational culture is composed of four distinct dimensions:

- Involvement: reflects an organization’s focus on building employee capabilities, ownership, and responsibility. It emphasizes the organization’s commitment to developing, instilling, and engaging employees’ minds and dedication. Involvement is demonstrated through empowerment, teamwork orientation, and competency development.

- Consistency: represents stability and internal cohesion within organizational culture. It highlights the importance of core values, consensus, cooperation, and integration among organizational members. Consistency ensures that members share a common understanding of principles and values, fostering alignment in organizational actions and behaviors.

- Adaptability: focuses on an organization’s ability to quickly adapt to external environmental signals, including customer needs and market demands. Adaptability emphasizes innovation, customer orientation, and organizational learning. It reflects the organization’s capacity to embrace change, remain flexible, and respond effectively to external challenges.

- Mission: defines the organization’s long-term goals and strategic direction. It ensures clarity in identifying whether the organization is strategically prepared or vulnerable due to the absence of long-term planning. Mission is expressed through vision, strategic direction, and goal-setting systems.

The Denison Model has been successfully applied in diverse cultural contexts and across varying levels of economic development worldwide. Its application in the Vietnamese organizational and cultural context is both appropriate and relevant, offering a robust framework for examining the relationship between organizational culture and key organizational outcomes.

Employee Work Motivation

Employee work motivation is a concept widely used across various fields of life. However, to date, there remain multiple schools of thought and differing perceptions of this

concept. This diversity has led to ongoing debates in both scientific understanding and practical application, with no universally accepted definition yet established (Pham Duc Chinh, 2021).

In their research on motivation, Mitchell (1982) define work motivation as “the desire and willingness of employees to exert effort towards achieving organizational goals, characterized by persistence and determination throughout the work process” (Mitchell, 1982). Sharing a similar perspective but focusing on the behavioral manifestations of employee motivation, Miner (1993) suggests that “a motivated individual works diligently, invests all their effort and dedication into their tasks, and operates with clear goals and direction” (Miner, 1993). Pinder (2014) further clarifies the concept of work motivation by describing it as “a set of external and internal factors that drive employee behavior, influencing the initiation, direction, duration, and intensity of their work-related actions.” According to Pinder, employee motivation is influenced by external factors such as the nature of the job, performance evaluation systems, compensation, and organizational reward structures, as well as internal factors such as personal drives and individual needs (Pinder, 2014). Similarly, Bui Anh Tuan (2013) argues that “work motivation consists of internal factors that stimulate individuals to work proactively under favorable conditions, resulting in high productivity and efficiency. Motivation manifests as readiness, effort, and passion for achieving both organizational and personal goals.” Motivation is also understood as a psychological process that drives and sustains an individual's actions related to their job, tasks, or organization (Hitka et al., 2019).

Building on the development of Self-Determination Theory (SDT), Ryan and Deci (2000) propose that work motivation consists of intrinsic motivation and extrinsic motivation. Intrinsic motivation refers to the internal drive and encouragement that originate from within an individual, stemming from their needs, values, and innate interests. It represents the internal satisfaction derived from performing a task or activity for its inherent enjoyment or fulfillment rather than for external rewards. Extrinsic motivation, on the other hand, arises from external factors and influences outside the individual, such as rewards, punishments, social recognition, or material benefits. Individuals are driven by extrinsic motivation to achieve specific goals or perform particular activities in response to these external stimuli. Together, these two forms of motivation provide a comprehensive understanding of the factors driving employee behavior and performance in organizational settings.

2.3 Theoretical Framework and Research Model:

The research hypotheses are developed based on two fundamental theories: the Organizational Culture Model proposed by Denison (1995) and the Self-Determination Theory (SDT) of motivation proposed by Richard M. Ryan and Edward L. Deci. The development of relationships between the components of organizational culture and the components of work motivation is grounded in the theoretical foundations mentioned above.

The Impact of Involvement on Employee Motivation:

A culture of involvement, with its emphasis on enhancing employee capabilities, fosters confidence and creates a sense of accessibility and growth for employees. When employees are trained and developed to acquire new skills and improve their competencies, they perceive a clear vision and opportunities for growth in their work. This perception generates intrinsic motivation, driving them to continue learning and advancing their skills. An involvement-oriented culture, characterized by employee empowerment and delegation of authority, cultivates a sense of autonomy and control over their work. This autonomy and sense of control stimulate intrinsic motivation because employees feel ownership and responsibility for their success, and they perceive their work as valuable and meaningful (Pink, 2009). Furthermore, an involvement culture that focuses on enhancing employee capabilities, empowering employees, and fostering teamwork enables employees to achieve better work outcomes, increases their likelihood of earning organizational rewards, enhances their self-worth, and

allows them to demonstrate their value within the organization and the broader community. These factors collectively contribute to strengthening extrinsic motivation (Huang, 2003; Denison & Neale, 2000). This theoretical foundation supports the development of the following hypotheses:

H1a: Involvement positively influences employees' intrinsic motivation.

H1b: Involvement positively influences employees' extrinsic motivation

The Impact of Consistency on Employee Motivation

Consistency, as viewed by Denison (1995), represents the stability and internal cohesion of organizational culture. Consistency is first reflected through a system of values that create a unique identity shared within the organization. These shared values foster consensus on critical organizational issues, resolve conflicts and disagreements when challenges arise, and ensure alignment in organizational priorities. Consistency is also demonstrated through the creation of an environment of collaboration and mutual support among members, facilitating collective efforts to achieve organizational goals. When cultural values are widely accepted and agreed upon, they create an environment that positively influences employee motivation (Aida Azadi et al., 2013; Firuzjaeyan et al., 2015). Organizational consistency significantly impacts intrinsic motivation by providing guidance, fairness, trust-building, passion, meaning, and a clearly defined work culture with consistent norms and messages. These elements collectively enhance the intrinsic motivation of organizational members, fostering a sense of belonging and purpose in their work. Consistency also plays a crucial role in influencing extrinsic motivation. When there is alignment between goals, values, actions, and outcomes, extrinsic motivation is strengthened and sustained. This theoretical foundation supports the development of the following hypotheses:

H2a: Consistency positively influences employees' intrinsic motivation.

H2b: Consistency positively influences employees' extrinsic motivation.

The Impact of Adaptability on Employee Motivation:

Adaptability, from Denison's perspective, refers to an organization's ability to create an adaptive environment to address change, understand customers, and foster a culture of learning and knowledge sharing. This environment encourages creativity, provides support, and offers opportunities for employee growth and development. Individuals with a high need for achievement are often better suited to organizational cultures that emphasize adaptability (Hon & Leung, 2011). A strong culture of adaptability influences both intrinsic and extrinsic motivation, as it empowers employees to innovate, respond effectively to change, and feel supported in their professional development. This theoretical foundation supports the development of the following hypotheses:

H3a: Adaptability positively influences employees' intrinsic motivation.

H3b: Adaptability positively influences employees' extrinsic motivation.

The Impact of Organizational Mission on Employee Motivation:

The organizational mission reflects the core purpose and reason for the enterprise's existence, as well as the benefits, meaning, and values it delivers to customers. The mission is expressed through the organization's vision, strategic direction, and goal-setting systems. It serves as a fundamental component of organizational culture, and numerous studies have affirmed its significant influence on employee motivation. This influence can be explained from multiple perspectives.

When employees understand and align with the organizational mission, they experience a greater sense of purpose in their work, which enhances their intrinsic motivation to contribute towards achieving the organization's goals. Furthermore, the mission plays a crucial role in shaping vision, values, and management policies, which are also essential factors influencing

extrinsic motivation by aligning incentives, recognition, and reward systems with the organization's overarching goals. This theoretical foundation supports the development of the following hypotheses:

H4a: The organizational mission positively influences employees' intrinsic motivation.

H4b: The organizational mission positively influences employees' extrinsic motivation.

Based on the theoretical overview and the proposed hypotheses, the research model is constructed as follows:

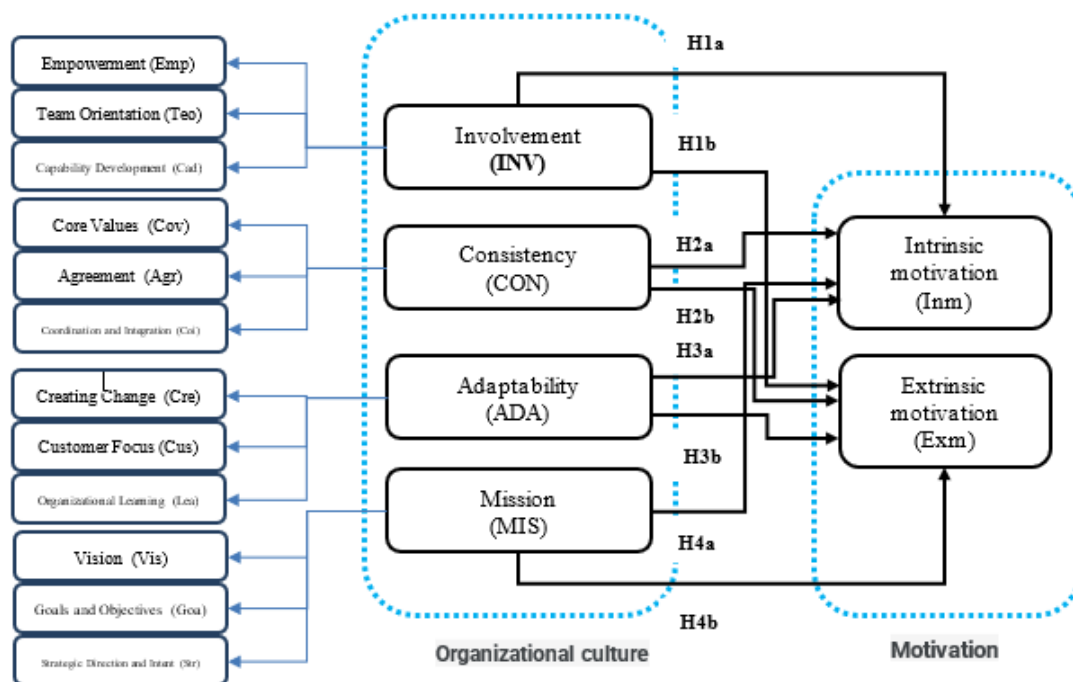


Figure 1 Research Model

Research Methodology

3.1 Population and Sample

This study focuses on employees currently working in enterprises across Vietnam. The sample was selected using quota sampling, ensuring diversity in gender, work experience, job position, and professional qualifications. A total of 625 valid survey responses were collected, which meets the requirements for Structural Equation Modeling (SEM) analysis. According to Hoyle (1995), a minimum sample size of 200 respondents is considered sufficient for SEM, ensuring that the dataset is robust for statistical analysis. The sample structure and demographic distribution were carefully examined to ensure representativeness and validity.

3.2 Data Collection

The survey was conducted over six months (January 2024 – June 2024) using a combination of face-to-face interviews, online interviews, and email surveys. Since multiple methods of data collection may introduce bias, a nonresponse bias test was conducted following the same approach used to assess differences in opinions among response groups. This step ensures that variations in data collection methods do not significantly influence the study's findings. By applying this test, the study minimizes potential discrepancies and enhances data reliability.

3.3 Measurement

The study adopts Denison’s Organizational Culture Model to measure organizational culture characteristics using 60 observed variables. The four cultural dimensions—Involvement, Consistency, Adaptability, and Mission—are each assessed through three subcomponents, with five observed variables per subcomponent (Denison & Neale, 2000). Employee motivation, including intrinsic and extrinsic motivation, is measured using scales adapted from Amabile et al. (1994). All measurement items are assessed using a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

To ensure alignment with Vietnamese enterprises' cultural and business context, the measurement scales were refined through two rounds of focus group discussions and ten in-depth interviews with enterprise managers and employees. The feedback gathered was used to adjust the wording, enhance clarity, and ensure relevance, making the measurement tools more applicable to the study’s specific context.

3.4 Validity and Reliability

To ensure the accuracy and consistency of the measurement scales, a series of statistical techniques were applied. Cronbach’s Alpha analysis was conducted to assess the internal consistency of each construct, verifying that all items demonstrated sufficient reliability. This process involved examining the Corrected Item-Total Correlation coefficients and Cronbach’s Alpha values to confirm unidimensionality and ensure that each scale was internally coherent.

Building on this, Confirmatory Factor Analysis (CFA) was performed in two stages to validate the construct structure. The first-order CFA was employed to assess the convergent and discriminant validity of the latent variables representing the four dimensions of organizational culture. Once these constructs were confirmed, the second-order CFA was conducted to evaluate the overall stability and robustness of the measurement model within a hierarchical framework. Throughout this process, key Model Fit indices were analyzed to ensure that the measurement model met established statistical thresholds, further reinforcing its validity.

By integrating these validation techniques, the study ensures that the measurement scales are both theoretically sound and statistically robust. This provides a solid foundation for hypothesis testing and structural model analysis, allowing for meaningful interpretations of the relationships between organizational culture and employee motivation.

3.5 Statistical Techniques

To analyze the relationship between organizational culture and employee motivation, Structural Equation Modeling (SEM) is employed as the primary statistical method. First, descriptive statistics are used to summarize sample characteristics and demographic information. Next, Cronbach’s Alpha is applied to assess the reliability of the measurement scales, ensuring that all constructs demonstrate high internal consistency. Following this, Confirmatory Factor Analysis (CFA) is conducted to validate the measurement model and assess construct validity, evaluating how well the observed data fit the theoretical framework.

Once the measurement model is confirmed, SEM is used to test the hypothesized relationships between organizational culture dimensions and employee motivation. This approach allows for an in-depth examination of both direct and indirect effects, providing empirical evidence on how different cultural traits influence intrinsic and extrinsic motivation. By employing these statistical techniques, the study ensures a rigorous and comprehensive analysis, offering valuable insights into the role of organizational culture in shaping employee motivation in Vietnamese enterprises.

Results

4.1 Scale Assessment

Exploratory Factor Analysis (EFA) was conducted to validate the measurement scales. In this study, 68 observed variables were subjected to EFA. The criteria applied included: Kaiser-Meyer-Olkin (KMO) coefficient > 0.5 , significance level (sig) < 0.05 , Principal Axis Factoring extraction method, and Promax rotation, with factor extraction stopping at Eigenvalues > 1 . After the first round of analysis, four observed variables (Agr5, Coi2, Lea2, Str3) did not meet the required conditions and were excluded. The remaining 64 observed variables (56 independent variables and 8 dependent variables) were retained for the second round of EFA analysis. The results of the analysis are presented in Table 2.

The KMO test results for the four dimensions of organizational culture and the two dependent variables of motivation all exceeded 0.5. Additionally, the Bartlett's Test of Sphericity produced a significance value (Sig.) of 0.000 (Sig. < 0.05), indicating that the observed variables included in the EFA analysis are correlated with each other. The total variance explained for the measurement scales of both cultural dimensions and intrinsic and extrinsic motivation exceeded 50%, demonstrating an adequate level of explanation for the variation in the observed variables included in the EFA analysis. The Factor Loading coefficients of the observed variables in the rotated matrix were all greater than 0.5, indicating that the correlation between the observed variables and their respective factors, and vice versa, meets the established criteria (Hair et al., 2010).

Cronbach's Alpha analysis was conducted to assess the reliability of the retained scales after the EFA analysis. The results are presented in Table 3. According to these results, all 68 observed variables satisfied the requirement, with Corrected Item-Total Correlation coefficients exceeding 0.3 and Cronbach's Alpha values greater than 0.6 for all factors. Therefore, the measurement scales meet the standards for unidimensionality, reliability, convergent validity, and discriminant validity, ensuring that the dataset is entirely suitable for further analysis.

Confirmatory Factor Analysis (CFA) was conducted for the independent variables in two stages. In the first-order CFA, the goal was to ensure that the 12 constructs (latent variables) representing the four dimensions of organizational culture met the requirements for convergent validity and discriminant validity. In the second-order CFA, the objective was to reassess the overall measurement model to ensure its stability and robustness when represented as a second-order structure. The results of the first-order CFA demonstrated that all 12 latent variables (Emp, Teo, Cad, Cov, Agr, Coi, Cre, Cus, Lea, Str, Goa, Vis) satisfied the criteria for convergent validity and discriminant validity. The results of the second-order CFA for the independent variables are presented in Figure 1. All Model Fit indices fell within acceptable thresholds: CMIN/DF = $1.845 < 3$; GFI = $0.829 > 0.9$; CFI = $0.925 > 0.9$; TLI = $0.921 > 0.9$; RMSEA = $0.037 < 0.08$; PCLOSE = $1.000 > 0.05$. Thus, the model achieves a good fit.

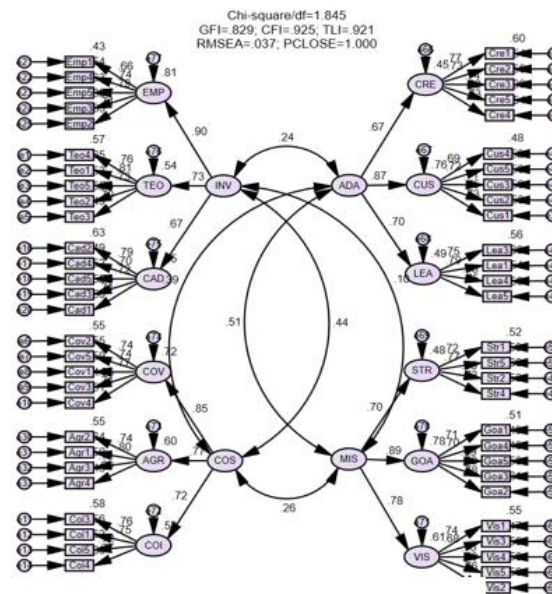


Figure 2 Second-order overall model for the independent

Similarly, the CFA analysis for the dependent variables (Inm and Exm) also yielded satisfactory results regarding model fit. Thus, all criteria are met, and the research model aligns well with the actual survey dataset.

The results of the convergent validity and discriminant validity analysis for both independent and dependent variables are presented in Table 4.

According to the results in Table 4, both the independent and dependent variables exhibit the following: the Composite Reliability (CR) values are all greater than 0.7, and the Average Variance Extracted (AVE) values exceed 0.5. This indicates that the measurement scales meet the criteria for convergent validity. Additionally, the square root of the AVE values is greater than the correlations between the latent variables, and the Maximum Shared Variance (MSV) values are smaller than the AVE values. Therefore, discriminant validity is also ensured.

4.2 Structural Equation Modeling (SEM) Evaluation

The results of the SEM analysis for the entire model are illustrated in Figure 2. According to the results, the model demonstrates a high degree of fit, meeting the required conditions: CMIN/DF = 1.706 < 3, GFI = 0.826 > 0.8, CFI = 0.929 > 0.9, TLI = 0.925 > 0.9, RMSEA = 0.034 < 0.08, and PCLOSE = 1.000 > 0.05.

Table 5 indicates the impact of organizational culture on intrinsic and extrinsic motivation, as well as the relationship between procedural justice and employee trust in the organization. Hypotheses H1a, H2a, H1b, H2b, H3b, and H4b have P-values smaller than 0.05, and are therefore accepted. In contrast, hypotheses H3a and H4a have P-values greater than 0.05, and are consequently rejected

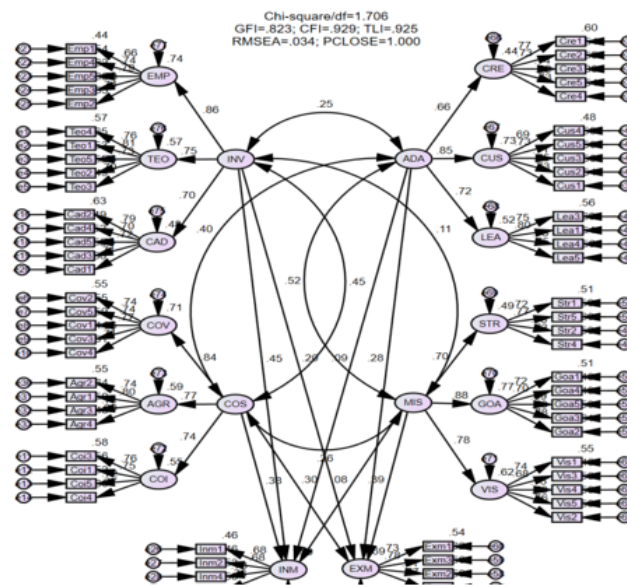


Figure 3 Results of Structural Equation Modeling (SEM) Analysis

This means that adaptability and organizational mission do not significantly affect employees' intrinsic motivation. The standardized regression coefficients reveal the order of influence of independent variables on dependent variables. The larger the absolute value of the coefficient, the stronger the impact. Additionally, the analysis results show that the R^2 value for the dependent variable Exm (extrinsic motivation) is 0.687, indicating that organizational culture variables explain 68.7% of the variance in extrinsic motivation. Similarly, the R^2 value for the dependent variable Inm (intrinsic motivation) is 0.584, demonstrating that organizational culture variables account for 58.4% of the variance in intrinsic motivation.

Discussion

The Impact of the Cultural Dimension "Involvement" on Motivation

Hypothesis H1a, which proposes that involvement positively affects intrinsic motivation, is accepted with a P-value of 0.000, indicating a significant influence on the variability of employees' intrinsic motivation (Inm). The standardized coefficient is 0.446, meaning that when involvement increases by one unit (on the Likert scale), intrinsic motivation correspondingly increases by 0.446 units. Hypothesis H1b, which suggests that involvement positively affects extrinsic motivation, is also accepted with a P-value of 0.000 and a standardized coefficient of 0.160. This indicates that when involvement increases by one unit, extrinsic motivation increases by 0.160 units.

It can thus be concluded that the "involvement" dimension of organizational culture positively influences both intrinsic and extrinsic motivation. However, involvement exerts a stronger impact on intrinsic motivation. This means that employees value their sense of belonging and inclusion within the organization, which becomes a source of pride and a primary driver for enhancing intrinsic motivation. The more managers focus on empowering employees, forming effective work teams aligned with organizational goals, and developing employees' capabilities, the more likely they are to foster employee engagement and commitment. This, in turn, significantly enhances work motivation, particularly intrinsic motivation. This conclusion aligns with findings from previous studies such as Muthuveloo & Che Rose (2005) and Taslim (2011). However, a notable difference in this study lies in the

observation that "involvement" has the strongest impact on intrinsic motivation, a conclusion that has not been explicitly highlighted in prior research.

The Impact of the Cultural Dimension "Consistency" on Motivation

The cultural dimension of "consistency" positively influences both intrinsic and extrinsic motivation (H2a with a P-value = 0.000 and a standardized coefficient of 0.304; H2b with a P-value = 0.000 and a standardized coefficient of 0.295). Consistency is reflected in core values, consensus, cooperation, and integration. It serves as a foundation for establishing core values that underpin a strong organizational culture, fostering unity and mutual understanding in sharing beliefs and values across individuals, groups, and departments within the organization. Consistency helps reduce tensions and conflicts, which is highly significant in enhancing both intrinsic and extrinsic motivation among employees. This result aligns with findings from previous studies, such as Khatri & Gupta (2017). However, while many studies suggest that consistency has the least impact on employee commitment and motivation among the four cultural dimensions in Denison's model (Kayani, 2023), this study reveals a relatively high level of influence, ranking as the second strongest factor for both intrinsic and extrinsic motivation. Given the collectivist nature of Eastern cultures, which emphasize community values and harmonious working environments, this conclusion proves to be highly relevant and contextually appropriate.

The Impact of the Cultural Dimension "Adaptability" on Motivation

Contrary to expectations, the research findings indicate that Hypothesis H3a, which proposes that adaptability positively affects intrinsic motivation, is not supported (P-Value = 0.100 > 0.05). Intrinsic motivation primarily stems from interest, passion, and a sense of self-fulfillment derived from performing tasks. While adaptability is undoubtedly essential, it is not a decisive factor in generating intrinsic motivation. Employees with high intrinsic motivation often exhibit autonomy, proactivity, and persistence in their work. They are naturally inclined to adapt to changes and face new challenges without requiring external stimuli. Therefore, adaptability does not directly determine intrinsic motivation. Instead, factors such as a sense of mastery, meaningfulness, and purpose in work serve as the primary drivers of intrinsic motivation. Adaptability may support these factors but is not a direct source of intrinsic motivation. This conclusion regarding Hypothesis H3a differs from some previous studies, such as Nguyen Quoc Nghi (2014) and Taslim (2011), which suggested a stronger relationship between adaptability and intrinsic motivation.

In contrast, Hypothesis H3b, which posits that adaptability positively affects extrinsic motivation, is supported (P-Value = 0.000, Standardized Coefficient = 0.387). Adaptability emerges as the strongest factor influencing extrinsic motivation among the cultural dimensions in Denison's model. An adaptive organizational culture enhances employees' capacity to adjust to changes in the workplace, enabling them to respond effectively to new tasks and challenges. This adaptability helps employees achieve their goals and earn rewards, thereby boosting their extrinsic motivation. Adaptability allows employees to quickly learn and apply new skills, enhancing their performance and productivity. Improved performance often leads to better outcomes and tangible rewards. Employees who demonstrate high adaptability are frequently entrusted with new tasks and projects, providing them with opportunities to achieve external accomplishments and rewards. Furthermore, adaptability enables employees to better meet the demands and expectations of their jobs, increasing their chances of receiving external rewards such as recognition, bonuses, or promotions. It can therefore be concluded that employee adaptability directly influences extrinsic motivation by helping them achieve work-related goals and rewards. This relationship represents a critical consideration for managing and fostering extrinsic motivation in employees. These findings are consistent with numerous

previous studies, including Hofstede (1980) and several other researchers, further validating the importance of adaptability in driving extrinsic motivation.

The Impact of the Cultural Dimension "Mission" on Motivation

An interesting finding from this study reveals that Hypothesis H4a, which proposes that "mission" positively affects intrinsic motivation, is not supported ($P\text{-Value} = 0.100 > 0.05$). This result contrasts with previous research findings from other countries, such as Hofstede (1980), Humphreys (2007), and Anatalia (2014). However, it aligns partially with a study conducted in Vietnam examining the relationship between mission and employee engagement (Cao Viet Hieu, 2019). To explain this discrepancy, we propose that an organization's mission does not always directly influence employees' intrinsic motivation. In Vietnamese enterprises, several reasons might account for this: First, individual differences: Each employee has unique needs, values, and personal goals. Some employees may not perceive the organization's mission as aligning with their personal aspirations, and thus, it fails to generate intrinsic motivation. Second, lack of connection: If employees do not see a clear link between their daily tasks and the organization's mission, they will struggle to perceive meaning and purpose in their work, leading to a lack of intrinsic motivation. Third, different priorities: Some employees may prioritize factors such as income, benefits, and career advancement opportunities over being driven by the organization's mission. Fourth, lack of autonomy: When employees feel they lack control or empowerment in their roles, it becomes challenging for them to derive meaning and purpose from their work, regardless of the organization's mission. Thus, while the mission is undoubtedly important in Vietnamese enterprises, it is not always a decisive factor in driving intrinsic motivation. Instead, factors such as personal needs, individual goals, a sense of autonomy, and meaningful work play a more critical role in fostering intrinsic motivation.

However, the "mission" cultural dimension positively affects extrinsic motivation, as Hypothesis H4b is supported ($P\text{-Value} = 0.000$, Standardized Coefficient = 0.279). This result aligns with conclusions from previous studies, such as Yilmar, C., and Ergun, E. (2008) and Korovedzai (2018). The cultural dimension of "mission" emphasizes an organization's clear vision, goals, and strategic direction, which help employees understand the purpose and significance of their work. This clarity enhances extrinsic motivation by aligning individual efforts with organizational objectives and providing employees with a sense of purpose and direction. When employees clearly understand the organization's goals and strategies, they are more likely to perceive their work as meaningful and contributory to the broader mission. Clear objectives and strategies also act as a guide for employees' efforts and actions, ensuring alignment with organizational goals. This clarity of organizational goals serves as a driving force, encouraging employees to exert more effort and contribute meaningfully to achieving those objectives.

Conclusion

By applying Denison's Organizational Culture Model, this study provides compelling evidence of the impact of organizational culture on employee motivation in Vietnamese enterprises. All four cultural dimensions influence extrinsic motivation in the following order: adaptability, organizational mission, consistency, and involvement. In contrast, the impact of organizational culture on intrinsic motivation is more limited, with only two dimensions, involvement and consistency, showing a positive effect. The cultural dimensions of adaptability and mission do not significantly affect intrinsic motivation. This finding represents a notable contribution, highlighting the unique influence of organizational culture on motivation within the context of a developing country like Vietnam, characterized by distinct socio-cultural attributes. These findings also offer practical implications for business managers

in Vietnam. First, there is a pressing need to invest more heavily in building a strong organizational culture, as fostering an effective organizational culture is inherently a means of enhancing employee motivation. Second, significant improvements are required in strategic planning, particularly in setting long-term goals, defining the organization's mission, and establishing a compelling vision. When an organization's mission and vision are sufficiently attractive and persuasive to employees, they serve as powerful drivers of intrinsic motivation. Third, there should be a greater emphasis on employee development and empowerment, enabling employees to take ownership and autonomy in executing their tasks.

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Appendix

Table 1 Research Sample Structure (n=625)

Demographic Information (625 Respondents)		Frequency	Percentage (%)
Gender	Male	303	48.5
	Female	322	51.5
Work Experience	Less than 5 years	188	30
	5–10 years	250	40
	More than 10 years	188	30
Job Position	Employee	319	51
	Middle Manager	231	37
	Company Executive	75	12
Educational Level	Vocational Training	153	24.5
	College	156	25
	University	219	35
	Postgraduate	75	12
	Other	22	3.5

(Source: Survey Results by the Research Team)

Table 2 Results of KMO and Bartlett's Test

KMO and Bartlett's Test		INV	CON	ADA	MIS	INM	EXM
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.925	.913	.916	.925	.784	.817
Bartlett's Test of Sphericity	Approx. Chi-Square	4.505.558	3.567.381	3.834.419	3.810.827	778.092	931.738
	df	105	78	91	91	6	6
	Sig.	.000	.000	.000	.000	.000	.000

(Source: Survey Results by the Research Team)

Table 3 Results of Reliability Analysis for Measurement Scales

Observed variables	Mean	Std. Deviation	Corrected Item-Total Correlation	Observed variables	Mean	Std. Deviation	Corrected Item-Total Correlation
Empowerment (Emp): $\alpha = 0.855$				Creating Change (Cre): $\alpha = 0.841$			
Emp1	3.77	.991	.610	Cre1	18.41	14.537	0.726
Emp2	3.35	.823	.668	Cre2	18.21	14.1	0.673
Emp3	3.32	.829	.695	Cre3	18.03	15.371	0.674
Emp4	3.93	.976	.677	Cre4	18.18	15.683	0.679
Emp5	3.78	.851	.715	Cre5	18.43	16.377	0.563
Emp1	3.77	.991					
Team Orientation (Teo): $\alpha = 0.861$				Customer Focus (Cus): $\alpha = 0.844$			
Teo1	3.50	.874	.735	Cus1	13.75	7.789	0.652
Teo2	3.76	.900	.664	Cus2	13.76	7.991	0.67
Tea3	3.74	.888	.631	Cus3	13.75	8.01	0.639
Tea4	3.64	1.052	.698	Cus4	13.75	8.215	0.624
Tea5	3.64	1.015	.680	Cus5	13.59	7.704	0.666
Capability Development (Cad): $\alpha = 0.852$				Organizational Learning (Lea): $\alpha = 0.842$			
Cad1	3.42	.846	.630	Lea1	3.60	.851	.702
Cad2	3.66	.941	.717	Lea3	3.58	.906	.675
Cad3	3.61	.893	.663	Lea4	3.64	.919	.671
Cad4	3.77	1.012	.649	Lea5	3.84	.869	.659
Cad5	3.82	.965	.662	Strategic Direction and Intent (Str): $\alpha = 0.842$			
Core Values (Cov): $\alpha = 0.846$				Str1	3.36	.859	.646
Cov1	3.46	.828	.683	Str2	3.39	.894	.689
Cov2	3.69	.905	.685	Str4	3.41	.839	.647
Cov3	3.86	.978	.610	Str5	3.37	.858	.678
Cov4	3.47	.839	.634	Goals and Objectives (Goa): $\alpha = 0.845$			
Cov5	3.49	.840	.664	Goa1	3.59	.912	.633
Agreement (Agr): $\alpha = 0.823$				Goa2	3.57	.928	.692

Observed variables	Mean	Std. Deviation	Corrected Item-Total Correlation	Observed variables	Mean	Std. Deviation	Corrected Item-Total Correlation
Agr1	3.32	.922	.708	Goa3	3.84	.924	.680
Agr2	3.26	.914	.666	Goa4	3.82	.919	.630
Agr3	3.28	.878	.620	Goa5	3.81	.922	.626
Agr4	3.50	.832	.595	Vision (Vis): $\alpha = 0.849$			
Coordination and Integration (Coi): $\alpha = 0.837$				TN1	3.72	.946	.669
Coi1	3.82	.885	.656	TN2	3.75	1.024	.683
Coi3	3.59	.901	.693	TN3	3.73	.961	.613
Coi4	3.61	.896	.689	TN4	3.75	.991	.682
Coi5	3.86	.881	.635	TN5	3.76	.952	.643
Intrinsic motivation (INM), $\alpha = 0.805$				Extrinsic motivation (EXM); $\alpha = 0.805$			
Inm1	3.25	.749	.625	Exm1	3.56	.609	.663
Inm2	3.36	.768	.616	Exm2	3.44	.645	.642
Inm3	3.59	.647	.648	Exm3	3.52	.641	.693
Inm4	3.45	.683	.599	Exm4	3.59	.639	.674

(Source: Data analysis results by the Research Team)

Table 4 Results of Convergent Validity and Discriminant Validity Testing

	CR	AVE	MSV	Exm	Inm
Exm	0.837	0.563	0.225	0.750	
Inm	0.807	0.512	0.225	0.474	0.715

	CR	AVE	MSV	INV	ADA	COS	MIS
INV	0.813	0.596	0.191	0.772			
ADA	0.794	0.566	0.259	0.237	0.753		
COS	0.825	0.613	0.191	0.437	0.392	0.783	
MIS	0.832	0.625	0.259	0.102	0.509	0.259	0.790

(Source: Data analysis results by the Research Team)

Table 5 Results of Structural Equation Modeling (SEM) Estimation

Hypothesis	Relationship		Estimate		S.E.	C.R.	P	Hypothesis Conclusion
			Not standardized	Standardized				
H1a	Involvement	→ Intrinsic Motivation	.404	.446	.052	7.709	***	Supported
H2a	Consistency	→ Intrinsic Motivation	.340	.376	.052	6.554	***	Supported
H3a	Adaptability	→ Intrinsic Motivation	.105	.091	.063	1.647	.100	Not Supported
H4a	Organizational Mission	→ Intrinsic Motivation	.097	.081	.060	1.615	.106	Not Supported
H1b	Involvement	→ Extrinsic Motivation	.160	.197	.036	4.430	***	Supported
H2b	Consistency	→ Extrinsic Motivation	.239	.295	.040	5.932	***	Supported
H3b	Adaptability	→ Extrinsic Motivation	.417	.387	.058	7.235	***	Supported
H4b	Organizational Mission	→ Extrinsic Motivation	.286	.279	.056	5.157	***	Supported

In which: Estimate represents the average estimated value; SE indicates the standard error; CR refers to the critical ratio; P denotes the significance level; and *** indicates $p < 0.001$. (Source: Data analysis results by the Research Team.

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Operations management strategies for promoting tourism in Nanning City, Guangxi province: A case study of Xiangsi Town

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Abstract

The objectives of this research were: to analyze the current situation of operations management for promoting tourism in Xiangsi Town, Nanning City; to analyze the key issues in operations management for promoting tourism in Xiangsi Town, Nanning City; and to propose strategic recommendations to enhance operations management for promoting tourism in Xiangsi Town, Nanning City. This qualitative research employed in-depth interviews and utilized SWOT and TOWS analyses to examine the development status, achievements, and experiences of Xiangsi Town, identifying gaps or issues in the current operations management. Additionally, PEST analysis was applied to evaluate the internal and external environment affecting Xiangsi Town's operations management, enabling the formulation of preliminary operational strategies that were feasible for implementation. The key informants were stakeholders categorized into four groups: five local government officials responsible for tourism and big data initiatives, five experts and professionals in tourism management, five business owners and operators in the tourism sector, and fifteen tourists visiting Xiangsi Town.

The findings revealed that Xiangsi Town leveraged its cultural heritage and eco-tourism potential but faced challenges related to activities, management, and infrastructure. Addressing these issues and pursuing further development could have positioned Xiangsi Town as a sustainable and competitive destination. The primary issues included underdeveloped infrastructure, fragmented management, inadequate planning, lack of digital tools, absence of modern amenities, and insufficient sustainable practices. These factors negatively impacted the visitor experience and business growth. Strategies for enhancing tourism in Xiangsi Town included integrated management, adoption of technological innovations, infrastructure development, product diversification, human resource development, targeted marketing, sustainability initiatives, and feedback mechanisms. These strategies aimed to improve visitor satisfaction.

Keywords: operations management, management strategy, tourism management

Introduction

Guangxi, as China's largest ethnic minority autonomous region, is home to 12 indigenous ethnic groups, including the Zhuang, Han, and Yao, and had a population of 56.95 million in 2019, with 39% being ethnic minorities. The region leverages its rich ethnic cultural resources to develop tourism towns and festivals with distinctive ethnic features, advancing

rural tourism and economic revitalization in ethnic rural areas. This aligns with national strategies, such as the National Rural Revitalization Strategic Plan (2018-2022) and the 14th Five-Year Plan, emphasizing cultural-tourism integration to foster world-class destinations and enhance economic sustainability.

Guangxi has actively promoted the "culture +" model, integrating tourism, cuisine, agriculture, and technology. Projects like Hepu County's South Pearl industry and Chongzuo City's Huashan Rock Art-centered tourism exemplify innovative approaches to creating multidimensional cultural experiences. Moreover, Guangxi has cultivated 79 ethnic tourism towns since 2018, showcasing the region's efforts to integrate ethnic culture into tourism development. However, challenges in operational management and resource utilization remain, particularly in ensuring sustainable development and market-oriented growth (Huang, 2016).

Xiangsi Town in Nanning serves as a flagship cultural tourism project that blends ethnic cultural elements with leisure and entertainment. Despite its growing popularity since its 2020 opening, inefficiencies in operations management, fragmented resource allocation, and inconsistent service quality have hindered its full potential. Effective operations management plays a critical role in optimizing tourism development by improving infrastructure, streamlining management processes, and enhancing visitor experiences. National regulations emphasize precise positioning and sustainable development for characteristic towns, highlighting the need for well-structured operational strategies.

This study examines Xiangsi Town's operational status, identifies key challenges, and proposes targeted management solutions. By strengthening its operational management strategies, Xiangsi Town can serve as a model for similar projects, providing valuable insights into the role of efficient tourism operations in enhancing the competitiveness and sustainability of cultural tourism towns across China.

1. Research Objectives

1.1 To analysis the current situation in operations management for promoting Tourism of Xiangsi Town in Nanning City.

1.2 To analysis the main problems in operations management for promoting Tourism of Xiangsi Town in Nanning City.

1.3 To propose strategies to strengthen the operations management for promoting Tourism of Xiangsi Town in Nanning City.

2. Review of Related Literatures

2.1 Concepts of operations management

The concept of operations management is relatively broad and is usually directly related to an enterprise's operations and business activities. From a theoretical perspective, it can be defined as a general term for a series of related management tasks in the operation process, covering planning, execution, and control related to product production and services. On the other hand, operations management can also be understood as managing enterprise operation systems, which mainly refers to the design, operation, evaluation, and improvement of product production and service provision systems. Operations management is planning, organizing, implementing, and controlling the operation process. It is a general term for various managements closely related to the production of products and the creation of services (William et al., 2015).

Based on domestic and foreign research and practice in operations management, operations management includes planning, organization, implementation, and control of the entire operation process. It is a total collection of management activities for producing products and subsequent services. Throughout the development history of enterprises in various

industries at home and abroad, the correct implementation of operations management is the key to ensuring smooth and normal operations of enterprises (Miller, 2001).

2.2 Concepts of operation management in cultural tourism town

A cultural tourism town represents a multifunctional space that integrates culture, tourism, community, and industry, evolving beyond the traditional single-town concept to encompass livability, industrialization, and cultural tourism. Driven by rising economic incomes and shifting tourism preferences toward personalized, interactive, and immersive experiences, cultural tourism towns have gained prominence. However, challenges persist in planning, operation, and management, with many developments neglecting local humanistic and rural characteristics. The construction of Wuxi's Nianhuawan Cultural Tourism Town demonstrates the significance of the "culture + tourism" model in achieving ecological, industrial, and cultural synergies, while promoting rural revitalization, enhancing local livelihoods, and supporting sustainable urbanization. This case provides valuable insights for the broader development of cultural tourism towns across China (Liu, 2016).

2.3 SWOT Analysis

SWOT analysis is a strategic tool used to evaluate an organization's internal strengths and weaknesses alongside external opportunities and threats, facilitating goal-oriented strategy development. Widely applied in tourism development planning, including for cultural towns and rural areas, SWOT analysis helps assess key factors like natural resources, cultural assets, infrastructure, and competition (Yan & Wang, 2021). It has been effectively used in regions like Henan and Fujian to identify tourism potentials and challenges, offering insights for strategic planning. Combining SWOT with tools like PEST and Porter's Five Forces enhances its effectiveness for comprehensive tourism development strategies (Xue, 2019).

2.4 TOWS Matrix

The SWOT matrix, or TOWS analysis, aids managers in formulating strategic plans by aligning internal strengths (S) and weaknesses (W) with external opportunities (O) and threats (T). This method generates four strategies: SO (leveraging strengths to capitalize on opportunities), WO (addressing weaknesses to exploit opportunities), ST (using strengths to mitigate threats), and WT (minimizing weaknesses and avoiding threats). Applied in diverse contexts, such as regional tourism in Anshan and Datong, public transportation in Kaohsiung, and indigenous tourism in Malaysia, TOWS analysis enhances objectivity and systematic planning, particularly for small and medium-sized scenic spots, by addressing the limitations of experience-based decision-making (Idris & Saleh, 2018).

2.5 Research on operations management in cultural tourism town

Qin (2018) based on the GEM (Groundings-Enterprises-Markets) model theory, from the reliability of the model analysis and calculation results, the feasibility of the data collection application platform, and the comprehensive information required for the sustainable and stable development of the town economy in the future, concluded that there are five core competitiveness of the town in the future, namely: existing infrastructure capacity, environmental resources, the scope and intensity of the government's main economic and technical support for the town, the development of industrial technology, technology application and industrialization level evaluation, and the funding policy for key support of smart town projects.

Li (2019) conducted a survey on the landscape design, use of plant landscaping, principles and importance of plant landscaping in characteristic towns, and proposed that we should adhere to the principle of adapting measures to local conditions and protecting the ecology, and correctly use plant landscaping to improve the ornamental value of the entire characteristic town ecology

Research Methodology

1. Research design

This paper used SWOT & TOWS to analyze the development status, achievements and experience of Xiangsi Town, identifies the differences or problems in the current operation and management status, and uses PEST to analyze the internal and external environment of Xiangsi Towns operation and management, so as to formulate an initial feasible operation implementation strategy.

First, in view of the research background and problems of this topic, the theoretical significance and practical significance of this topic are explained, and the research status, research review and research methods adopted in related fields are fully explained.

Secondly, this paper took the contingency theory and resource-based theory as the entry point to establish a solid theoretical foundation. These theories lay the foundation for the theoretical analysis of the research problem and the subsequent status quo investigation. Next, the operation status of Xiangsi Town was analyzed in depth. The analysis was conducted through interviews, focus interviews, etc., aiming to fully and objectively understand the basic aspects such as the operation of Xiangsi Town based on big data and the current status of digital development.

Third, the empirical analysis focuses on evaluating the necessity and feasibility of Xiangsi Towns operation strategy. Through SWOT and PEST analysis, the macro environment, industry environment, and internal environment of the towns operation strategy are objectively evaluated, and the TOWS matrix was used to determine the towns operation strategy (Mostafa, 2025). Finally, the operation strategy puts forward specific suggestions.

2. Research Instruments

Interview method is a scientific analysis method that interviews representative things and phenomena to obtain an overall understanding (Hossain et al., 2024). On the basis of relevant literature research, this paper adopts the method of online in-depth interviews to understand the situation of Xiangsi Town operation management, and amends and supplements the theoretical basis of the previous research, so that the selected theoretical framework matches the actual situation of the enterprise, and better selects the operation management of the town.

3. Populations and Samples

3.1 Populations were selected from Local government officials who responsible for tourism and big data initiatives, tourism management professionals and experts, business owners and operators in the tourism sector and tourists visiting Xiangsi town.

3.2 The sample will be divided into four groups with the respective sizes of 5, 5, 5, and 15 participants, a logical justification can be made based on the diversity of perspectives required to comprehensively address the research objectives. The first three groups (government officials, professionals, and community representatives) are smaller because their roles are more specialized, and their insights are focused on decision-making and operational expertise. Tourists and visitors represent a broader and more heterogeneous group, warranting a larger sample size to capture a wide range of opinions and experiences. The proposed sizes allow for in-depth qualitative data collection, ensuring that the sample remains manageable for analysis while still providing comprehensive insights (Christou, 2025).

4. Data Analysis

Researchers conducted literature retrieval and research, and conducted in-depth sorting and analysis of the relevant literature on the operations management for promoting Tourist of Xiangsi Town in Nanning City. Subsequently, the researcher established the research topic, research significance, and research framework, and clarified the theoretical value of the research topic and the direction of possible breakthroughs. This paper uses the TOWS matrix

combined with the SWOT & PEST analysis method to the macro environment, industry environment, and internal environment of the towns operation strategy are objectively evaluated, and the TOWS matrix is used to determine the towns operation strategy. Based on the goals and principles of operations management, it puts forward transformation suggestions at the company level, business level, and functional level to ensure the effectiveness of town operation and management. Interviews are used to obtain data, and content analysis is used to understand the operating situation of Xiangsi Town. Guidelines for the town operation and management strategy are proposed from three aspects: feasibility, policy, and framework. The researcher will draft the guidelines and invite five experts in the field of tourism town operation and management to evaluate its applicability, consistency, feasibility, and practicality.

Results

1. The current situation in operations management for promoting tourism in Xiangsi Town, Nanning City

Xiangsi Town, a cultural tourism initiative developed from the Xiangsi Lake Ethnic Culture and Style Street project, reflects significant strengths and challenges in its operations management. Despite a substantial investment exceeding 200 million yuan and a long development process, the town faces difficulties in achieving its potential as a thriving tourist destination. Strengths include its rich cultural heritage, natural beauty, and alignment with eco-tourism trends, supported by government policies and infrastructure investment. Technological advancements like mobile apps and digital tools have enhanced visitor accessibility, while government collaboration has fostered cohesive offerings. However, persistent challenges hinder its growth. These include limited visitor engagement due to a lack of regular activities, insufficient cultural exhibitions, fragmented management, and low-end, homogenous commercial offerings. Poor visitor experiences are exacerbated by inadequate infrastructure, such as parking, Wi-Fi connectivity, and multilingual resources, which limit appeal to international tourists. Operational weaknesses, such as workforce shortages and rising costs, further strain businesses. Opportunities exist in hosting frequent, diverse events, leveraging digital marketing, enhancing eco-tourism, and addressing gaps in upscale lodging and unique business offerings. By adopting sustainable practices, improving infrastructure, and strengthening public-private partnerships, Xiangsi Town can position itself as a competitive and eco-conscious destination, capitalizing on its cultural assets and aligning with global tourism trends.

2. The main problems in operations management for promoting Tourism of Xiangsi Town in Nanning City

Xiangsi Town faces significant challenges in promoting its tourism industry, primarily stemming from infrastructure limitations, fragmented management, and insufficient strategic planning. The town struggles with inadequate transportation options, aging facilities, and inconsistent service quality, which hinder the delivery of a seamless visitor experience. Despite its rich cultural heritage and eco-tourism potential, the lack of regular cultural activities, coordinated marketing efforts, and distinct commercial offerings limit its appeal to both domestic and international tourists. Seasonal revenue fluctuations and rising operational costs further strain local businesses, many of which face financial instability.

Additionally, the absence of modern amenities, digital tools, and sustainable infrastructure reduces Xiangsi Town's ability to attract tech-savvy and eco-conscious travelers, while demographic shifts such as an aging population and the rise of experiential tourism require more tailored offerings. To address these challenges, Xiangsi Town must adopt a

unified and forward-looking approach to tourism management. This includes improving infrastructure, fostering stronger collaboration between stakeholders, and enhancing the use of digital technologies like online booking platforms, augmented reality experiences, and personalized services.

Regular cultural events, innovative tourism packages, and strategic marketing campaigns targeting international audiences are crucial to diversifying the towns visitor base and boosting engagement. Investments in sustainability, professional training for local businesses, and improved connectivity and accessibility will further strengthen the towns competitiveness. By aligning its natural and cultural assets with modern tourist expectations, Xiangsi Town can achieve sustainable growth and establish itself as a distinctive and attractive destination.

3. Strategies to strengthen the operations management for promoting tourism of Xiangsi Town in Nanning City

Table 1 SWOT analysis of operations management for promoting Tourism of Town in Nanning City

SWOT analysis	Details
Strengths	<ul style="list-style-type: none"> ◆ Rich ethnic and cultural heritage (e.g., "Three Marches" festival). ◆ Advanced digital platforms and big data integration. ◆ Professional and tech-savvy workforce ensuring high service standards.
Weaknesses	<ul style="list-style-type: none"> ◆ Fragmented management and inconsistent service quality. ◆ Infrastructure gaps (e.g., parking, Wi-Fi, multilingual resources). ◆ Limited cultural events and low-end commercial offerings. xxx
Opportunities	<ul style="list-style-type: none"> ◆ Diversifying cultural events and integrating eco-tourism initiatives. ◆ Leveraging digital marketing and AR/AI technologies. ◆ Developing upscale accommodations and tailored tourism packages.
Threats	<ul style="list-style-type: none"> ◆ Competition from similar destinations. ◆ Shifting demographics and preferences for experiential tourism. ◆ Economic and political risks, including reliance on government funding and policy changes.

According to Table 1 & Table 2, SO (Strengths-Opportunities) Strategy: Leverage cultural heritage to diversify events: Use the rich ethnic and cultural heritage, such as the "Three Marches" festival, to create new cultural events and eco-tourism activities that appeal to diverse audiences. Integrate digital platforms for personalized experiences: Employ advanced digital tools and big data analytics to create tailored tourism packages based on visitor preferences. Utilize tech-savvy workforce for innovation: Train the professional workforce to implement AR/AI technologies that enhance visitor engagement, such as virtual cultural tours or interactive eco-tourism experiences. Promote upscale accommodations through cultural branding: Combine luxury accommodations with immersive cultural experiences, positioning Xiangsi Town as a premium destination for cultural and eco-tourism.

ST (Strengths-Threats) Strategies Differentiate through cultural authenticity: Highlight the town's unique cultural heritage and community-driven initiatives to stand out from competing destinations. Adapt offerings to shifting demographics: Use big data insights to understand and cater to the preferences of experiential tourists seeking authentic and meaningful travel experiences. Promote stability through partnerships: Strengthen

collaborations between government, private enterprises, and local communities to reduce the impact of economic and political risks. Enhance visitor experience with technology: Use digital platforms to attract tech-savvy younger travelers, ensuring Xiangsi Town remains relevant amidst demographic shifts.

Table 2 TOWS Analysis for Xiangsi Town

	Opportunities (O)	Threats (T)
	O1 Diversifying cultural events and integrating eco-tourism initiatives. O2 Leveraging digital marketing and AR/AI technologies. O3 Developing upscale accommodations and tailored tourism packages	T1 Competition from similar destinations. T2 Shifting demographics and preferences for experiential tourism. T3 Economic and political risks, including reliance on government funding and policy changes.
Strengths (S)	SO Strategies	ST Strategies
S1 Rich ethnic and cultural heritage (e.g., "Three Marches" festival). S2 Advanced digital platforms and big data integration. S3 Professional and tech-savvy workforce ensuring high service standards.	1. Leverage cultural heritage to diversify events. 2. Integrate digital platforms for personalized experiences. 3. Utilize tech-savvy workforce for innovation. 4. Promote upscale accommodations through cultural branding.	1. Differentiate through cultural authenticity. 2. Adapt offerings to shifting demographics. 3. Promote stability through partnerships. 4. Enhance visitor experience with technology.
Weaknesses (W)	WO Strategies	WT Strategies
W1 Fragmented management and inconsistent service quality. W2 Infrastructure gaps (e.g., parking, Wi-Fi, multilingual resources). W3 Limited cultural events and low-end commercial offerings	1. Address management fragmentation with technology. 2. Improve infrastructure to support new initiatives. 3. Expand cultural events to increase offerings. Upgrade commercial offerings for premium tourists.	1. Strengthen management to counter competition. 2. Mitigate demographic shifts with infrastructure upgrades. 3. Reduce government reliance through diversification. Focus on sustainability to appeal to conscious travelers.

WO (Weaknesses-Opportunities) Strategies Address management fragmentation with technology: Implement centralized management systems and digital tools to streamline operations and ensure consistent service quality. Improve infrastructure to support new initiatives: Develop multilingual resources, reliable Wi-Fi, and parking facilities to support

eco-tourism and cultural event diversification. Expand cultural events to increase offerings: Address the lack of events by introducing year-round festivals and workshops that appeal to niche audiences, supported by digital marketing campaigns. Upgrade commercial offerings for premium tourists: Enhance shopping and dining options to attract high-spending visitors and complement upscale accommodations and tailored packages.

WT (Weaknesses-Threats) Strategies Strengthen management to counter competition: Establish clear leadership and coordination among stakeholders to improve service quality and differentiate Xiangsi Town from competitors. Mitigate demographic shifts with infrastructure upgrades: Modernize infrastructure, such as smart visitor centers and IoT solutions, to appeal to experiential tourists seeking convenience and engagement. Reduce government reliance through diversification: Develop alternative funding sources, such as public-private partnerships, to minimize dependency on government policies and budgets. Focus on sustainability to appeal to conscious travelers: Address infrastructure gaps with eco-friendly solutions, such as green transportation and sustainable practices, to attract environmentally conscious visitors and reduce competitive risks.

Discussion

1. The current situation in operations management for promoting Tourism of Xiangsi Town in Nanning City

Xiangsi Town's rich cultural heritage and eco-tourism initiatives, supported by modern technology and government policies, provide a solid base for sustainable tourism growth (Zhou et al., 2023). However, challenges such as fragmented management, insufficient infrastructure, and workforce shortages hinder its potential. To address these issues, the town should focus on hosting regular cultural events, enhancing digital marketing, improving facilities, and adopting eco-friendly practices. By aligning with global sustainability trends and fostering innovation, Xiangsi Town can position itself as a competitive and eco-conscious tourism destination.

2. The main problems in operations management for promoting Tourism of Xiangsi Town in Nanning City

Xiangsi Town faces significant challenges in infrastructure, management, and digitalization that limit its tourism potential. Inadequate transportation, signage, and accommodations reduce visitor satisfaction, highlighting the need for targeted investments in facilities and service delivery (Cheng & Zhang, 2021). Additionally, fragmented management structures hinder coordination and resource allocation, emphasizing the importance of a unified framework to streamline operations and enhance competitiveness (Wang & Wang, 2019). To address these issues, Xiangsi must modernize its infrastructure, adopt digital tools like AR and mobile apps, and implement cohesive marketing strategies to attract and engage a global audience.

3. Strategies to strengthen the operations management for promoting Tourism of Xiangsi Town in Nanning City.

Xiangsi Town can achieve sustainable tourism growth through an integrated management framework, technological innovations, and sustainable practices. A centralized management body enhances coordination among stakeholders, streamlining decision-making and ensuring efficient resource allocation (Zhang & Fan, 2020). By clearly defining the roles of government, private enterprises, and local communities, the town fosters collaboration and inclusivity in its development strategies. Additionally, leveraging technological advancements, such as smart kiosks, real-time navigation, and AI-driven analytics, optimizes visitor experiences and operational efficiency (Chen & Huang, 2021). Sustainable practices, including eco-friendly accommodations and cultural preservation initiatives like showcasing Zhuang

textiles, further bolster Xiangsi’s appeal as a responsible and authentic travel destination. These strategies collectively position Xiangsi Town as a model for sustainable and innovative tourism development.

Conclusion and Implication

1. Conclusion

Xiangsi Town possesses significant potential as a cultural and eco-tourism destination, with its rich heritage, strategic infrastructure, and technological advancements aligning with global tourism trends. However, its growth is hindered by challenges such as inadequate infrastructure, fragmented management, and limited international outreach. To address these issues and enhance its competitiveness, the town must implement strategic infrastructure investments, foster public-private collaborations, and leverage digital tools to optimize tourism operations. Additionally, diversifying tourism offerings and adopting sustainable practices will ensure long-term growth while preserving its cultural and natural assets. By integrating strategic planning, technological innovation, and community engagement, Xiangsi Town can strengthen its operations management, improve visitor experiences, and establish itself as a leading sustainable tourism destination, driving economic growth and enhancing its regional and global appeal.

2. Theoretical Contribution

This study contributes to the theoretical understanding of operations management in cultural and eco-tourism development by integrating perspectives from strategic planning, stakeholder collaboration, and digital transformation. It expands existing tourism management frameworks by emphasizing the role of public-private partnerships, technological advancements, and service diversification in fostering sustainable tourism growth.

Furthermore, the study bridges gaps in destination competitiveness theory by highlighting the interplay between infrastructure, management efficiency, and tourism diversification in enhancing a location’s attractiveness. It also contributes to sustainable tourism theories by demonstrating how balancing economic development with cultural preservation and environmental conservation can lead to long-term success.

By applying a holistic operations management approach, this research provides a new framework for analyzing and optimizing tourism in culturally rich but operationally constrained destinations like Xiangsi Town. Future studies can build upon this foundation to explore comparative models of tourism management in similar emerging destinations.

3. Managerial Contribution

From a practical perspective, this study provides actionable insights for local policymakers, tourism operators, and investors seeking to enhance Xiangsi Town’s competitiveness. One key managerial contribution is strategic infrastructure investment, which involves improving transportation networks, digital infrastructure, and sustainable facilities to overcome operational inefficiencies and enhance visitor experiences. Additionally, diversifying tourism offerings through innovative cultural events, eco-tourism packages, and themed experiences can attract a broader audience and increase visitor engagement. Another important aspect is leveraging digital transformation, where AI-driven marketing, big data analytics, and smart tourism applications can be utilized to understand visitor preferences, predict tourism trends, and optimize resource allocation. Furthermore, enhancing public-private collaboration by strengthening partnerships between government agencies, private enterprises, and local communities will improve funding, service quality, and overall operational efficiency. Lastly, sustainability-driven development should be prioritized by implementing eco-friendly policies, responsible tourism practices, and capacity-building programs to ensure long-term growth while preserving the town’s cultural and natural assets.

By implementing these strategies, Xiangsi Town can enhance its appeal, improve operational effectiveness, and position itself as a premier cultural and eco-tourism destination, ensuring sustainable economic growth and global competitiveness.

4. Limitations and Future Research

Despite the valuable insights provided by this study, several limitations should be acknowledged. First, the research primarily relies on cross-sectional data, which captures a snapshot of tourism operations in Xiangsi Town at a specific point in time. This approach limits the ability to assess long-term trends and the evolving impact of implemented strategies. Second, the study's findings may be context-specific and not fully generalizable to other tourism destinations with different economic, cultural, and infrastructural conditions. Future studies could adopt a comparative approach by examining similar tourism-driven towns to enhance external validity. Third, the research may be constrained by the availability and accuracy of secondary data sources, which could influence the robustness of the analysis. Additionally, while qualitative insights from stakeholders provide depth to the findings, there is a need for more empirical, quantitative measures to validate the identified trends.

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Entrepreneurial Intention: A Study of University Students' Willingness to Return Home to Start Their Own Business in Nanning City

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Abstract

This research objective was to analyze the factors affecting the willingness of university students to return home to start their own businesses in Nanning City. The study employed a quantitative research approach. Data were gathered from 550 students across three universities in Nanning City using the Questionnaire Star platform. The data were analyzed by using descriptive statistics and correlation analysis, and binary logistic regression was used to examine the effects of social support, entrepreneurship education, personal traits, and risk preference on students' willingness to return home and start businesses. The findings revealed that social support significantly influenced university students' willingness to return home and start businesses, with support from family, friends, and government playing a key role. Specifically, support from family, friends, and government played a prominent role in enhancing students' intention to start businesses back home. However, entrepreneurship education, personal traits, and risk preference did not have a significant impact. The regression model had an overall prediction accuracy of 71.45%, indicating a good fit, with social support being the strongest predictor. This underscores the critical role of social support in reducing uncertainties and financial barriers, providing necessary resources, and fostering a supportive environment that encourages students to pursue entrepreneurial opportunities in their hometowns.

Keywords Entrepreneurial Intention; Social Support; Entrepreneurship Education; Personal Traits; Risk Preference

Introduction

Youth employment has become an urgent societal issue amidst rising numbers of college graduates and intensifying competition in the job market. The urban unemployment rate for individuals aged 16-24 in China reached a staggering 21.3% in 2023, with university graduates being disproportionately affected (Yu et al., 2024). By 2024, the number of college graduates is expected to reach a record 11.79 million, further exacerbating employment challenges. These challenges not only hinder individual career development but also pose significant risks to social stability and economic growth (Yu et al., 2024).

In parallel, China's rural revitalization strategy underscores the need to attract and retain talent for driving rural economic development. Despite these efforts, rural areas continue to face severe brain drain, limited entrepreneurial opportunities, and a mismatch between local

governance structures and developmental needs (Sarfo et al., 2024). Encouraging college graduates to return to their hometowns and start businesses presents a potential solution to both urban employment pressures and rural economic stagnation. However, there remains a lack of understanding of the factors influencing graduates' willingness to pursue entrepreneurial ventures in rural areas, leaving a gap between national policy aspirations and practical implementation (Alamineh, 2022).

Existing research on entrepreneurial intentions has primarily focused on urban settings, emphasizing factors such as access to resources, networks, and institutional support (Amini Sedeh et al., 2021; Rusu et al., 2022). However, study addressing rural entrepreneurial intentions—especially among university students—are limited (Bouichou et al., 2021). This creates a significant knowledge gap in understanding how rural-specific variables, such as social support and rural entrepreneurship education, influence entrepreneurial intentions. Additionally, while theoretical frameworks like the Theory of Planned Behavior (TPB) provide a foundation for studying entrepreneurial intentions, their application in the context of rural entrepreneurship remains underexplored (Sarwar et al., 2021). For example, the role of social support and risk preferences has not been sufficiently integrated into TPB-based models, highlighting a theoretical gap that this study aims to address (Ha et al., 2023).

To bridge these gaps, this study investigates the factors influencing university students' willingness to return to their hometowns in Nanning, China to start their own businesses. Specifically, the research explores the impact of social support, entrepreneurship education, personal traits (e. g. , self- efficacy, innovation, and achievement motivation), and risk preferences on entrepreneurial intentions (Hossain et al., 2024). By applying robust data analysis techniques, this study seeks to contribute new insights into the intersection of rural entrepreneurship and youth employment. The findings of this study will have significant implications for policymakers, educational institutions, and families. For policymakers, the results can guide the development of targeted policies to improve the rural entrepreneurial environment. For universities, the study highlights the need to enhance the practical components of entrepreneurship education. For families, it underscores the importance of emotional and resource support to boost students' confidence in pursuing rural entrepreneurship (Ghouse et al., 2024).

In summary, this study addresses critical gaps in the literature by investigating both the unique contextual factors of rural entrepreneurship and the broader theoretical framework of entrepreneurial intention. It also aligns with national priorities for rural revitalization, offering actionable recommendations to bridge the gap between policy and practice.

1. Research Objective

This study aims to investigate the factors affecting the willingness of university students to return home to start their own businesses in Nanning City.

2. Review of Related Literatures

Entrepreneurial intention, defined as an individual's willingness to establish a new business, has been a central focus of entrepreneurship research. This study investigates four key factors influencing university students' willingness to return home to start businesses: social support, entrepreneurship education, personal traits, and risk preference (Hossain et al., 2024) as show in conceptual framework (see Figure 1).

Social support encompasses the emotional, informational, and material assistance individuals receive from their surroundings, including family, peers, and government entities. Prior studies have emphasized the importance of social support in shaping entrepreneurial intention. Family and peer encouragement often bolster an individual's confidence and provide

tangible resources necessary for entrepreneurial activities (Tam et al., 2021). Government support, through financial incentives, training programs, and favorable policies, further facilitates entrepreneurship, particularly in rural areas.

In the rural entrepreneurship context, social support plays a crucial role in mitigating resource constraints and creating a supportive environment. For instance, supportive family attitudes have been shown to directly enhance entrepreneurial self-efficacy and intention (Ahmed et al., 2021). However, there is limited research specifically addressing how these forms of support influence graduates' willingness to return to their hometowns to start businesses.

H1: Social support has a positive impact on university students' willingness to return home to start their own business.

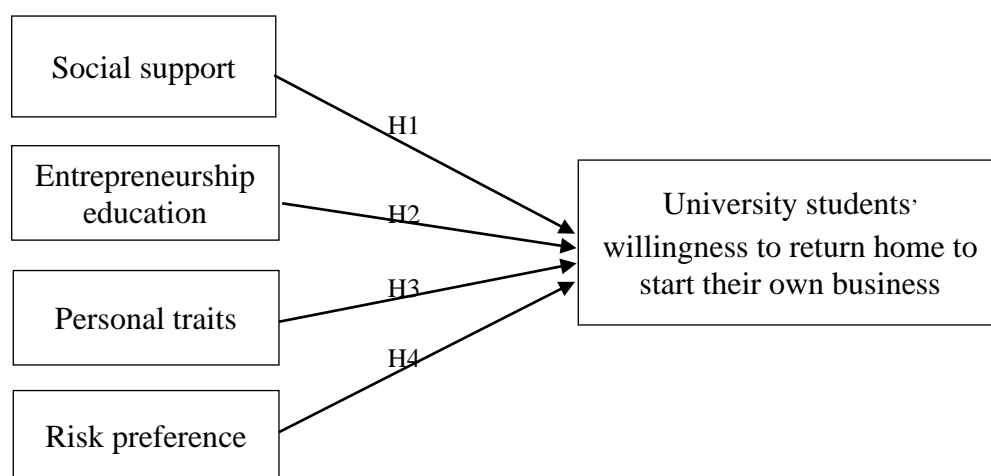


Figure 1 Conceptual framework

Entrepreneurship education aims to equip individuals with the knowledge, skills, and mindset necessary to engage in entrepreneurial activities (Bell & Bell, 2020). Studies have confirmed the positive relationship between entrepreneurship education and entrepreneurial intention (Duong, 2022; Wu et al., 2022). Such education fosters entrepreneurial attitudes, enhances risk-taking ability, and develops practical skills, all of which are critical for starting a business. In the context of rural entrepreneurship, specialized education addressing rural market challenges, resource limitations, and community engagement is essential (Chan et al., 2021). Yet, the integration of rural-specific entrepreneurial training within university curricula remains underexplored (Zhao et al., 2023). This creates a need to investigate how entrepreneurship education affects students' willingness to pursue rural ventures.

H2: Entrepreneurship education has a positive impact on university students' willingness to return home to start their own business.

Personal traits refer to intrinsic characteristics such as self-efficacy, innovation, and achievement motivation, which influence entrepreneurial intention. Self-efficacy, or the belief in one's ability to execute entrepreneurial tasks, has been consistently linked to entrepreneurial behaviors (Yousaf et al., 2021). Similarly, innovative individuals are more likely to identify and exploit entrepreneurial opportunities, while those with high achievement motivation are driven to succeed in challenging endeavors (Maran et al., 2021). While these traits are widely

recognized as predictors of entrepreneurial intention, their influence in the rural entrepreneurship context requires further investigation. Rural entrepreneurship often demands greater resilience, creativity, and adaptability due to unique environmental challenges, suggesting the need for targeted exploration of these traits (Hutchinson et al., 2021).

H3: Personal traits have a positive impact on university students' willingness to return home to start their own business.

Risk preference refers to an individual's tolerance for uncertainty and willingness to engage in ventures with uncertain outcomes. Entrepreneurs often face significant risks, including financial loss, market unpredictability, and operational challenges. Studies have consistently shown that individuals with higher risk tolerance are more likely to pursue entrepreneurial activities (Gurel et al., 2021; Todaro et al., 2021). In the rural entrepreneurship context, the perception of risk is often heightened due to factors such as limited market access, scarce resources, and volatile income streams. However, little research has examined how risk tolerance and perceived risk specifically impact graduates' willingness to return to rural areas for entrepreneurial endeavors (Zichella & Reichstein, 2023). Understanding this relationship is critical for designing effective interventions to reduce perceived risks and enhance entrepreneurial intention.

H4: Risk preference has a positive impact on university students' willingness to return home to start their own business.

The hypotheses outlined in this review address critical gaps in understanding the factors influencing university students' willingness to return to their hometowns for entrepreneurial ventures. By examining the roles of social support, entrepreneurship education, personal characteristics, and risk preference, this study contributes to both theoretical and practical advancements in rural entrepreneurship research.

Research Methodology

1. Research design

This study adopts quantitative research methods to investigate the influencing factors of college students' willingness to return home and start businesses. Structured questionnaire survey was used to collect the data of college students from three different types of universities in Nanning to ensure the reliability and validity of the survey results.

2. Sample

The study was conducted on a sample of 550 college students from different institutions using a simple random sampling method to ensure diversity and representativeness. The sample size of 550 was determined based on Krejcie and Morgan (1970) sample size determination, ensuring statistical power and generalizability for a large student population. To achieve a balanced representation, students were selected from three different types of universities in Nanning. The data were collected through the Questionnaire Star platform, allowing for broad accessibility and efficient distribution.

3. Measurement

The dependent variable in this study is university students' willingness to return home to start their own businesses, measured as a binary outcome (Yes or No). The independent

variables include social support, entrepreneurship education, personal traits, and risk preference, each capturing different aspects of influence on entrepreneurial intention. Social support is categorized into family, peer, and government support, reflecting the emotional, informational, and resource-based assistance available to students. Entrepreneurship education focuses on access to entrepreneurship courses and training programs, equipping students with the necessary knowledge and skills for entrepreneurial endeavors. Personal traits, such as self-efficacy, innovation, and achievement motivation, are also examined as key predictors of entrepreneurial behavior, capturing intrinsic factors that drive entrepreneurial intention. Additionally, risk appetite is assessed through risk tolerance and risk perception, addressing students' willingness to engage in ventures with uncertain outcomes.

The data is collected using a structured questionnaire consisting of Likert Scale items, where respondents indicate their level of agreement with statements related to each variable (1 = strongly disagree to 5 = strongly agree). Reliability analysis result as show in Table 1.

Table 1 Reliability analysis results

Measure	Cronbach's Alpha	Remark
Social Support	0.859	High reliability
Entrepreneurship Education	0.880	High reliability
Personal Traits	0.937	High reliability
Risk preference	0.936	High reliability

The reliability analysis revealed that the Cronbach's alpha coefficients for social support (0.859), entrepreneurship education (0.880), Risk preference (0.936), and personal traits (0.937) exceeded 0.8, reflecting high reliability.

The validity analysis, assessed using KMO and Bartlett's sphericity tests, confirmed the suitability of the data for factor analysis. The KMO value was 0.954, well above the threshold of 0.8, and Bartlett's test showed significance ($\chi^2 = 10080.635$, $p < 0.001$), indicating excellent data validity. Factor loadings for all items, were above 0.4, and the cumulative variance explained was 75.9%, further supporting the construct validity of the scales.

4. Data Analysis

This paper studies the willingness of university students to return home and start their own business. On this basis, a binary regression model is established, and the dependent variable Y= the willingness of university students to return home and start businesses. Students who are willing to return home to start a business are recorded as "1", and those who are not willing to return home to start a business are recorded as "1" "0". This paper uses statistical software to establish binary Logistic regression model for analysis. Use $p_1 = p$ to represent the probability of "willing to return to China to start a business", and use $P_2 = (1-P)$ to represent the probability of "unwilling to return to China to start a business".

Let's use $X_1, X_2, X_3, \dots, X_n$ represents the influencing factors respectively, and the regression equation is as follows:

$Y=(P_1/P_2) = a_0+a_1X_1+a_2X_2+\dots +a_nX_n$ is the explained variable, and the influencing factors are regression; is the regression coefficient, and n is the number of explanatory variables.

$$Y = \begin{cases} 0 = & \text{Unwillingness to return home} \\ 1 = & \text{Willing to return home} \end{cases}$$

$P1/P2$ is called the odds ratio, which represents the ratio of the probability of event occurrence to the probability of non-occurrence. The logarithm is obtained by taking the natural logarithm.

Through the above formula, the probability of event occurrence can be predicted based on the value of the independent variable, and the model parameters a_0, a_1, \dots, a_n is usually determined by methods such as maximum likelihood estimation to maximize the probability of the occurrence of the observed data.

a_i (regression coefficient): The positive or negative of a_i determines the direction of the influence of the independent variable on the dependent variable

a_0 (intercept term): is the base value and does not itself explain the effect of the variable on the dependent variable

$a_i > 0$ indicates that X_i is positively correlated with the probability p of the event occurrence, that is, as x_i increases, p tends to increase

$a_i < 0$ indicates that X_i is negatively correlated with the probability p of the event, that is, as x_i increases, p also tends to decrease

The statistical analysis for this study was conducted using SPSSAU to ensure a robust evaluation of the data. Descriptive statistics were used to summarize and aggregate the demographic characteristics of the respondents, providing an overview of the sample population. Reliability and validity testing were performed to ensure the consistency and accuracy of the measurement scales used in the questionnaire. Furthermore, binary logit analysis was employed to determine the strength and direction of the relationship between the independent variables and the dependent variable, which is university students' willingness to return home to start their own businesses. Finally, hypotheses were tested to evaluate the influence of each factor, including social support, entrepreneurship education, personal traits, and risk preference, on entrepreneurial intention.

Results

1. Respondent data

Descriptive statistics show that there are 550 respondents in the sample, of which 114 are male, accounting for 20.73% of the total, and 436 are female, accounting for 79.27% of the total. This indicates that there were significantly more women than men participating in the survey. In terms of age distribution, the largest number of respondents were aged 19-22, with 452, accounting for 82.18% of the total, followed by those aged 18 and below, with 81, accounting for 14.73%. In terms of education distribution, there were 309 higher vocational/junior university students, accounting for 56.18% of the total; There are 239 undergraduate students, accounting for 43.45% of the total, and 2 graduate students, accounting for 0.36% of the total

2. Binary regression analysis results

The binary logit regression analysis explores the factors influencing university students' willingness to return home to start their own businesses as show in Table 2. Among the variables analyzed, social support emerged as the most significant factor, with a regression coefficient of 0.767 and a p-value of 0.001, indicating a statistically significant positive effect. The odds ratio ($OR = 2.153$) suggests that students with higher social support are 2.153 times more likely to exhibit willingness to return home for entrepreneurship compared to those with less support. This relationship is further supported by a 95% confidence interval ranging from 1.354 to 3.424, confirming its reliability.

Table 2 Binary logit regression analysis results

Hypothesis	Variable	Regression coefficient	Standard Error	Z-value	Wald χ^2	p value	OR value	OR value 95% CI
H1	Social support	0.767	0.237	3.242	10.512	0.001	2.153	1.354 to 3.424
H2	Entrepreneurship education	0.253	0.216	1.168	1.363	0.243	1.288	0.842 to 1.968
H3	Personal Traits	0.379	0.252	1.503	2.260	0.133	1.461	0.891 to 2.395
H4	Risk preference	0.295	0.243	1.214	1.475	0.225	1.343	0.834 to 2.162
McFadden R square = 0.155								
Cox & Snell R square = 0.184								
Nagelkerke R square = 0.251								
Note: Dependent variable = University students' willingness to return home to start their own businesses								

Other variables, including entrepreneurship education, personal traits, and risk preference, showed positive regression coefficients (0.253, 0.379, and 0.295, respectively), suggesting a potential positive relationship with students' willingness to return home. However, their p-values (0.243, 0.133, and 0.225, respectively) exceed the 0.05 threshold for statistical significance, indicating that their effects are not conclusive in this model. Additionally, the odds ratios for these variables include 1 within their confidence intervals, further supporting their lack of statistical significance.

Regarding the model's overall fit, the McFadden R^2 value of 0.155 indicates that the independent variables explain approximately 15.5% of the variance in the dependent variable. Cox & Snell R^2 (0.184) and Nagelkerke R^2 (0.251) suggest moderate explanatory power, with Nagelkerke R^2 indicating that 25.2% of the variance is accounted for by the model. Overall, the analysis highlights the critical role of social support in shaping students' entrepreneurial intentions while suggesting that other factors may require further exploration or refinement for conclusive results.

Table 3 summarizes the prediction accuracy of the binary logit regression model used to analyze university students' willingness to return home to start their own businesses. The table compares the predicted values with the true values to evaluate the model's classification performance.

Table 3 Binary Logit regression prediction accuracy summary

		Predicted Value		Prediction accuracy	Prediction error rate
		0	1		
True value	0	95	104	47.74%	52.26%
	1	54	297	84.90%	15.10%
Summary				71.45%	28.55%

For cases where the true value is "0" (students unwilling to return home), the model correctly predicted 95 cases, resulting in an accuracy of 47.74%. However, it misclassified 104 cases as "1" (students willing to return home), leading to a prediction error rate of 52.26% in this group.

For cases where the true value is "1" (students willing to return home), the model performed better, correctly classifying 297 cases, achieving an accuracy of 84.90%. It misclassified 54 cases as "0," yielding a prediction error rate of 15.10%.

In summary, the model's overall prediction accuracy is 71.45%, meaning it correctly classified 71.45% of all cases. The overall prediction error rate is 28.55%, representing the proportion of cases where the model's predictions were incorrect. These results suggest that the model is more effective at predicting willingness to return home ("1") compared to unwillingness ("0"), as indicated by the higher accuracy for "1" cases. However, the relatively high error rate for "0" cases points to potential areas for improvement in the model's classification of unwillingness.

Table 4 Summary of the hypothesis testing results

Hypothesis	Regression Coefficient	p value	Odds Ratio (OR)	95% Confidence Interval (CI)	Result
H1	0.767	0.001	2.153	1.354 to 3.424	Supported
H2	0.253	0.243	1.288	0.842 to 1.968	Not Supported
H3	0.379	0.133	1.461	0.891 to 2.395	Not Supported
H4	0.295	0.225	1.343	0.834 to 2.162	Not Supported

The binary logit regression analysis tested four hypotheses related to factors influencing university students' willingness to return home to start their own businesses (see Table 4). H1, which posited that social support positively impacts students' willingness, was supported, as social support showed a statistically significant positive effect ($p = 0.001$) with an odds ratio of 2.153. In contrast, H2, H3, and H4, which examined the effects of entrepreneurship education, personal traits, and risk preference, were not supported.

Discussion

This research aimed to explore the factors influencing university students' intention to return home and start businesses in Nanning City. The findings revealed that social support had a significant positive impact, while school education, personal characteristics, and risk preference did not significantly affect students' entrepreneurial intentions.

The study found that social support, including family, friends, and government support, plays a crucial role in influencing students' intention to return home and start businesses. These

results are consistent with prior research which suggests that strong social networks and community support are essential for entrepreneurial intentions (Al Halbusi et al., 2023). In particular, government policies were identified as critical factors in motivating students to start businesses back home. Social support has been shown to provide both emotional and instrumental resources that significantly influence entrepreneurial intentions (Neneh, 2022).

Although the study found that entrepreneurship education did not significantly affect the intention to return home, this contradicts some previous studies that emphasize the importance of entrepreneurship education in fostering entrepreneurial intentions (Porfírio et al., 2022). The lack of a significant effect may be attributed to the limited practical application of entrepreneurship courses offered at universities. Researchers have highlighted that practical, hands-on entrepreneurship experiences are more impactful than theoretical education in developing entrepreneurial skills (Lackéus, 2020). Therefore, the lack of practical relevance in the curriculum could explain why school education did not show a significant effect in this study.

Personal traits, such as entrepreneurial confidence and innovation ability, did not significantly influence students' intention to return home and start businesses. This finding aligns with studies suggesting that external factors, such as social support and market conditions, may have a stronger influence on entrepreneurial intentions than individual traits (Lee et al., 2011). While personal characteristics are generally considered essential in entrepreneurship, the context of returning home to start a business may require more external environmental factors, such as access to resources, than intrinsic qualities alone (Lumpkin et al., 2013).

Risk preference also showed no significant effect on the students' entrepreneurial intentions. This result is in contrast to research that identifies risk tolerance as a key factor influencing entrepreneurial decisions (Kusnindar et al., 2024). The findings may reflect the unique challenges associated with starting a business in one's hometown, such as limited market opportunities and insufficient resources, which reduce the impact of risk appetite on decision-making (Mandel & Parija, 2024). These structural constraints may overshadow the influence of personal risk tolerance, suggesting that external factors are more critical in determining entrepreneurial intentions in this specific context.

The findings underscore the importance of social support in fostering entrepreneurial intentions among university students. Policymakers and universities should consider strengthening their support systems, including government-backed entrepreneurial resources and family support initiatives, to encourage students to start businesses back home. Furthermore, educational programs should focus on offering more practical entrepreneurship experiences rather than solely relying on theoretical courses. Creating a more supportive environment that enhances students' confidence in their entrepreneurial ventures could increase the likelihood of students returning home to start businesses.

In summary, this study highlights the significance of social support in influencing university students' entrepreneurial intentions. While entrepreneurship education, personal traits, and risk preference did not show significant effects, the study suggests that external factors such as family, community, and government support play a dominant role.

Conclusion

This research revealed that social support plays a crucial role in influencing university students' willingness to return home and start their own businesses in Nanning, China, with a statistically significant positive impact. The findings support H1, as students with higher social support were 2.153 times more likely to express entrepreneurial intentions. However, H2, H3,

and H4, which examined the effects of entrepreneurship education, personal traits, and risk preference, were not supported due to their non-significant p-values, indicating that these factors did not have a conclusive effect in this study. The model's prediction accuracy was moderate, correctly classifying 71.45% of all cases, with a higher accuracy for students willing to return home. Overall, the study underscores the importance of social support in fostering entrepreneurial intentions among university students, while suggesting that further research is needed to better understand the role of other factors such as education, personal traits, and risk preference.

This study highlights the significance of social support in shaping university students' entrepreneurial intentions, offering valuable insights for policymakers, universities, local governments, and entrepreneurs. Policymakers and local governments can leverage these findings by designing targeted incentives, such as financial aid, tax benefits, and startup grants, to encourage students to return home and establish businesses. Universities can integrate entrepreneurship training into their curricula, establish incubators, and provide mentorship programs that connect students with experienced entrepreneurs. Entrepreneurs and business leaders can support this initiative by offering internship opportunities, networking events, and investment in student-led startups. By collaboratively strengthening social support systems, these stakeholders can create a more favorable environment that enhances students' confidence and willingness to engage in entrepreneurship in their hometowns.

This research contributes to the existing literature on entrepreneurial intentions by focusing on the specific context of university students' willingness to return home and start their own businesses in Nanning, China. By applying binary logit regression analysis, the study provides a quantitative understanding of how social support influences students' entrepreneurial intentions, while also testing other factors like entrepreneurship education, personal traits, and risk preference. The findings extend the theory of entrepreneurial intentions, offering empirical evidence that social support is a critical factor in fostering entrepreneurial behavior, which can inform future research on entrepreneurship in different cultural and regional settings.

Future research could explore the factors that contribute to social support and its influence on entrepreneurial intentions. For example, qualitative studies could investigate the types of social support that have the most impact (e.g., family, peers, mentors, or community networks) and how these influences vary across different demographic groups. Additionally, further research could examine the interaction between entrepreneurship education and social support, as it is possible that the combination of these factors may have a synergistic effect on entrepreneurial intentions. Exploring these factors in different geographical contexts and cultural settings could help generalize the findings and provide deeper insights into the dynamics of entrepreneurship among students.

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Digital Marketing Applications for Hotel Brand Development: A Case Study of Lao Cai, Vietnam

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Abstract

In the era of Industry 4.0, with the strong development of the internet and digital media, digital marketing plays a vital role in the growth of any business, regardless of size or sector, especially in tourism services – including the hospitality industry. This study highlights some achievements as well as existing limitations faced by hotels. Hotels have utilized social media platforms to enhance their image and brand promotions; however, marketing effectiveness remains low. With the study recommendations, hotels can gradually improve and leverage their use of digital marketing tools. This approach will help build a stronger brand image, enabling hotels to sustain and grow in the current 4.0 era. Additionally, the challenges faced by hotels should be addressed by the most suitable solutions. Key problems include a lack of experienced staff, limited focus on enhancing advertising activities and user engagement on social platforms such as Facebook, Wechat, Tiktok, in spite of their potential to reach a vast prospective customers. Hotels need to make more financial investment in training, recruiting professional employees, as well as developing digital marketing tools.

Keywords: hotel industry, digital marketing, facilities, Lao Cai.

Introduction

According to Vietnam E-business index report 2024 from Vietnam E-commerce Association, the e-commerce sector continued to thrive with a growth rate exceeding 25% compared to 2022 and reaching a scale of over 25 billion USD. As reported by VnExpress, Vietnam's e-commerce market size is estimated to reach over 25 billion USD in 2024, marking a 20% increase compared to 2023. This achievement positions Vietnam among the top three countries in Southeast Asia's digital economy. Recently, in addition to the presence of domestic retail e-commerce platforms such as Shopee, Tiktok Shop, Lazada, Tiki and Sendo, the market has observed the entry of cross-border platforms like Temu and Shein.

This rapid growth highlights the transformative power of the internet and digital platforms in shaping consumer behavior. As businesses navigate this digital era, traditional marketing methods have increasingly lost their effectiveness, paving the way for digital marketing to become the preferred strategy for engaging customers, including travel agencies, hotels, and tourism companies. In the era of Industry 4.0, as consumers shift their habits toward online consumption, businesses must devise strategies to adapt to this behavior. Consequently, business owners are proactively leveraging online tools to connect with customers. Therefore, these companies need dedicated teams skilled in customer engagement and creative enough to effectively sell their products.

Tourism is one of the industries most significantly influenced by, and parallel to, the development of digital technology. It is also among the first to implement digital marketing strategies in practice, ensuring that its customers can access services in the most convenient way possible.

Literature review

As per American Marketing Association (2013), digital marketing is defined as “any marketing methods conducted through electronic devices which utilize some form of a computer, including online marketing efforts conducted on the internet”. According to Desai (2019), digital marketing refers to the “use of numerous digital tactics and channels to connect with customers where they spend much of their time: online”.

The achievement of digital marketing initiates with the on-going process of converting leads into loyal customers with a positive customer experience (Cook, 2014). Moreover, benefits of digital marketing includes better brand building, competitiveness with large corporations, increase in sales and brand awareness for small business (Lavanya & Radhikamani, 2021)

In the field of marketing and communication, Waters, Burnett, Lamm, and Lucas (2009) argued that online platforms create many opportunities for businesses to implement marketing strategies such as customer interaction and relationship management or building and enhancing consumer loyalty and brand development strategies (Bughin, 2014). Studies on digital marketing applications are often popular in areas such as travel services (Pelsmacker, Tilburg, & Holthof, 2018) and recently educational services in the context of globalization (Fierro, Arbelaez, & Gavilanez, 2017). It can be seen that the application of digital marketing in business fields in general and education in particular is an inevitable trend and is increasingly attracting the attention of researchers as well as administrators.

Research methodology

Data collection method

This study collected primary data using questionnaire. A questionnaire design provides a quantitative description of trends, attitudes, or opinions of a population by studying a sample of that population.

The authors conducted a survey to measure the level of customer satisfaction with hotel products. In this study, to determine the number of customers who would be surveyed to evaluate the application of digital marketing tools to build the hotel brand, the authors used the formula by Slovin (1960) to determine the sample size, specifically as follows:

$$n = N / (1 + N * e^2)$$

In which: n: sample size; N: total number; e: standard error

Applying the above formula with a confidence interval of 95%, the standard error $e = 0.05$ gives the result of 40. The author will conduct a survey to select a sample of 40 customers. The survey will be conducted by distributing questionnaires to each customer.

The survey was designed with questions to evaluate the performance of digital marketing tools. A 5-point Likert scale was used in this study.

Secondary data is also used through published materials such as books, textbooks, and research papers on Marketing and Digital Marketing; documents from the Government, the Party, and the State related to the topic; and data that is processed and analyzed to draw scientifically grounded conclusions and evaluations to support the research.

Data synthesis and processing methods

Data synthesis method: Conducted by statistical disaggregation method, mainly used to synthesize survey and interview results.

Data processing method: Data processing is the standardization and cleaning of raw data for data analysis.

Data analysis method

Statistical analysis method: The study uses both descriptive statistics and comparative statistics. The main tools in this method are the application of statistical analysis methods such as relative numbers, absolute numbers, average numbers, development rates, growth rates, time series; charts, diagrams, descriptive graphs... to analyze indicators to meet the research purpose.

Synthetic analysis method

Synthesized analysis, combining the results of several studies to solve a series of related hypotheses.

Data analysis

The impact of Digital marketing on branding for hotels in Lao Cai, Vietnam.

For the question of how customers learn about hotels in Lao Cai, 31 out of 40 respondents (77.5%) chose social media platforms (Facebook, Zalo, TikTok, Google, etc.), 3 out of 40 (7.5%) indicated word-of-mouth recommendations, and 6 out of 40 (15%) selected advertisements. Moreover, 97.5% (39 out of 40) of survey participants agreed that these information sources were useful. This indicates that digital marketing tools play a significant role in promoting the hotel's image to customers.

Among the 40 surveyed customers, 38 (95%) remembered and chose to use the hotel's services through advertisements.

Positive Impacts on Hotel Branding in Lao Cai:

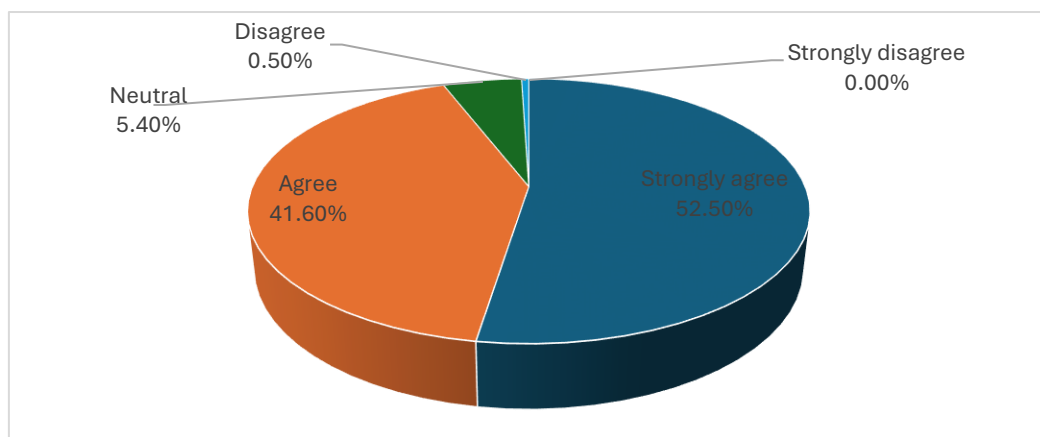


Figure 1 Positive Impact

Based on the survey results, we can observe the positive impacts that digital marketing has brought to the hotel. The percentage of customers who agreed or strongly agreed with the benefits of advertising is very high, nearly all exceeding 90%.

Negative Impacts of digital marketing:

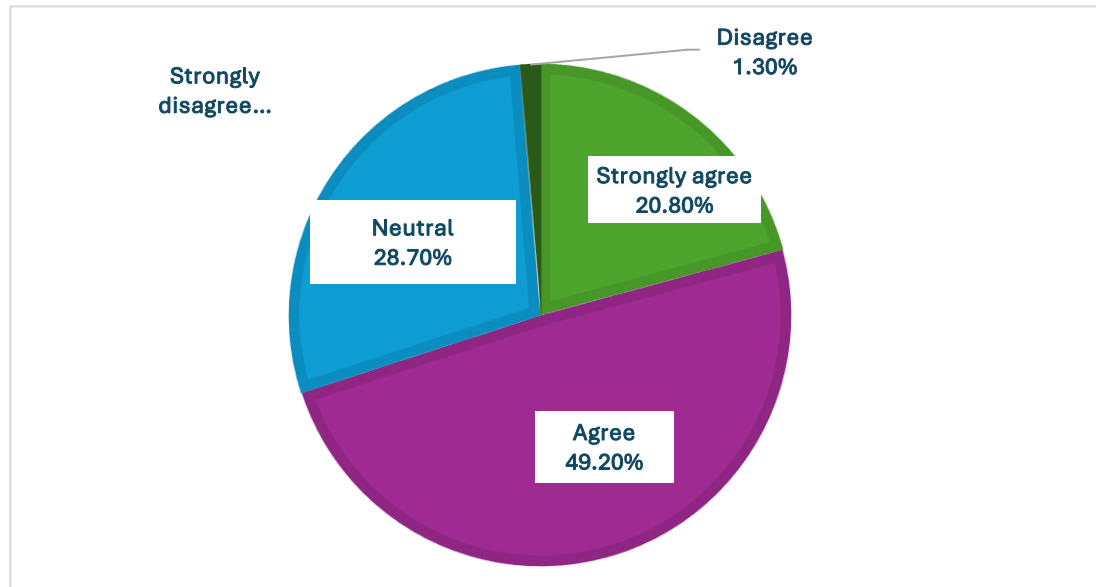


Figure 2 Negative impacts

The survey results highlighted almost all the common negative points associated with using digital marketing tools in hotels. While these impacts may not be beneficial for building a hotel's brand, the occurrence rate of these issues is relatively low, and they are not always encountered. Moreover, these problems can be resolved through various measures. For instance, regarding data security concerns, hotels can enhance their cybersecurity systems on social media platforms and improve the technical expertise of their IT staff.

Which form of advertising have customers chosen to use the services of hotels in Lao Cai?

With the advancement of smart technology, social media platforms make searching for information and booking rooms online significantly easier and faster, boosting hotel productivity. The proportion of customers conducting surveys and making bookings through online booking applications reaches up to 90%.

Recommendations

For company websites:

Enhance page load speed:

A slow-loading website can frustrate visitors and drive them to competitors' sites. To retain customer interest and prevent abandonment, companies should prioritize optimizing their website's loading speed. A fast and seamless browsing experience not only improves customer satisfaction but also strengthens the company's online presence.

Provide added value through utilities for customers:

A hotel's website can become more engaging by offering free value-added services, such as popular software tools, eBooks about travel, or articles sharing travel tips and customer experiences at the hotel. Regularly updating these resources on a consistent schedule can encourage repeat visits and enhance customer loyalty. Such utilities create a sense of added value, making the website more than just a booking platform.

Build strategic partnerships:

Partnering with reputable websites and high-traffic platforms, such as popular travel information websites, can amplify the hotel’s reach through advertisements, banners, or collaborations. These efforts help to promote the hotel brand to a wider audience. Additionally, partnerships with local businesses, such as restaurants, tourist attractions, and entertainment venues, can create mutually beneficial opportunities while broadening the hotel’s visibility.

For the company’s fanpage:

Invest in strategic advertising campaigns

Facebook, being the largest social network globally, offers a vast pool of potential customers. Hotels should develop creative and timely advertising strategies, particularly during peak seasons such as festivals and holidays, to maximize customer engagement. Tailored advertising campaigns can increase visibility, draw attention to special offers, and ultimately boost bookings.

Create engaging and innovative content

Content that lacks originality or usefulness can quickly lose customer interest. Hotels must break away from outdated approaches and invest in crafting compelling posts that resonate with their audience. This includes a mix of practical travel advice, captivating visuals, and engaging storytelling that reflects the unique experiences the hotel can offer. High-quality, innovative content will encourage interactions, build trust, and inspire customers to connect with the brand.

Enhance customer interaction

Active customer interaction on the fanpage plays a critical role in increasing the visibility and reach of posts. Encouraging comments, shares, and discussions not only amplifies brand exposure but also fosters a sense of community. This interaction is key to creating long-term relationships, building trust, and cultivating a loyal customer base.

Develop a professional digital marketing team

The cornerstone of any successful digital marketing strategy lies in the expertise and dedication of the team behind it. Companies should prioritize recruiting skilled professionals and investing in continuous training to ensure their team remains adaptive and innovative. A well-rounded digital marketing team is equipped to navigate the complexities of the online landscape, delivering results that align with the company’s goals.

Expand the use of digital marketing tools

Diversifying digital marketing efforts is essential in staying competitive. Hotels should explore advanced tools such as automation marketing (e.g., email marketing and mobile marketing), PPC campaigns, and affiliate marketing. These tools enable targeted outreach, cost-effective advertising, and measurable results, all of which are crucial for maximizing digital marketing impact.

Conclusion

With its superior advantages compared to traditional communication methods, digital marketing enables hotels to engage with customers more proactively and effectively at a more reasonable cost. Building marketing strategies has become more crucial than ever in the operations of businesses.

Through research, the basic results achieved by the hotel as well as its existing limitations have been identified. Based on these achievements, the hotel can continue to gradually improve and develop its digital marketing tools. This will help build the hotel’s brand image, allowing it to maintain a strong position and grow in the current era of Industry 4.0.

Additionally, the hotel must quickly address its current limitations. The workforce lacks sufficient experience, and there has been insufficient focus on boosting advertisements and increasing engagement on Facebook, despite it being a platform with a vast pool of potential

customers. Hotels should allocate more financial resources to train and recruit a specialized team and develop their digital marketing tools further.

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The Impact of Business Industry and Enterprises Type on the Intention to Adopt Environmental Accounting of Manufacturing Enterprises in Thua Thien Hue Province

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Abstract

In the context of increasing concern for environmental protection and sustainable development, the adoption of environmental accounting has become a significant and necessary topic. Businesses, especially manufacturing businesses, are facing numerous challenges related to the environmental impact of their operations. The application of environmental accounting in manufacturing enterprises still presents several prominent issues. This study evaluates the impact of business industry and enterprise type as independent variables on the dependent variable of the intention to apply environmental accounting in manufacturing enterprises in Thua Thien Hue province. With a sample size of 110 manufacturing enterprises, the results from a multivariate linear regression model and the moderation model using the Process Macro technique indicate that business industry and enterprises type significantly influence the intention to adopt environmental accounting. The article offers several implications for governmental agencies in formulating policies to promote the adoption of environmental accounting among enterprises today.

Keywords: Environmental accounting, business industry, enterprise type, manufacturing enterprises, Thua Thien Hue

Introduction

The environment plays a crucial role in human life and health, serving as the foundation for the existence and development of society. It not only provides essential resources for life and sustenance but also profoundly impacts psychological, biological, and cultural development. Environmental degradation and pollution have been causing severe consequences for health and ecological balance, thereby threatening sustainable development on this planet (IPCC, 2014). Environmental protection has thus become a shared responsibility of society and a vital factor for sustainable development in businesses (Bebbington et al., 1999). Currently, industrialization, modernization, and increased production are exerting immense pressure on the global environment, particularly in developing countries like Vietnam. According to Nguyen (2020), the rapid growth of industrial and agricultural sectors in Vietnam has led to numerous negative environmental consequences, including soil degradation, water, and air pollution. To address environmental protection needs, Vietnam has actively participated

in World Environment Day since 1982 and committed to adhering to international environmental protection agreements, as highlighted by UNEP (2021).

Environmental accounting (EA) has emerged as an effective tool to help businesses manage their environmental impacts. According to Schaltegger & Burritt (2000), EA supports businesses not only in controlling and efficiently utilizing resources but also in minimizing negative environmental impacts and enhancing their public image. Companies that adopt EA can identify, manage, and reduce environmental costs, contributing to optimized resource utilization and better compliance with environmental protection regulations. The implementation of EA in Vietnam depends on various factors such as business industries, types of enterprises, and current accounting systems. In Vietnamese manufacturing enterprises, the demand for resource management and environmental protection is increasing. Particularly, Thua Thien Hue, as a developing economic region, significantly contributes to the national budget through industrial production activities. However, this development comes with risks to natural resources and the living environment.

Studies on environmental accounting, the influence of business industry, and types of enterprises have been conducted extensively both globally and in Vietnam. According to Zhang et al. (2019), different types of enterprises, such as limited liability companies, joint-stock companies, and private enterprises, have varying structures and management mechanisms, which influence the level and approach to EA adoption. However, research on EA within specific business industry remains limited, especially concerning the indirect impact of enterprise types on business industries and their intention to adopt EA. This study aims to investigate the impact of business industry and enterprise types on the intention to adopt environmental accounting in manufacturing enterprises in Thua Thien Hue province. The goal is to assess how these factors influence the intention to adopt EA and propose solutions to promote EA adoption not only in Thua Thien Hue but also in manufacturing enterprises nationwide. This effort aims to contribute to environmental protection and sustainable development.

1. Research Objectives

1.1 To examine the impact of the Business industry on the intention to adopt environmental accounting in manufacturing enterprises in Thua Thien Hue province.

1.2 To investigate the impact of Enterprise type on the intention to adopt environmental accounting in manufacturing enterprises in Thua Thien Hue province.

1.3 To assess the intermediary effect of Enterprise type on the relationship between Business industry and the intention to adopt environmental accounting in manufacturing enterprises in Thua Thien Hue province.

2. Review of Related Literatures

Environmental Accounting (EA) is a specialized area within business management that quantifies and analyzes the environmental impacts of enterprises. By collecting, processing, and providing information on environmental activities, EA enables businesses to assess performance, optimize resource usage, and make sustainable decisions. Furthermore, EA enhances transparency, providing stakeholders such as investors, customers, and regulators with essential environmental data (Burritt & Schaltegger, 2002). According to the International Federation of Accountants (IFAC, 2005), EA broadly encompasses systems designed to manage economic and environmental activities. It integrates tailored accounting systems to address environmental concerns, ensure regulatory compliance, and promote corporate social responsibility. EA accounts for direct environmental costs and long-term benefits, fostering a balance between economic growth and ecological sustainability.

The growing application of EA worldwide is driven by increasing legal regulations, market demands, and heightened awareness of social responsibility (Qain & Burritt, 2007). In manufacturing enterprises, the intention to adopt EA depends on internal factors such as enterprise size, financial capacity, type, and industry, as well as external pressures from regulations and stakeholders. Research highlights that business industry and enterprise type are critical factors influencing EA adoption (Mokhtar et al., 2016).

In the context of manufacturing enterprises, this attitude is also influenced by the business sector. Enterprises in environmentally sensitive industries, such as chemical or energy production, may exhibit a more positive attitude as they are more aware of the responsibilities and benefits of implementing environmental accounting (EA). Ajzen's (1991) Theory of Planned Behavior (TPB) provides a crucial theoretical foundation for studying the intention to perform a behavior, helping to explain the intention to adopt EA in businesses through positive attitudes derived from its benefits, social pressure from stakeholders such as shareholders, customers, regulatory bodies, and the confidence in the enterprise's own capacity and resources. Previous studies, such as those by Mokhtar et al. (2016) and Malek et al. (2020), have applied the TPB to assess the intention to adopt environmental protection measures in businesses. The intention to adopt EA in manufacturing enterprises results from a combination of attitudes, subjective norms, and perceived behavioral control. These factors do not exist independently but interact with one another and are moderated by specific factors. For instance, business industry play a role in which environmentally sensitive industries face greater pressure, leading to higher intentions to adopt EA. Similarly, enterprise types such as state-owned enterprises or publicly listed companies, including limited liability companies, tend to comply better due to regulatory pressure and transparency requirements. Accordingly, business industry and enterprise types can be considered moderating factors that influence attitudes, subjective norms, and perceived behavioral control in the adoption of EA.

2.1 Business industry and the Intention to Adopt Environmental Accounting

Each business industry possesses unique production characteristics, leading to varying environmental impacts. Heavy industries such as metallurgy, chemicals, and cement production consume significant amounts of energy and emit large quantities of hazardous waste, causing pollution of air, water, and soil. The degree of environmental impact depends on factors such as production scale, technology, and waste management practices. For example, larger enterprises typically have higher impacts due to greater output and raw material consumption. Furthermore, outdated technologies that rely on harmful chemicals are more detrimental to the environment compared to modern, eco-friendly alternatives. Waste management practices, including collection, treatment, and recycling, also play a critical role in environmental preservation.

Numerous global studies have demonstrated the influence of business industry on the implementation of EA. Deegan & Gordon (1996) and Burritt & Schaltegger (2000) concluded that environmental disclosures are more prevalent in industries sensitive to environmental concerns, such as mining, chemical production, and coal extraction, in response to stakeholder and regulatory demands. Similarly, Qian & Burritt (2007), Al Kisher (2013), Nguyen (2018), Nguyen & Pham (2020) found that production-oriented sectors are significantly influenced by stakeholder pressures and government regulations, driving EA adoption. Mokhtar et al. (2016) highlighted that sectors with high emissions, such as manufacturing and energy, are more likely to adopt EA practices. Pham et al. (2016) showed that high-emission industries, such as brick production, are motivated to implement EA to manage costs and comply with environmental regulations. Several other studies have affirmed that business industry impact EA practices. Based on the arguments presented above, the research hypotheses are proposed as follows:

H1: Business industries have a positive impact on the intention to adopt environmental accounting.

2.2 Enterprise Type and the Intention to Adopt Environmental Accounting

The type of enterprise significantly influences its intention to adopt Environmental Accounting (EA). State-owned enterprises (SOEs) often lead in EA adoption due to strict government oversight and legal requirements, aligning with their focus on compliance and social responsibility. In contrast, private enterprises, which operate with more flexibility, face varying adoption levels depending on their size, industry, target market, and owners' environmental awareness. Foreign-invested enterprises, frequently limited liability or joint-stock companies, tend to adopt higher environmental standards due to parent company mandates or local regulations. These enterprises often possess greater financial resources for investing in modern environmental technologies, though some prioritize short-term profits over environmental concerns.

Research highlights the role of enterprise type in EA adoption. Burritt & Schaltegger (2000) found larger enterprises more likely to implement EA due to financial capacity and image concerns. Qian & Burritt (2007) emphasized that SOEs adopt EA more frequently than private enterprises because of regulatory and government pressures. Mokhtar et al. (2016) demonstrated that publicly listed companies adopt EA more readily due to shareholder and regulatory demands. In Vietnam, Nguyen (2020) noted SOEs' higher adoption rates due to strict regulations and international compliance standards.

Despite these insights, research in Vietnam, especially in Thua Thien Hue, remains limited. Prior studies often treat business industry and enterprise types as quantitative variables, overlooking their qualitative aspects. This research bridges the gap by analyzing their moderating role in EA adoption among manufacturing enterprises in Thua Thien Hue. The findings will inform policies supporting EA implementation, contributing to environmental protection and sustainable development. Based on the arguments presented above, the research hypotheses are proposed as follows:

H2: Enterprise types have a positive impact on the intention to adopt environmental accounting.

2.3 The Impact of Enterprise Types on Business Industry and the Intention to Adopt Environmental Accounting

Contingency Theory posits that there is no single best approach to management or decision-making applicable to all circumstances. Instead, optimal actions depend on internal and external organizational contexts. This theory emphasizes that managers need to understand the circumstances to adjust their strategies and operations in alignment with the context. In his book *The Contingency Theory of Organizations* (2014), Donaldson asserted that organizations achieve the best performance when there is alignment between their structure and external environmental factors. Kamisah (2010) also confirmed that Contingency Theory is widely used in management and accounting research. In this study, the author employs Contingency Theory to examine the influence of enterprise types and business industries on the intention to adopt environmental accounting.

In practice, different manufacturing sectors (e.g., mining, garment production, building materials manufacturing, chemicals) may face unique environmental challenges and regulatory requirements, necessitating the implementation of environmental accounting practices. Enterprise types also significantly influence the adoption of environmental accounting. Large enterprises, joint-stock companies, or limited liability companies may have more resources compared to private businesses. In large enterprises within environmentally sensitive industries, the likelihood of adopting environmental accounting is higher than in enterprises

operating in less environmentally sensitive sectors. Based on these arguments, the research hypothesis is proposed as follows:

H3: Enterprise types act as a mediating variable influencing the relationship between business industries and the intention to adopt environmental accounting.

Research Methodology

In this study, the authors employed a non-probability sampling method, specifically convenience sampling, focusing on manufacturing enterprises located in Thua Thien Hue province. The research involved interviews with experts, including business managers and chief accountants, to design the questionnaire and conduct a pilot survey. The questionnaire was structured as short, concise questions to collect feedback from experts. The survey was distributed through Google Forms, email, and telephone. As a result, the authors collected 110 valid responses, which were deemed sufficient for conducting the research and data analysis. After data collection, the survey data were coded for variables in the model to facilitate analysis using SPSS 26.0 software.

In this study, the authors utilized one-way ANOVA to analyze differences, as well as multiple linear regression (OLS) to examine the effects of two qualitative variables - Business industry and Enterprise type on the dependent variable, Intention to Adopt Environmental Accounting among manufacturing enterprises. Additionally, a mediation analysis was conducted to explore the role of Enterprise type as a mediating variable in the relationship between Business industry and the Intention to Adopt Environmental Accounting.

Proposed Research Model

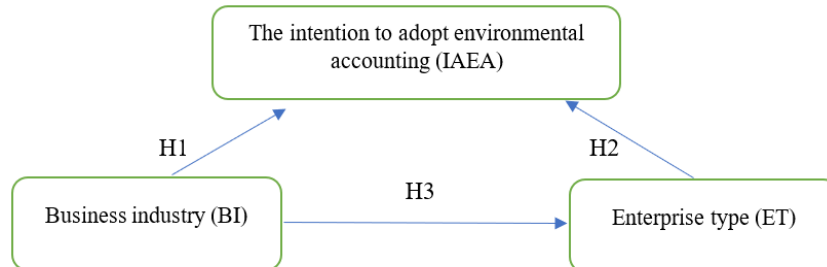


Figure 1 Proposed Research Model

H1: Business industries have a positive impact on the intention to adopt environmental accounting.

H2: Enterprise types have a positive impact on the intention to adopt environmental accounting.

H3: Enterprise types act as a mediating variable influencing the relationship between business industries and the intention to adopt environmental accounting.

Proposed Regression Model

$$IAEA = \alpha + \beta_1 * BS + e$$

$$IAEA = \alpha + \beta_3 * ET + e$$

$$BI = \alpha + \beta_2 * ET + e$$

IAEA is the dependent variable representing the prediction of the intention to adopt environmental accounting.

$\beta_1, \beta_2, \beta_3$: are the regression coefficients.

e: error term.

Results

The impact of the Business industry on the intention to adopt environmental accounting in manufacturing enterprises in Thua Thien Hue province.

Based on the 110 collected samples, the research team summarized and produced the following results for manufacturing industries in this study: mineral production, construction material production, footwear production, textile and garment production, and basic chemical products production such as cajuput oil. The statistical results of the research sample are presented in Table 1 below.

Table 1. Statistical results of samples of business industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Minerals	8	7.3	7.3	7.3
	Construction materials	18	16.4	16.4	23.6
	Footwears	28	25.5	25.5	49.1
	Textile and garments	39	35.5	35.5	84.5
	Basic chemicals	17	15.5	15.5	100.0
	Total	110	100.0	100.0	

(Source: Data processed using SPSS 26.00 software)

Table 1 shows that enterprises in the Textile and garment industry account for the largest proportion with 39 samples, representing 35.5%, followed by Footwear manufacturing enterprises with 28 samples accounting for 25.5%. Enterprises producing Construction materials account for 16.4%, basic chemical products (cajuput oil) producers account for 15.5%, and the lowest is Mineral extraction and production enterprises at 7.3%. To explore the impact of the "Business industry" factor on the intention to adopt environmental accounting, the research team analyzed the data to identify differences among these sectors regarding their intention to adopt environmental accounting. Additionally, the homogeneity of variances across business industry was tested.

The results in Tables 2 and 3 indicate that the Sig. values for all tests are greater than 0.05. This implies that there is no significant difference in variance between the business industry concerning their intention to adopt environmental accounting. Thus, the hypothesis that variances across sectors are homogeneous is not rejected. This provides a basis for proceeding with multiple linear regression analysis using the OLS method.

Table 2. Homogeneity of Variances test for business industry groups

		Levene Statistic	df1	df2	Sig.
Intention to adopt environmental accounting	Based on Mean	.843	4	105	.501
	Based on Median	.931	4	105	.449
	Based on Median and with adjusted df	.931	4	84,081	.450
	Based on trimmed mean	1.011	4	105	.405

(Source: Data processed using SPSS 26.00 software)

Table 3. ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.246	4	1.312	2.308	.063
Within Groups	59.672	105	.568		
Total	64.918	109			

(Source: Data processed using SPSS 26.00 software)

Regression Analysis

The results of the multiple linear regression analysis using OLS, as shown in Table 4, indicate that the coefficient $R = 0.277$ and $R^2 = 0.076$, which means that 7.6% of the variability in the intention to adopt Environmental Accounting is explained by the Business Industry. Although the variability value is not high, it still indicates that there is a certain impact of the Business Industry factor on the intention to adopt Environmental Accounting. Additionally, the R^2 coefficient being quite close to R shows that the regression model is not affected by the number of variables.

Table 4. Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.277 ^a	.076	.068	.74506	2.110

a. Predictors: (Constant), Business Industry

b. Dependent Variable: Intention to adopt environmental accounting

(Source: Data processed using SPSS 26.00 software)

Table 5. ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.966	1	4.966	8.945	.003 ^b
	Residual	59.953	108	.555		
	Total	64.918	109			

a. Dependent Variable: Intention to adopt environmental accounting

b. Predictors: (Constant), Business industry

(Source: Data processed using SPSS 26.00 software)

From Table 5, it shows that the F value = 8.945 and the Sig value = 0.003 indicate that the regression model is statistically significant, meaning that the Business Industry has an impact on the intention to adopt environmental accounting.

Table 6. Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.948	.221		13.362	.000	2.511	3.385
	Business Industry	.186	.062	.277	2.991	.003	.063	.310

(Source: Data processed using SPSS 26.00 software)

Table 6 shows that the regression coefficient $\beta_1 = 0.186$, with a Sig. = 0.003, indicates that the influence of the business industry on the intention to adopt environmental accounting is statistically significant.

The regression equation is derived as follows $IAEA = 2.948 + 0.186 * BI$

Thus, based on the regression model results, it can be concluded that the business industry has a significant and positive impact on the intention to adopt environmental accounting. Although the R coefficient ($R = 0.277$ and $R^2 = 0.076$) is relatively low, the impact remains statistically significant. This suggests that other factors within the business industry should be further explored to better understand the decision to adopt environmental accounting.

The impact of Enterprise type on the intention to adopt environmental accounting in manufacturing enterprises in Thua Thien Hue province.

Based on the collected data, the research team compiled the following results regarding types of enterprises: Joint-stock companies accounted for 15 cases, representing 13.6%; limited liability companies (LLCs) accounted for 33 cases, representing 30%; private enterprises accounted for 36 cases, representing 32.7%; and other types, such as partnerships and cooperatives, accounted for 26 cases, representing 23.6%.

Table 7. Enterprises Types

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Joint-stock	15	13.6	13.6	13.6
	Limited liability company (LLC)	33	30.0	30.0	43.6
	Private	36	32.7	32.7	76.4
	Other	26	23.6	23.6	100.0
	Total	110	100.0	100.0	

(Source: Data processed using SPSS 26.00 software)

The authors analyzed the differences among these types of enterprises in terms of their intention to adopt environmental accounting using data analysis software. The homogeneity of variances among the groups was tested.

The results, presented in Tables 8 and 9, indicate that the Sig. values for all tests are greater than 0.05. This means there is no significant difference in variances among the enterprises types regarding their intention to adopt environmental accounting. The results confirm that the hypothesis of homogeneous variances across groups cannot be rejected. This provides a basis for proceeding with multiple linear regression analysis using the OLS method.

Table 8. Test of Homogeneity of Variances of Enterprises Types

		Levene Statistic	df1	df2	Sig.
Intention to adopt environmental accounting	Based on Mean	8.704	3	106	.605
	Based on Median	3.307	3	106	.423
	Based on Median and with adjusted df	3.307	3	91.849	.524
	Based on trimmed mean	8.705	3	106	.504

(Source: Data processed using SPSS 26.00 software)

Table 9. ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7.096	3	2.365	4.336	.086
Within Groups	57.822	106	.545		
Total	64.918	109			

(Source: Data processed using SPSS 26.00 software)

Regression analytics:

The results of the multiple linear regression analysis using OLS show that the $R = 0,291$ and $R^2 = 0,085$, indicating that 8,5% of the variation in the intention to apply environmental accounting is explained by the enterprise types. The R^2 being quite close to R indicates that the regression model is not significantly affected by the number of variables.

Table 10. Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.291 ^a	.085	.076	.74178	2.192

a. Predictors: (Constant), Enterprises types

b. Dependent Variable: Intention to adopt environmental accounting

(Source: Data processed using SPSS 26.00 software)

Table 11. ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.492	1	5.492	9.981	.002 ^b
	Residual	59.426	108	.550		
	Total	64.918	109			

a. Dependent Variable: Intention to adopt environmental accounting

b. Predictors: (Constant), Enterprises types

(Source: Data processed using SPSS 26.00 software)

From Table 11, it shows that the F value = 9.981 and the $Sig = 0.002$ indicate that the regression model is statistically significant, meaning that the type of enterprise affects the intention to apply environmental accounting.

Table 12. Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.968	.204		14.545	.000	2.564	3.372
	Enterprises types	.227	.072	.291	3.159	.002	.085	.369

a. Dependent Variable: Intention to adopt environmental accounting

(Source: Data processed using SPSS 26.00 software)

The regression coefficient $\beta_1 = 0.227$ and Sig = 0.002 indicate that the impact of the type of enterprise on the intention to apply environmental accounting is statistically significant.

The derived regression equation is $IAEA = 2.968 + 0.072 * EI$

The regression model shows that the R coefficient ($R = 0.291$ and $R^2 = 0.085$) is not very high, but it can still be concluded that the type of enterprise has a significant and positive impact on the intention to apply environmental accounting. The research results also suggest that different types of enterprises, with different structures and resources, will have varying levels of interest in applying environmental accounting.

The Impact of Enterprise Type on Business Industry and the Intention to Adopt Environmental Accounting

In this study, the authors tested the role of enterprise type as a mediating variable influencing the business industry (BI) and the intention to adopt environmental accounting (IAEA) among manufacturing enterprises in Thua Thien Hue province. The research team conducted an evaluation of the mediating role of enterprise type in the relationship between business sector and the intention to adopt EA using the Process Macro tool by F. Hayes on SPSS.

Table 13. Model Summary

R	R-sq	MSE	F	df1	df2	P
.4543	.2064	.7829	28.0940	1.0000	108.0000	0.000

(Source: Data processed using SPSS 26.00 software)

Table 14. Model

	coeff	se	T	p	LLCI	ULCI	Standardized coefficients Coeff
constant	1.3488	.2620	5,1476	0.000	.8294	1.8682	
BI	.3920	.0739	5,3004	0.000	.2454	.5385	.4543

(Source: Data processed using SPSS 26.00 software)

The derived regression equation is $ET = 1.3488 + 0.3920 * BI$

The coefficient $\beta_2 = 0.3920$ indicates that when the business industry increases by 1 unit, the enterprise type increases by 0.3920 units, assuming all other factors remain constant.

Tables 15, 16, and 17 show the correlation coefficient between the independent variable (BI) and the dependent variable (IAEA), with $R = 0.2766$ indicating a positive but relatively weak relationship between the two variables. The proportion of variance in the dependent variable (IAEA) explained by the independent variable (BI), represented by $R^2 = 0.0765$, suggests that the model accounts for only a small portion of the variation in IAEA. The $F = 8.9453$ and $p = 0.0034 < 0.05$ indicate that the model is statistically significant, and the BI variable has a significant impact on IAEA.

Table 15. Model Summary outcome variable IAEA

R	R-sq	MSE	F	df1	df2	P
0.3330	0.1109	0.5394	6.6720	2.0000	107.0000	.0019

(Source: Data processed using SPSS 26.00 software)

Table 16. Model

	coeff	se	t	p	LLCI	ULCI	Standardized coefficients Coeff
constant	.7288	.2427	11.2432	.0000	2.2477	3.2100	
BI	.1225	.0689	.7785	.0782	.0141	.2591	.1820
ET	.1625	.0799	2.0344	.0444	.0042	.3208	.2082

(Source: Data processed using SPSS 26.00 software)

Table 17. Total effect Model

R	R-sq	MSE	F	df1	df2	P
.2766	.0765	.5551	8.9453	1.0000	108.0000	.0034

(Source: Data processed using SPSS 26.00 software)

Table 18 presents the results the intercept of the regression equation is 2.9840, indicating that when the value of the independent variable BI is 0, the mean value of IAEA will be 2.9840.

The regression coefficient for the Business Industry (BI) variable is 0.1862, suggesting that when BI increases by 1 unit, the intention to adopt environmental accounting (IAEA) increases by an average of 0.1862 units, assuming other factors remain constant. The standard error of the BI regression coefficient is 0.0623, a small value indicating higher precision in estimation. The $t = 2.99909 > 2$ and $p = 0.0034 < 0.05$ indicate that the impact of BI on IAEA is statistically significant. The 95% confidence interval for the BI regression coefficient is LLCI = 0.0628 and ULCI = 0.3097. Since this interval does not include 0, it can be concluded that BI has a significant effect on IAEA. The standardized coefficient (coef) of 0.2766 indicates the relative influence of BI on IAEA, showing a medium level of impact.

Table 18. Model

	coeff	se	t	P	LLCI	ULCI	Standardized coefficients coeff
constant	2.9480	.2206	13.3618	.0000	2.5107	3.3853	
BI	.1862	.0623	2.9909	.0034	.0628	.3097	.2766

(Source: Data processed using SPSS 26.00 software)

Table 19. Total, Direct, and Indirect Effects of BI on IAEA

Effect	Effect	SE	T	p	LLCI	ULCI	Standardized Coefficient (c/c')
1. Total Effect of BI on IAEA	0.186 2	0.0623	2.9909	0.0034	0.062 8	0.309 7	0.2766
2. Direct Effect of BI on IAEA	0.122 5	0.0689	1.7785	0.0082	0.014 1	0.259 1	0.1820
3. Indirect Effect via ET	Effect	BootSE	BootLLCI	BootULCI			
Through ET	0.063 7	0.0401	0.0018	0.1589	-		

Effect	Effect	SE	T	p	LLCI	ULCI	Standardized Coefficient (c/c')
4. Standardized Indirect Effect	Effect	BootSE	BootLLCI	BootULCI			
Through ET	0.0946	0.0578	0.0028	0.2291	-		

(Source: Data processed using SPSS 26.00 software)

Table 19 presents the total effects, direct effects, and indirect effects of the independent variable (BI) on the dependent variable (IAEA), with the mediation of an intermediary variable ET.

1. Total Effect of BI on IAEA: The total effect of Business Industry (BI) on the Intention to Adopt Environmental Accounting (IAEA) is 0.1862. This indicates that a one-unit increase in BI leads to an increase of 0.1862 units in IAEA. The standard error (SE = 0.0623) ensures the precision of the estimate. The t-statistic ($t = 2.9909$) exceeds the critical value of 2, and the p-value ($p = 0.0034$) is below the 0.05 threshold, confirming statistical significance. The 95% confidence interval (LLCI = 0.0628, ULCI = 0.3097) does not include zero, reinforcing the reliability of the finding. The completely standardized coefficient ($c_{cs} = 0.2766$) indicates a moderate effect size.

2. Direct Effect of BI on IAEA: The direct effect of BI on IAEA is 0.1225 when controlling for the mediating variable ET. This suggests that BI independently contributes to IAEA. The standard error (SE = 0.0689) and t-statistic ($t = 1.7785$) meet the statistical conditions for significance (p-value = 0.0082). The 95% confidence interval (LLCI = 0.0141, ULCI = 0.2591) excludes zero, confirming the robustness of the direct effect. The completely standardized coefficient ($c'_{cs} = 0.1820$) represents a low-to-moderate impact.

3. Indirect Effect of BI on IAEA through ET: The indirect effect of BI on IAEA through the mediator ET is 0.0637. This value quantifies the contribution of ET in the transmission process. The bootstrapped standard error (BootSE = 0.0401) ensures the reliability of the estimate. The 95% bootstrapped confidence interval (BootLLCI = 0.0018, BootULCI = 0.1589) does not include zero, validating the statistical significance of the indirect effect. These results suggest that ET plays a critical role as a mediating variable in linking BI to IAEA.

4. Completely Standardized Indirect Effect

The completely standardized indirect effect of BI on IAEA through ET is 0.0946, indicating a small but meaningful impact. The bootstrapped standard error (BootSE = 0.0578) and the 95% confidence interval (BootLLCI = 0.0028, BootULCI = 0.2291) confirm statistical significance. The findings emphasize the mediating role of ET, which accounts for a portion of the overall relationship between BI and IAEA. Conclusion, the findings from Table 19 reveal that the Business Industry (BI) has a significant total impact on the Intention to Adopt Environmental Accounting (IAEA). Part of this relationship is mediated through the intermediary variable ET.

Discussion

This study examines the influence of business industries and enterprise types on the intention to adopt environmental accounting (EA) among manufacturing enterprises in Thua Thien Hue province. The findings reveal the following key insights:

Impact of Business Industries: Enterprises in environmentally sensitive industries, such as garment manufacturing, chemical production, and mining, demonstrate a higher

intention to adopt EA. This is driven by regulatory pressures, stakeholder expectations, and the need to manage environmental impacts effectively.

Role of Enterprise Types: Joint-stock companies and limited liability companies show a stronger intention to adopt EA compared to private enterprises. These differences are attributed to greater financial capacity, higher levels of stakeholder pressure, and stricter compliance requirements.

Mediating Role of Enterprise Types: Enterprise types act as a significant mediating variable, enhancing the relationship between business industries and the intention to adopt EA. The findings suggest that the structural and organizational characteristics of enterprises influence their capacity and willingness to implement EA practices.

Conclusion

Based on the findings from the empirical research conducted on manufacturing enterprises in Thua Thien Hue province, Vietnam, the authors propose the following recommendations:

Guidelines for Large Enterprises: Develop clear and practical guidelines targeting large-scale enterprises, joint-stock companies, and environmentally sensitive sectors to encourage voluntary EA adoption.

Government Incentives: Introduce financial incentives, such as tax reductions or subsidies, to motivate enterprises in high-emission industries to adopt EA practices. Simultaneously, establish mandatory regulations for waste treatment and environmental cost reporting.

Support for Small Enterprises: Provide training programs and resource support to small and private enterprises, particularly those operating in sectors with significant environmental impacts. Raising awareness of the economic and social benefits of EA can help overcome resistance to its adoption.

By implementing these measures, policymakers and enterprises can work collaboratively to enhance the adoption of environmental accounting, thereby contributing to sustainable development and environmental protection in Thua Thien Hue province and beyond.

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The Impact of Economic Freedom and Regulatory Quality on Banking Function

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Abstract

The study provides empirical evidence on how two national governance tools economic freedom and regulatory quality affect the operations of 156 banks in Southeast Asia between 2018 and 2022. The study demonstrates a positive interaction between liquidity creation and bank capital through seemingly unrelated regression (SUR). In particular, the analysis indicates that nations with higher levels of economic freedom and quality of regulation are more likely to create liquidity and have higher bank capital ratios. These results strengthen banks' confidence in the implementation of capital and liquidity regulations under the Basel framework by banks. Hence, increasing the regulatory quality and economic freedom indices in countries will allow banks to engage in a wider range of activities, allowing them to exploit economies of scale and scope, thus generating higher income from traditional sources. Finally, the author uses the convergence diagnostics of Markov Chain Monte Carlo (MCMC) chains for Bayesian inference to robust the model.

Keywords: Liquidity creation, Bank capital, Bank efficiency,
Seemingly Unrelated Regression, Markov Chain Monte Carlo

Introduction

Regulatory quality refers to a government's capability to design and enforce effective policies and regulations that support and encourage private sector growth. Enhancing regulatory quality fosters economic growth by providing efficient and effective incentives for the private sector, whereas overly restrictive regulations hinder economic performance by causing inefficiencies and reducing productivity. The Worldwide Governance Indicators (WGI) measure this dimension. Economic freedom represents the fundamental right of individuals to have control over their labor and property. In societies with economic freedom, people can freely work, produce, consume, and invest as they choose, while governments ensure the free movement of labor, capital, and goods without imposing unnecessary constraints, except to safeguard liberty (Nagaraj & Zhang, 2019). Economic freedom is a core value, and strong regulatory quality serves as a key driver of the wealth that underpins various economic and social achievements. Recent studies confirm that embracing the principles of economic freedom leads to rapid income growth, significant reductions in poverty, sustainable advancements in education, health, and environmental outcomes, and fosters democracy and peaceful cooperation among nations (Miller et al., 2019). Regulatory quality and economic freedom are two pivotal pillars of economic governance that significantly influence a nation's financial stability, institutional effectiveness, and overall economic performance. Regulatory quality reflects the government's ability to design and enforce sound policies that foster market

efficiency, reduce uncertainty, and support sustainable growth. Meanwhile, economic freedom emphasizes the degree to which individuals and businesses can operate free from undue interference, benefiting from property rights, open markets, and minimal regulatory burdens. Together, these factors shape the economic landscape, driving investment, innovation, and development.

Liquidity creation and bank capital are two fundamental roles of banks. In response to the financial crisis, the Basel Committee introduced Basel III, an international regulatory framework that established stricter capital requirements and new liquidity regulations. This framework mandates that banks comply with two key liquidity ratios: the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). Research highlights the intricate relationship between liquidity creation and bank capital, with evidence suggesting that capital can either facilitate or constrain a bank's ability to create liquidity. Liquidity creation, essential for increasing credit flow within the economy, is positively associated with real economic output (Diamond & Rajan, 2001; Berger & Udell, 2014). However, heightened liquidity creation increases banks' exposure to maturity transformation risk, a core banking function that involves funding long-term assets with short-term liabilities, thereby intensifying funding liquidity risk. The literature identifies two competing hypotheses to explain the interplay between liquidity creation and bank capital (Berger & Udell, 2014). The **financial fragility crowding-out hypothesis** posits a negative relationship, arguing that higher capital levels diminish liquidity creation. Conversely, the **risk absorption hypothesis** suggests a positive relationship, where increased capital boosts liquidity creation. Regulatory measures aimed at raising capital ratios and mitigating maturity transformation risk could overly constrain banks' ability to generate liquidity, potentially limiting their role in channeling credit into the economy and adversely impacting economic growth.

In Southeast Asia, the interplay between regulatory quality and economic freedom offers a compelling context for exploration. The region is marked by diverse political systems, varying levels of economic liberalization, and rapidly evolving financial sectors. As nations in the region navigate globalization and economic reforms, the balance between effective regulation and economic freedom has become a critical determinant of their success in fostering resilient and competitive financial systems. This study aims to examine the dual role of regulatory quality and economic freedom in shaping the banking sector's performance in Southeast Asian economies. Specifically, it investigates how these governance factors influence key aspects of banking, such as liquidity creation and capital adequacy, within the broader framework of economic liberalization. By addressing these issues, the study seeks to unravel the dynamic interdependencies that underpin economic growth and financial sector stability. The findings of this paper are expected to contribute to the literature on institutional quality and economic governance, offering insights for policymakers and stakeholders. By understanding the nuanced impacts of regulatory quality and economic freedom, governments can better design frameworks that balance the need for market oversight with the benefits of economic autonomy, ultimately promoting sustainable development and financial resilience.

The remainder of this paper is organised as follows: Section 2 presents the literature review. Section 3 discusses methodology and data, respectively. Section 4 reports empirical findings while Section 5 draws a conclusion.

1. Research Objectives

1.1 It thoroughly investigates the relationship between liquidity creation and bank capital.

1.2 It examines the effects of regulatory quality and economic freedom on the banking sector in Southeast Asian countries.

1.3 It examines the factors that impact Liquidity Creation and Bank Capital.

2. Review of Related Literatures

2.1 The effects of regulatory quality and economic freedom

The literature exploring the impact of regulatory quality and economic freedom has garnered increasing attention in recent years. As noted by Belasen and Hafer (2013), numerous studies have identified a positive relationship between financial development, higher levels of economic freedom, and economic growth. Research by Ashby et al. (2013), Bennett and Vedder (2013), and Belasen and Hafer (2013) highlights the role of economic freedom in fostering entrepreneurship, enhancing efficiency and production, and promoting equity across diverse economic and cultural contexts. Ahmed (2013) further emphasizes that institutional factors, including economic freedom, significantly influence growth and financial development in Sub-Saharan Africa (SSA).

Hafer (2013) provides evidence that countries with greater initial levels of economic freedom tend to experience higher levels of financial intermediary development over time. Conversely, stricter regulations can incentivize risk-taking behaviors among banking institutions, reducing charter value and compromising banking system stability (Fernández & González, 2005). Specifically, studies by Fernández and González (2005) and Sufian and Habibullah (2010a) demonstrate that increased freedom in setting interest rates—a critical element of financial freedom—is positively associated with cost efficiency in banking. This indicates that nations with greater financial freedom and autonomy tend to exhibit more cost-efficient banking systems.

Recent findings also suggest that banks in countries with higher levels of freedom for banking activities are more profitable compared to those in more restricted environments (Chortareas et al., 2013; Sarpong-Kumankoma et al., 2018; Sufian & Habibullah, 2010). These insights underscore the importance of regulatory quality and economic freedom in shaping banking performance. However, despite this growing body of evidence, the banking literature lacks comprehensive analyses linking economic freedom, regulatory quality, and key banking factors. The combined effect of regulatory quality and economic freedom on bank liquidity creation, bank capital, and efficiency remains theoretically ambiguous. Consequently, this study revisits the interconnectedness between these banking functions, taking into account variations in regulatory quality and economic freedom across countries.

Based on these empirical studies, the following hypothesis is proposed:
H1: Regulatory quality and economic freedom have a positive and significant impact on bank capital and liquidity creation

2.2 The Relationship Between Liquidity Creation and Bank Capital

In the study of (Berger & Bouwman, 2009) discussed two opposing hypotheses about the relationship between capital and liquidity creation: the financial fragility-crowding out theory states that higher capital reduces liquidity creation. Conversely, the Brisk absorption theory states that higher capital increases liquidity creation. Liquidity creation may increase bank losses, as it implies having more illiquid assets to meet the liquidity demands of customers (Allen & Gale, 2004). Therefore, because capital may help banks to absorb greater risk (Repullo, 2004). (Berger & Bouwman, 2009) infer that higher capital may allow banks to create more liquidity. Literature also suggests a causal relationship that moves from liquidity creation to capital. Again, two opposing hypotheses are proposed. (Horváth et al., 2014) analyze the relationship between liquidity creation and capital by examining empirical works regarding the impact of risk on banks' capital buffers (Jokipii & Milne, 2011). According to the so-called liquidity risk hypothesis, as greater liquidity creation increases the risk of illiquidity for banks, banks should strengthen their solvency because capital acts as a buffer

against unexpected withdrawals from customers. Therefore, this hypothesis would imply a positive relationship between liquidity creation and bank capital. Nonetheless, the liquidity substitution hypothesis proposed by (Distinguin et al., 2013) suggests a negative relationship between liquidity creation and bank capital. When banks face higher illiquidity, they may consider certain liquid liabilities as stable funding sources and thus substituting capital with these ‘stable’ liabilities. The latter means that banks may not strengthen their capital when they face illiquidity, as defined in the new Basel rules.

Based on these empirical studies, the following hypothesis is proposed: H2: There is an interactive relationship between liquidity creation and bank capital.

Research Methodology

1. Data research

Table 1. Number of banks in each economy and number of banks in the Southeast Asia sample in 2022

Economies	Number of banks in each economy	Number of banks in the sample
Brunei	2	2
Cambodia	30	2
Indonesia	77	44
Laos	7	4
Malaysia	47	46
Philippines	24	12
Singapore	7	6
Thailand	23	21
Vietnam	38	19
Total	255	156

Source: Authors’ own estimation

Our sample is a balance sheet that includes financial data for the top 156 commercial banks in nine economics in Southeast Asia, including Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam. Table 1 shows that the total number of banks in the Southeast Asian region is 255 banks. However, the study only selected 156 banks with full database for the research process. The research sample includes 156 banks out of the total number of banks, accounting for 61.18%. Therefore, the number of research samples can represent the total number of banks in the Southeast Asian region. All financial items related to banking characteristics are mainly drawn from TheBankerdatabase.com and the reports of different banks in their annual financial statements (2018–2022).

2. Methodology

The study uses the SUR method of (Zellner, 1962) to examine the simultaneous interaction between liquidity creation, bank capital. The Seemingly Unrelated Regression (SUR) method is a technique in econometrics used to estimate coefficients in a regression model with multiple equations, where the errors between the equations may be correlated.

SUR is an extension of the multivariate regression model, where each equation has a different dependent variable, but the errors between the equations can be related. This can occur when the regression equations share common factors or exhibit correlation with each other. The SUR method helps estimate the coefficients for all the equations in a system without assuming that the errors in each equation are uncorrelated.

General formula for the SUR model:

Suppose there are k regression equations, each with the form:

$$y_i = X_i\beta_i + u_i \quad (i = 1, 2, \dots, k)$$

Where: y_i : is the dependent variable of the i-th equation. X_i is the matrix of independent variables for the i-th equation. β_i is the vector of coefficients to be estimated for the i-th equation. u_i is the error vector for the i-th equation.

The use of the SUR method was firstly motivated by the gain efficiency in estimation, since it results in information combination from different equations. Second, using this method, it will be able to test restrictions that involve parameters in different equations. Compared with OLS estimators, the two-stage general least squares (GLS) and ML estimators of the SUR model are considered the most efficient. These two methods provide smaller standard errors especially for large samples. However, with reference to (Hanushek & Jackson, 1977) dealing with small samples and having covariances of disturbances for the multiple equations equal to zero, the OLS estimators are the best linear unbiased estimates. Taking into consideration, the advantage of this estimator and since the sample used in this study is made by of only 156 banks; we performed the OLS estimators of the SUR method.

Steps to implement the SUR method:

Step 1: Estimate the individual equations: First, perform regression for each equation using the OLS method to obtain preliminary error values.

Step 2: Compute the covariance matrix of the errors: Use the estimated errors from the previous step to estimate the covariance matrix of the errors.

Step 3: Simultaneous estimation with information about error correlations: Use the covariance matrix to re-estimate the regression coefficients using methods like Maximum Likelihood or Generalized Least Squares (GLS).

To retest the model, the author performed a convergence diagnosis of the MCMC chain for Bayesian inference. If the MCMC chains converge, we can conclude that the model is strong. Testing the convergence of the MCMC series is done through trace plots, histograms, autocorrelation plots, and density plots (data is processed by Stata 17).

The SUR model can be written as follows:

$$LC_{i,t} = \alpha_0 + \alpha_1 CAP_{i,t} + \alpha_2 ROA_{i,t} + \alpha_3 REG_{i,t} + \alpha_4 ECO_{i,t} + \alpha_5 LNTA_{i,t} + \alpha_6 GDP_{i,t} + \alpha_7 INF + \varepsilon_{i,t} \quad (1)$$

$$CAP_{i,t} = \beta_0 + \beta_1 LC_{i,t} + \beta_2 ROA_{i,t} + \beta_3 REG_{i,t} + \beta_4 ECO_{i,t} + \beta_5 LNTA_{i,t} + \beta_6 GDP_{i,t} + \beta_7 INF_{i,t} + \delta_{i,t} \quad (2)$$

Where $LC_{i,t}$ stands for the measure of liquidity creation (Nonfat liquidity/Total assets (%)), $CAP_{i,t}$ stands for capital tier 1 (%). $ECO_{i,t}$ and $REG_{i,t}$ symbolizes economic freedom and regulatory level, respectively. The subscripts i and t denote bank and time period, i ranges from 1 to 156 and t varies from 2018 to 2022. The α, β represent the slope of the all variables and ε, δ represent the error terms.

Liquidity creation (LC) is calculated according to Berger and Bouwman (2009). While Berger and Bouwman’s preferred measure is the "cat fat" version, we use only the "non-fat" liquidity creation measure due to the lack of detailed information on off-balance sheet activities in our sample dataset. However, it is important to note that the trends in both the non-fat and cat fat measures over time are similar, differing primarily in their dollar values (Berger & Bouwman, 2009). The liquidity creation measure used in the empirical models is the ratio of "non-fat" liquidity creation to the bank’s total assets. Bank capital (CAP) is defined

as the ratio of Tier 1 capital (paid-up shares and common stock) and reserves to total assets. Tier 1 capital is a standard feature of banking systems across all countries, and total assets encompass both financial and non-financial assets.

The measure of economic freedom (ECO) used here is the average of the ten sub-indexes of economic freedom developed by The Heritage Foundation. This indicator ranges from 0 to 100, with higher values reflecting an economic environment or policy set that is more conducive to economic freedom. The regulatory quality index (REG), created by the Worldwide Governance Indicators (WGIs) of the World Bank (Kaufmann et al., 2011), is used to assess the quality of institutional development in each country. The Regulatory quality index spans from approximately -2.5 (indicating weak governance) to 2.5 (indicating strong governance).

Bank efficiency (ROA) – Return on asset - According to previous studies by (Al Zaidanin & Al Zaidanin, 2021; Liaqat Ali & Zou, 2019) return on assets (ROA) is an indicator that evaluates the bank's ability to manage financial resources and real assets to generate profits, indicating the bank's profitability per asset. (COHEN et al., 1997) used return on assets (ROA) to measure accounting profits and said that ROA is a popular measure of financial bank efficiency among market analysts because it shows whether the asset is effective in generating profits or not. Bank size (LNTA) - Ln of Total asset – the absolute measure of the bank size (Berger & Bouwman, 2009); (Lei & Song, 2013); (Horváth et al., 2014); (Chipeta & Deressa, 2016). Non-performing loans (NPL) the non-performing loan ratio. As stated by (Berger & Bouwman, 2009), it is important to control for risk because it helps to isolate the role of capital in supporting the liquidity creation of banks from the role of capital in supporting banks' function as risk transformers. LA: Loans to assets ratio (%). According to Bunda and Desquilbet (2009), a higher ratio indicates lower liquidity for the bank. An increase in loans can boost the bank's earnings by raising lending interest rates while reducing deposit interest rates, which in turn leads to higher bank capital. Banks may look for new lending opportunities, expand into new geographic markets, and/or increase their market share in existing markets (Levine, 2002).

GDP annual growth rate per capital (%). Economic growth per capita growth is another macroeconomic factor that can potentially influence banking sector stability. *INF Inflation rate (%)*. This study control for macroeconomic factors affecting liquidity creation. Inflation (INF) is used to control for macroeconomic factors influencing banking sector stability.

Results and Discussion

1. Descriptive Statistics

Table 2. Descriptive statistics

Variable	Obs	Mean	Std.Dev.	Min.	Max.
LC	780	0.278	0.171	-0.964	0.750
CAP	780	13.44	10.02	0.35	94.44
ROA	780	0.988	1.008	-8.93	5.46
REG	780	0.249	0.554	-0.987	2.227
ECO	780	62.20	18.65	4	89.7
LNTA	780	9.078	1.586	4.552	13.226
NPL	780	2.911	3.627	0.01	34.9
LA	780	63.273	17.3	1.87	105.34

Variable	Obs	Mean	Std.Dev.	Min.	Max.
GDP	780	2.261	4.125	-11	13.5
INF	780	3.152	3.372	-3.3	24.2

Notes: Liquidity creation (LC), Capital tier 1 (CAP), Bank efficiency (ROA), Regulatory quality (REG), Economic freedom (ECO), Bank size (LNTA), Non-performing loans (NPL); Loans to assets ratio (LA); Economic growth rate per capital (GDP), Inflation rate (INF).

Source: Authors’ own estimation

Table 3. Correlation Matrix of Variables

	LC	CAP	ROA	REG	ECO	LNTA	NPL	LA	GDP	INF
LC	1									
CAP	0.19*	1								
ROA	-0.02	-0.01	1							
REG	0.04	0.00	0.22*	1						
ECO	0.06	0.06	0.09*	0.29*	1					
LNTA	-0.15*	0.50*	0.12*	0.25*	0.09*	1				
NPL	0.02	0.31*	-0.28*	0.02	0.02	-0.26*	1			
LA	0.31*	0.36*	0.02	-0.07*	-0.03	0.33*	-0.23*	1		
GDP	-0.03	-0.03	0.1*	-0.11*	-0.18*	0.01	-0.05	0.02	1	
INF	-0.12	0.06	0.03	0.02	0.11*	-0.06	0.01	-0.12*	0.47*	1

Notes: Liquidity creation (LC), Capital tier 1 (CAP), Bank efficiency (ROA), Regulatory quality (REG), Economic freedom (ECO), Bank size (LNTA), Non-performing loans (NPL); Loans to assets ratio (LA); Economic growth rate per capital (GDP), Inflation rate (INF).

Source: Authors’ own estimation

Table 2 represents descriptive statistics of all the variables used in this study. Table 3 provides information on correlation coefficients between pairs of variables in the sample with the "p" values in parentheses. The correlation coefficients are not above 0.8, so it is difficult to have serious multicollinearity (Pliskin & Kennedy, 1987).

2. Empirical results

Table 4. The results

Variable	Model 1 (LC)		Model 2 (CAP)	
	Coef.	P> z	Coef.	P> z
LC			22.889***	0.000
CAP	0.0081***	0.000		
ROA	0.0045	0.439	2.058***	0.000
ECO	0.0009**	0.005	0.0509**	0.002
REG	0.0431***	0.000	1.1221*	0.056

Variable	Model 1 (LC)		Model 2 (CAP)	
	Coef.	P> z	Coef.	P> z
LNTA	-0.0116**	0.008	-2.1813***	0.000
NPL	-0.0015	0.373	0.5357***	0.000
LA	0.0051***	0.000	-0.1876***	0.000
GDP	0.0004	0.790	-0.0214	0.792
INF	-0.0049**	0.008	0.0998	0.314

Notes: ***, **, * indicate significant at 1%; 5% and 10% levels, respectively.

Model 1: The factors impact on liquidity creation; Model 2: The factors impact on bank capital

Liquidity creation (LC), Capital tier 1 (CAP), Bank efficiency (ROA), Regulatory quality (REG), Economic freedom (ECO), Bank size (LNTA), Non-performing loans (NPL); Loans to assets ratio (LA); Economic growth rate per capital (GDP), Inflation rate (INF)

Source: Authors' own estimation

2.1. The interactive relationship between liquidity creation and bank capital

The results of models 1 and 2 show that liquidity creation and bank capital have a positive correlation and are statistically significant. Specifically, when bank capital increases by 1%, liquidity creation increases by 0.0081%, conversely, when liquidity creation increases by 1%, capital adequacy increases by 22.889%. Thus, in this relationship, liquidity creation has a great impact on the capital adequacy of banks. This is also considered one of the solutions to help banks meet the capital regulations according to the Basel framework. This result is consistent with the Brisk absorption theory, which states that higher capital increases liquidity creation. Liquidity creation may increase bank losses, as it implies having more illiquid assets to meet the liquidity demands of customers (Allen & Gale, 2004). Therefore, because capital may help banks to absorb greater risk (Repullo, 2004); (Berger & Bouwman, 2009) infer that higher capital may allow banks to create more liquidity. (Horváth et al., 2014) analyze the relationship between liquidity creation and capital by examining empirical works regarding the impact of risk on banks' capital buffers (Jokipii & Milne, 2011). According to the so-called liquidity risk hypothesis, as greater liquidity creation increases the risk of illiquidity for banks, banks should strengthen their solvency because capital acts as a buffer against unexpected withdrawals from customers. Therefore, this hypothesis would imply a positive relationship between liquidity creation and bank capital.

2.2. The effects of regulation quality and economic freedom

The results indicate that both the economic freedom index and regulatory quality have a positive and statistically significant impact on liquidity creation and bank capital. Specifically, a 1% increase in the economic freedom index results in a 0.0009% increase in liquidity creation and a 0.0509% increase in bank capital. Similarly, a 1% increase in regulatory quality leads to a 0.0431% increase in liquidity creation and a 1.1221% increase in bank capital. This suggests that banks in economies with higher economic freedom and regulatory quality are more likely to increase their liquidity creation and bank capital.

The explanations for these results are as follows: (i) the relationship between management quality and liquidity creation is explained by Nagaraj & Zhang (2019), who argue that better regulatory quality reduces the cost of capital. Well-defined regulations make it easier for foreign firms to operate in the host economy, fostering integration with the global economy. Simple, clear regulations can promote financial integration, reducing capital costs. Lower information asymmetry can stimulate credit expansion, further lowering capital costs. (ii) Regarding the relationship between regulatory quality and bank capital, the findings align

with Anginer et al. (2018), who found that higher bank capital is linked to reduced systemic risk. This effect is particularly noticeable in countries with weaker public and private financial supervision and lower information availability. Their study suggests that capital can compensate for weak institutional environments in mitigating systemic risk.

Additionally, the positive impact of the economic freedom index on bank liquidity and capital formation is consistent with previous research by Gropper et al. (2015), who found a connection between bank performance, powerful politicians, and economic freedom. Their study highlighted that bank performance is positively correlated with a country's economic freedom. Furthermore, Sufian & Habibullah (2010) found that general economic freedom and entrepreneurial freedom positively affect bank profitability. This supports the view that increasing economic freedom allows banks to diversify their activities, exploit economies of scale and scope, and generate higher income from non-traditional sources.

2.3. The factors impact on liquidity creation and bank capital

The factors that have a positive and significant impact on liquidity creation are LA and ROA. Specifically, when LA and ROA increase by 1%, liquidity creation increases by 0.0051% and 0.0045%, respectively. Conversely, variables such as LNTA and INF have a negative and significant impact on liquidity creation. Specifically, when LNTA and INF increase by 1%, liquidity creation decreases by 0.0116% and 0.0049%, respectively. The explanation for these results is as follows: (i) LA and ROA positively impact liquidity creation because they help banks maintain stable cash flows and have a greater capacity to provide credit. (ii) LNTA and INF negatively impact liquidity creation because large asset size can reduce flexibility in managing liquidity, and inflation increases costs and reduces the real value of assets. Studies by Levine (2002), Diamond & Rajan (2001), Bikker & Metzmakers (2005), and Jokipii & Monnin (2013) have clarified the relationship between these factors and banks' ability to maintain liquidity.

The factors that have a positive and significant impact on bank capital are ROA and NPL. Specifically, when ROA and NPL increase by 1%, bank capital increases by 2.058% and 0.5357%, respectively. Conversely, variables such as LNTA and LA have a negative and significant impact on bank capital. Specifically, when LNTA and LA increase by 1%, bank capital decreases by 2.1813% and 0.1876%, respectively. The explanation for these results is as follows: (i) ROA and NPL positively impact bank capital because banks can use profits from efficient operations to strengthen capital and reduce risk costs from non-performing loans. (ii) LNTA and LA negatively impact bank capital because large banks or those with high loan ratios may face difficulties in maintaining liquidity and protecting capital, especially during financial risk situations. Studies by Berger & Bouwman (2009), Chortareas et al. (2013), and Sufian & Habibullah (2010) have clarified the relationship between these factors and banks' ability to maintain capital.

3. Robustness checks

To re-verify the model, the author diagnoses the convergence of the MCMC chain according to Bayesian inference. In which, Figure 1 shows the role of economic freedom and regulatory quality on the two functions of banks (liquidity and capital). The convergence of the MCMC chain is checked through 4 charts: trace plot, histogram, autocorrelation plot, and density plot. The test results from Figures 1 and 2 show that the traces run quickly through the distribution. The correlation plot decreases rapidly, indicating low correlation. The shape of the histogram, simulating the shape of the exact distributions, is uniform. From this, it can be concluded that Bayesian inference is effective and reasonable. However, there are relationships that need attention and through the charts, the estimated efficiency is not high. The impact of regulatory quality on liquidity creation (LC: REG) in Figure 1. This result is contrary to the results in Table 4, showing that the impact of regulatory quality and economic

freedom on the banking industry. This is also one of the reasons why banks are hesitant in the process of implementing regulations under the Basel framework.

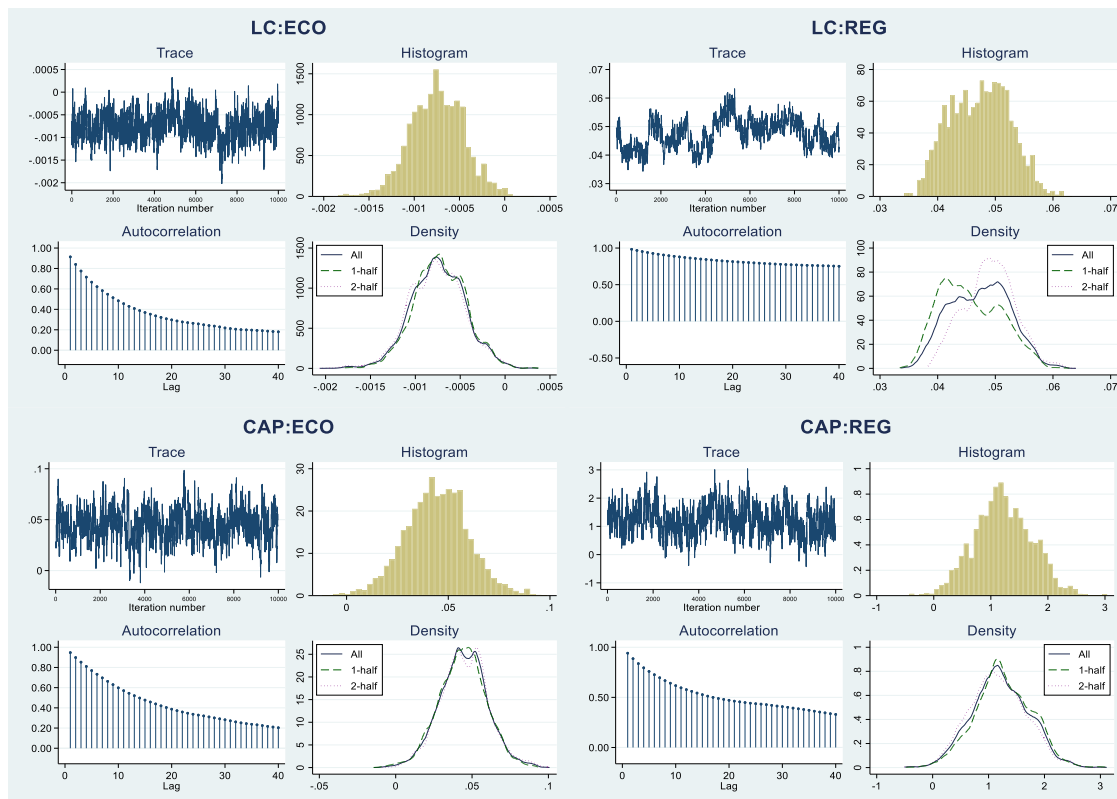


Figure 1 Graphical diagnostics for MCMC convergence – the impact of regulation quality and economic freedom

Source: Authors’ own estimation

Conclusion

This study investigates the interaction between liquidity creation, capital and bank efficiency in 156 Southeast Asian banks during 2018-2022. Firstly, the study found a positive relationship between liquidity creation and bank capital. Secondly, the study provides empirical support for existing studies, namely that banks in countries with higher economic freedom, better regulatory quality will have better liquidity creation and capital levels. This is consistent with the trend of the implementation of Basel regulations for banks. Especially banks in Southeast Asia are in the process of implementing Basel regulations. To achieve an optimal balance, banks need to manage these three factors well. Good liquidity management reduces risk and enhances stability, while capital and efficiency management require a trade-off between maintaining safety and maximizing profits. Understanding the interrelationship between these factors is key to maintaining stability and success in banking operations. However, the study also points out a point to note. That is, better and more stringent regulatory quality in countries not only improves but also restricts the functions of banks (creating liquidity and bank capital). This explains why the higher the regulatory quality and the more stringent the regulation, the more difficult it is to implement Basel regulations. These results should help functional units and bank managers consider and strengthen economic control or expand economic freedom.

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Application of Digital Technology and Sustainable Economic Development for Ethnic Minorities in Lao Cai Province: Current Situation and Prospects

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Abstract

This paper discusses the application of digital technology in sustainable economic development for ethnic minorities in Lao Cai Province, a mountainous region in the northwest of Vietnam. The current economic development situation for ethnic minorities in this region faces many challenges, including infrastructure limitations and a lack of resources, but there are new opportunities emerging through the use of digital technology. The paper analyzes models of digital technology applications, ranging from e-commerce platforms and artificial intelligence in agricultural production to tourism promotion through digital platforms. Ultimately, the paper proposes solutions to harness digital technology to promote sustainable development for ethnic minorities in Lao Cai.

Keywords: Digital Technology, Sustainable Economic Development, Ethnic Minorities, Lao Cai.

Introduction

Lao Cai is a province located in the northwest of Vietnam, home to many ethnic minorities with rich cultural diversity and long histories. However, economic development in the region has faced many challenges, including poor infrastructure, a shortage of skilled labor, and agricultural production relying largely on traditional methods. Despite these challenges, one of the factors that could significantly drive economic change in ethnic minority communities in Lao Cai is the application of digital technology. Digital technology, especially in areas such as e-commerce, artificial intelligence (AI), and the Internet of Things (IoT), can create significant breakthroughs in sustainable economic development.

Given the environmental challenges and uneven development across different regions, the use of digital technology in promoting sustainable economic growth for ethnic minorities in Lao Cai is a promising and feasible direction.

Main Content

1. Economic Development of Ethnic Minorities in Lao Cai

Lao Cai has unique characteristics as a mountainous region with many ethnic minorities living primarily through agriculture and animal husbandry. However, the people in the region still face challenges in maintaining and developing production activities, from the lack of scientific knowledge to limited infrastructure and services.

Agriculture: While agricultural products in Lao Cai, such as tea, rice, and fruit, are unique and have export potential, most farmers still rely on traditional cultivation methods, which reduce productivity and product quality.

Tourism: Cultural and ecological tourism in Lao Cai has significant potential, but the lack of information systems and digital tourism promotion platforms makes it difficult for tourists to access information about these destinations.

2. Digital Technology and New Opportunities for Sustainable Economic Development

Digital technology can play a critical role in promoting sustainable economic development in Lao Cai, particularly in the following areas:

E-commerce: With the development of the internet and e-commerce platforms, ethnic minorities in Lao Cai can sell agricultural products and handicrafts directly to consumers both domestically and internationally, bypassing intermediaries. Platforms such as Lazada, Shopee, and Tiki have helped expand the market for Lao Cai’s products.

Artificial Intelligence (AI) and IoT in Agriculture: The use of automated systems in agriculture, such as smart irrigation and crop monitoring through sensors, helps farmers save costs and increase labor productivity. Furthermore, AI can be used to analyze market trends, weather forecasts, and enhance production efficiency.

Tourism Development via Digital Platforms: Smart tourism apps, websites, and video-sharing platforms like YouTube can help Lao Cai promote its tourism potential while providing tourists with detailed information about local attractions, products, and services.

3. Successful Digital Technology Applications in Lao Cai

Several successful models of digital technology application have been implemented in Lao Cai, including:

E-commerce for Agricultural Products: Cooperatives in Lao Cai have started using e-commerce platforms to sell clean agricultural products such as rice, Shan Tuyet tea, and citrus fruits. These platforms have helped connect farmers directly with consumers both domestically and internationally.

Smart Tourism Model: Lao Cai has implemented mobile apps to assist tourists in finding information about tourist attractions, booking hotels, and accessing other services. These apps also allow tourists to rate services, which helps improve the quality of tourism services in the area.

IoT in Agriculture: Some cooperatives in Lao Cai have applied sensors and smart management systems to monitor crop conditions, controlling factors such as humidity and temperature, which optimizes production processes.

4. Challenges and Solutions for Implementing Digital Technology in Lao Cai

Although there are many opportunities, the application of digital technology in Lao Cai faces several significant challenges:

Lack of Infrastructure: Many areas in Lao Cai still lack stable and fast internet connections, limiting the widespread application of digital technology.

Lack of Digital Skills: The people, especially ethnic minorities, have limited skills in using information technology. Therefore, training and support programs for digital skills are crucial.

Solutions

Investing in Digital Infrastructure: The government and organizations should continue to invest in the development of telecommunications infrastructure, electricity, and internet services in remote areas.

Enhancing Digital Skills Training: Organizing digital training programs for local people, particularly in using e-commerce platforms and smart agricultural tools, is essential.

Encouraging Technology Investments: The government and international organizations should create favorable policies and support businesses, cooperatives, and farmers in accessing new technologies.

Conclusion

Digital technology holds significant potential for promoting sustainable economic development among ethnic minorities in Lao Cai. The application of technology in agriculture, e-commerce, and smart tourism can bring breakthroughs in economic development for the region. However, to make these models a reality, it is necessary to invest in infrastructure and digital skill training and to create an enabling environment for technology access and application. With its rich natural resources and cultural heritage, Lao Cai has a great opportunity to develop a sustainable economy, improving the livelihoods of ethnic minorities in the province.

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Trends in the Demand for Chinese-Speaking Staff in the Guesthouse and Hotel Services Sector in Luang Prabang

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Abstract

The rapid growth of Chinese outbound tourism has significantly impacted the hospitality industry in Southeast Asia, particularly in Luang Prabang, Laos, a UNESCO World Heritage site renowned for its cultural and natural attractions. This study investigates the rising demand for Chinese-speaking staff in Luang Prabang’s guesthouse and hotel services sector, driven by the increasing influx of Chinese tourists. Using a mixed-methods approach, the research combines qualitative interviews with hospitality stakeholders and quantitative surveys of Chinese-speaking tourists to analyze trends, challenges, and implications for the local workforce. Findings reveal a substantial demand for bilingual staff, with 75% of hotel and guesthouse managers emphasizing the importance of Chinese-speaking employees to enhance customer satisfaction and service quality. However, challenges such as a shortage of qualified candidates, limited access to language training, and financial constraints, particularly for smaller establishments, hinder the sector’s ability to meet this demand. Survey results indicate that 85% of Chinese tourists prefer accommodations with Chinese-speaking staff, and those who interacted with such staff reported higher satisfaction levels with mean 4.5 compared to those who did not (mean score of 3.2/5). The study highlights the critical role of language proficiency in improving guest experiences and fostering repeat business. It also underscores the need for workforce development initiatives, including government-supported language training programs and partnerships with educational institutions, to address staffing gaps. The findings align with global trends in tourism, where multilingual staff are increasingly prioritized to cater to international tourists. This research provides valuable insights for policymakers and industry practitioners, emphasizing the importance of adapting to the linguistic and cultural needs of a diverse clientele to ensure the sustainable growth of Luang Prabang’s tourism sector.

Keywords: Demand, Chinese-Speaking Staff, Guesthouse, Hotel, Luang Prabang

Introduction

The global tourism industry has undergone rapid transformations in recent decades, influenced by factors such as emerging markets, changing travel patterns, and economic growth in previously underrepresented regions. In particular, the rise of Chinese tourists has reshaped tourism industries around the world. For countries in Southeast Asia, including Laos, the influx of Chinese-speaking tourists has significantly impacted local tourism infrastructure and business operations. One city that has been particularly affected by this development is Luang

Prabang, a UNESCO World Heritage site located in northern Laos. Known for its stunning natural landscapes, rich cultural history, and vibrant religious traditions, Luang Prabang has become an increasingly popular destination for international tourists, especially from China (Tourism Development Department of Laos, 2021). As a result, the demand for skilled Chinese-speaking staff in the local hospitality sector, specifically in guesthouses and hotels, has risen considerably.

Over the past decade, Luang Prabang has experienced substantial growth in tourism, driven by its status as a culturally significant destination and its accessibility to international travelers. According to the Ministry of Information, Culture and Tourism of the Lao People’s Democratic Republic (2022), tourism is one of the most important sectors contributing to the country’s economy, with Chinese visitors being a primary source of revenue. The popularity of Luang Prabang among Chinese tourists is particularly notable due to its proximity to China, direct flight connections, and the growing interest in the region’s history, heritage, and natural beauty. This influx of Chinese visitors has created a pressing need for the tourism and hospitality industry in Luang Prabang to adapt to the linguistic and cultural preferences of this market.

The need for Chinese-speaking employees in guesthouses and hotels is a direct consequence of the increasing number of Chinese tourists seeking personalized services in their native language. Language has long been recognized as a critical component of customer satisfaction in the hospitality industry, as it facilitates better communication, enhances guest experiences, and fosters positive relationships between guests and service providers (Hsu, 2016). In a competitive tourism market such as Luang Prabang, where guests are accustomed to high standards of service, the ability to communicate in Chinese can be a significant factor in attracting and retaining customers. This trend aligns with broader global patterns in tourism, where service providers in various countries are increasingly prioritizing multilingual staff to meet the demands of international tourists (Li, 2017).

Furthermore, the demand for Chinese-speaking staff in Luang Prabang’s hospitality sector reflects broader economic and social trends in the region. China’s economic expansion has not only led to a surge in outbound tourism but has also contributed to the growth of Chinese-speaking communities abroad. In Luang Prabang, the increasing prevalence of Chinese-speaking tourists necessitates a workforce capable of accommodating their linguistic needs. Guesthouses and hotels in the city are particularly affected, as smaller establishments often rely on local staff with limited access to formal language training. In this context, the availability of Chinese-speaking personnel is becoming an essential factor for businesses seeking to remain competitive in a growing market (Nguyen, 2020).

In addition to the practical implications of staffing requirements, the rise of Chinese-speaking employees in Luang Prabang also has broader implications for the local workforce and community. The demand for bilingual staff presents both opportunities and challenges for local workers, particularly in terms of employment, language acquisition, and professional development. As the hospitality sector evolves, there is an increasing need for training programs that equip local workers with the necessary language skills to serve Chinese tourists effectively. Such initiatives can help bridge the gap between local workers and international guests, improving service quality and contributing to the professional growth of individuals within the tourism industry (Goh & Lo, 2019).

The shift toward bilingual staff also speaks to a larger cultural exchange occurring between Laos and China. While tourism brings economic benefits, it also fosters greater cross-cultural understanding and interaction between the two countries. In Luang Prabang, Chinese-speaking employees often serve as cultural intermediaries, not only assisting with communication but also helping to promote a positive image of Laos to Chinese visitors. This

dynamic is important in enhancing the tourism experience and ensuring that the local community benefits from the increasing presence of Chinese tourists.

However, the growing demand for Chinese-speaking staff in the guesthouse and hotel services sector in Luang Prabang also raises questions about the sustainability of this trend. Will the supply of qualified Chinese-speaking workers be able to meet the demand? Are there sufficient resources and training programs in place to help local workers acquire the necessary language skills? How do businesses balance the need for multilingual staff with the challenges of maintaining high-quality service in a culturally diverse environment? These questions are critical for understanding the future trajectory of the tourism industry in Luang Prabang and its ability to adapt to evolving market needs.

This study aims to explore the trends in the demand for Chinese-speaking staff in the guesthouse and hotel services sector in Luang Prabang. By examining the factors driving this demand, the challenges faced by Hotels and Guesthouse owners, and the implications for the local workforce, this research seeks to provide valuable insights into the intersection of language, tourism, and hospitality in Laos. The findings will offer a comprehensive understanding of how the tourism industry in Luang Prabang is responding to the growing presence of Chinese tourists and contribute to ongoing discussions about workforce development in the hospitality sector.

Methodology

The purpose of this study is to explore the trends in the demand for Chinese-speaking staff within the guesthouse and hotel services sector in Luang Prabang. Given the growing number of Chinese-speaking tourists visiting the city, it is essential to understand how the hospitality industry has adapted to meet their needs. The methodology employed in this research combines qualitative and quantitative methods to provide a comprehensive analysis of the demand for Chinese-speaking employees, the challenges faced by the hospitality sector, and the impact of this trend on the local workforce.

1. Research Design

This study follows a mixed-methods research design, combining both qualitative and quantitative approaches to gather a wide range of data. The qualitative component aims to understand the experiences and perceptions of hospitality industry stakeholders, including hotel managers, guesthouse owners, and employees. The quantitative component involves the collection of statistical data on the number of Chinese-speaking tourists, the staffing needs of hospitality establishments, and language proficiency levels among local workers.

By using both approaches, the study seeks to present a holistic picture of the current demand for Chinese-speaking staff in Luang Prabang's hospitality sector. This design allows for both depth and breadth in data collection, offering insights into both the individual experiences of industry participants and broader trends across the city.

2. Sampling and Participants

The study employs purposive sampling to select participants who are directly involved in the hospitality industry in Luang Prabang. Specifically, the target population consists of:

- Hotel and guesthouse managers who oversee operations and staffing decisions.
- Front-line employees (such as receptionists, concierges, and tour guides) who interact directly with guests.
- Local training providers who offer language courses or hospitality training programs.

In addition to these groups, the study also includes a sample of Chinese-speaking tourists visiting Luang Prabang. This group will help assess how well their language needs are being met during their stay.

3. Sample group

The sample size for the qualitative interview consisted of 20 participants, including 20 hotel or guesthouse managers and 20 employees. The sample size for the survey of Chinese-speaking tourists included 100 respondents, selected from various tourist sites and accommodations across the city. This ensured a diverse range of perspectives regarding service quality and language accessibility.

4. Tools to Collect Data

Quality data were used the interview form to collect. The interview form included open-ended questions focusing on the following areas:

- The current demand for Chinese-speaking staff in the hospitality sector.
- Challenges faced by employers in hiring and training Chinese-speaking personnel.
- The impact of Chinese-speaking staff on customer satisfaction and service quality.
- The perceived future demand for Chinese-speaking staff in the sector.

Quantitative data were collected through structured surveys. The surveys were distributed to a sample of 100 Chinese-speaking tourists who are staying in hotels or guesthouses in Luang Prabang. The survey gathered information about the guests' language preferences, experiences with communication, and their satisfaction with services provided by Chinese-speaking staff.

- The survey included questions such as:
- Whether the tourist preferred to be served by Chinese-speaking staff.
- The perceived quality of communication with Non-Chinese-speaking staff.
- The level of satisfaction with services based on language assistance.
- The frequency of encountering language barriers during their stay.

Additionally, hotel and guesthouse managers were asked to complete a brief survey to collect data on the current staffing levels, language skills of their employees, and the frequency with which Chinese-speaking tourists visit their establishments.

5. Data Collection

The qualitative data were gathered through semi-structured interviews with hotel and guesthouse managers, employees, and language training providers. The interviews were conducted in person or via video conferencing, depending on the availability of participants. The semi-structured format allowed for flexibility in the interview process, enabling participants to elaborate on their experiences and perceptions while still addressing key research questions.

6. Data analysis

The qualitative data collected from interviews were transcribed and analyzed using thematic analysis. This method involves identifying recurring themes and patterns in the responses to better understand the experiences and perspectives of the participants. The themes were categorized to address specific research questions related to demand, challenges, and workforce development in the hospitality sector.

Thematic analysis were performed in the following steps:

- Reading through the interview transcripts and survey responses to get an overview of the data.

- Identifying significant statements, phrases, or sections of text that are relevant to the research questions.
- Grouping the codes into overarching themes that represent common experiences or challenges.
- Analyzing the patterns and connections between themes to draw conclusions about the demand for Chinese-speaking staff in Luang Prabang.
- The quantitative survey data were analyzed using descriptive statistics to identify patterns and trends in the responses. This included calculating the frequency of responses, the percentage of tourists who prefer Chinese-speaking staff, and the satisfaction levels of tourists with regard to language accessibility.
- The data were analyzed using statistical software such as SPSS or Excel. Descriptive statistics such as mean scores, percentages, and frequency distributions used to summarize the data. The findings from the tourist surveys were compared with the staffing data from hotels and guesthouses to assess the alignment between demand and supply in terms of Chinese-speaking staff.

Result

The analysis of the data collected from interviews, surveys, and statistical reports revealed significant trends and patterns regarding the demand for Chinese-speaking staff in the guesthouse and hotel services sector in Luang Prabang. These findings offer valuable insights into the current state of the hospitality industry, the language needs of Chinese-speaking tourists, and the challenges faced by local businesses in meeting these demands. This section presents the key results from both the qualitative and quantitative components of the study.

1. Demand for Chinese-Speaking Staff

Interviews with hotel and guesthouse managers (n = 20) revealed that there has been a notable increase in the demand for Chinese-speaking staff in recent years. Most participants (80%) reported that they have observed a steady rise in the number of Chinese-speaking tourists visiting their establishments, since opening China-Lao high speed train in 2021. Many managers noted that Chinese tourists make up a significant portion of their clientele, especially during peak travel seasons such as Chinese New Year and school holidays.

As many managers stated: *"In the past few years, we have noticed that almost 40-50% of our guests come from China. We find that having Chinese-speaking staff is essential to provide a high level of service, as it directly impacts guest satisfaction."*

Managers also reported that Chinese-speaking guests are more likely to stay in hotels and guesthouses where staff can communicate in their native language, which improves their overall experience and comfort. Approximately 70% of managers agreed that language barriers often lead to misunderstandings, missed business opportunities, and decreased satisfaction.

2. Challenges Faced by Employers

The primary challenge identified by managers in hiring Chinese-speaking staff was the lack of local language proficiency among job seekers. In particular, most employees in Luang Prabang's hospitality sector are local Lao citizens with limited Chinese language skills. Managers expressed difficulty in finding qualified candidates with both fluency in Chinese and experience in hospitality roles. As many guesthouse owners explained: *"It's hard to find staff who are fluent in Chinese, especially among younger generations. Most of them speak basic English, but that's not enough for our Chinese guests."*

3. Impact on Service Quality

Despite these challenges, a majority of managers (75%) reported that the addition of Chinese-speaking staff has led to improvements in customer service and satisfaction. Guests who were served by Chinese-speaking staff were more likely to express higher levels of satisfaction with the overall service quality. Managers observed that Chinese-speaking employees helped bridge cultural gaps, facilitated smoother communication, and provided more personalized services, such as assisting with local attractions and guiding tours.

4. Survey of Chinese-Speaking Tourists

A total of 100 Chinese tourists participated in the survey. The survey aimed to understand their language preferences and satisfaction levels regarding communication with hotel and guesthouse staff.

85% of respondents reported that they preferred to be served by Chinese-speaking staff, particularly for check-in/check-out procedures, inquiries about local attractions, and booking tours. Among these, 40% stated that they would actively seek out accommodations with Chinese-speaking staff when booking their stay.

Approximately 60% of tourists indicated that they encountered communication difficulties during their stay, especially when interacting with non-Chinese-speaking staff. Common issues included miscommunication regarding room preferences, payment methods, and directions to local attractions.

Tourists who interacted with Chinese-speaking staff rated their overall experience as significantly higher with the mean of 4.5 compared to those who were assisted by non-Chinese-speaking staff with the mean of 3.2. Guests who had positive experiences with Chinese-speaking staff expressed higher levels of satisfaction with the personalized services they received.

5. Staffing Data from Hotels and Guesthouses

Data collected from 20 hotels and guesthouses in Luang Prabang showed that:

- **Chinese-Speaking Staff Proportion:** On average, only 15% of staff in these establishments are proficient in Chinese. The proportion was higher in larger, more internationalized hotels (up to 30%), but much lower in smaller guesthouses (around 5%).
- **Tourist Demographics:** Among these establishments, 60% reported that over 30% of their guests were from China, with 20% of businesses reporting that more than 50% of their guests came from Chinese-speaking regions.

6. Staffing Needs

When asked about future staffing plans, 70% of hotel managers indicated that they intend to increase the number of Chinese-speaking staff over the next few years to meet growing demand. Larger establishments were more likely to invest in professional language courses, while smaller guesthouses were looking for ways to hire bilingual staff directly.

Discussion

The findings of this study confirm the rising demand for Chinese-speaking staff in Luang Prabang’s guesthouse and hotel services sector. This trend reflects global patterns in the hospitality industry, particularly in regions experiencing an influx of Chinese-speaking tourists. By comparing the results of this study with existing literature, several key themes emerge, including the increasing importance of language proficiency for customer satisfaction,

challenges in staffing, and future workforce development needs. This section discusses these findings in relation to other research in the field.

1. Rising Demand for Chinese-Speaking Staff

The results of this study indicate a significant increase in the demand for Chinese-speaking staff in Luang Prabang, with 75% of hotel and guesthouse managers reporting a need for bilingual employees. This demand is driven by the growing number of Chinese-speaking tourists visiting the city, which aligns with global trends in the tourism industry. According to Li (2017), the increasing middle class in China and the expansion of Chinese outbound tourism have made Chinese tourists a dominant group in global travel. Studies by Chen & Xie (2020) and Goh & Lo (2019) also confirm that countries across Southeast Asia are seeing a surge in Chinese tourism, necessitating the hiring of Chinese-speaking staff in the hospitality sector.

Similarly, in Thailand, a study by Thitiphan & Charoenrat (2018) found that the rapid increase in Chinese tourist arrivals led to a growing demand for Chinese-speaking staff in hotels, particularly in tourist-heavy areas such as Bangkok and Phuket. This suggests that the demand for Chinese-speaking employees in Luang Prabang is part of a broader trend in Southeast Asia, where businesses catering to Chinese-speaking tourists are prioritizing bilingual staff to improve service delivery.

2. Challenges in Staffing and Training

Despite the growing demand for Chinese-speaking staff, the study revealed significant challenges related to staffing. Approximately 70% of hotel and guesthouse managers cited difficulties in finding qualified candidates with fluency in Chinese. This shortage of bilingual employees is a challenge not only in Luang Prabang but also in other tourist destinations. In Vietnam, Nguyen (2020) highlighted similar staffing shortages in the hospitality industry, particularly in regions that attract large numbers of Chinese tourists. Similarly, in Singapore, a study by Wong & Tan (2019) found that the hospitality sector was struggling to meet the language needs of Chinese-speaking visitors due to a lack of skilled bilingual workers.

The lack of available candidates with both Chinese language skills and hospitality experience is a challenge identified in multiple studies. According to Hsu (2016), language skills alone are not sufficient; hospitality workers must also possess the necessary customer service skills to meet the expectations of international tourists. In Luang Prabang, this dual skillset is particularly difficult to find. As highlighted by Goh & Lo (2019), while many local workers have basic English language skills, proficiency in Chinese is relatively rare. This gap is exacerbated by the cost of language training programs. The study found that 30% of hotels and guesthouses offered language training to staff, but the cost of such training was a barrier, particularly for smaller businesses.

This challenge is further documented by Chen & Xie (2020), who noted that while larger hotel chains in China have been able to invest in language training programs, smaller independent hotels in countries like Laos and Vietnam often lack the resources to do so. This disparity in resources contributes to uneven language competency in the hospitality sector.

3. Language and Customer Satisfaction

A key finding of this research was the positive correlation between the availability of Chinese-speaking staff and customer satisfaction. Tourists who interacted with Chinese-speaking employees rated their overall experience significantly higher than those who did not. This finding is consistent with research by Li (2017), who found that language barriers negatively impacted the service quality and satisfaction of Chinese tourists in Southeast Asia. Similarly, a study by Chen et al. (2019) in Cambodia revealed that Chinese-speaking tourists

expressed higher satisfaction levels when interacting with staff who could communicate in their native language, especially for personalized services and information about local attractions.

The importance of language proficiency in enhancing guest experiences is also emphasized in Hsu (2016), who argues that language is a crucial factor in shaping tourists' perceptions of service quality. In a similar vein, the findings of Lee & Chang (2018) in Taiwan revealed that multilingual staff, especially those fluent in Chinese, were able to provide higher levels of service, leading to greater customer loyalty. The positive impact of Chinese-speaking employees on customer satisfaction in Luang Prabang reflects these global patterns and highlights the importance of language proficiency in fostering positive guest experiences.

Moreover, a study by Cheng & Mak (2020) on the hospitality industry in Macau found that the integration of Chinese-speaking staff into hotel operations was linked to increased guest retention rates, as tourists from Chinese-speaking regions felt more comfortable and valued. This aligns with the findings in Luang Prabang, where managers indicated that Chinese-speaking staff helped build trust with Chinese guests and fostered repeat business.

4. Future Trends and Workforce Development

Looking to the future, this study found that 70% of hotel and guesthouse managers in Luang Prabang plan to hire more Chinese-speaking staff in the coming years. This proactive approach to workforce development reflects the growing recognition of the need to address the language gap in the hospitality sector. A similar trend was observed in a study by Jang & Lee (2017) in South Korea, where hotels in Seoul were increasingly focused on hiring multilingual staff to accommodate the growing number of Chinese tourists. Similarly, a report by the Pacific Asia Travel Association (2019) highlighted the need for Southeast Asian countries to invest in multilingual workforce training to meet the demands of Chinese-speaking tourists.

In Luang Prabang, businesses are also exploring partnerships with local language schools to provide language training for existing employees. This trend is in line with research by Goh & Lo (2019), who emphasized the importance of continuous skill development and cross-cultural training to ensure that hospitality workers can effectively serve international tourists. In Singapore, the Singapore Tourism Board (2020) has implemented initiatives to support language training for tourism workers, particularly in response to the increase in Chinese tourist arrivals. These types of programs could provide valuable models for workforce development in Luang Prabang.

5. Implications for Policy and Practice

The findings of this study have important implications for both the hospitality industry and tourism policy in Laos. Given the increasing demand for Chinese-speaking staff and the challenges associated with staffing and training, there is a need for targeted policy interventions. These could include government-funded language training programs and initiatives to encourage private sector investment in workforce development. A similar approach has been successfully implemented in Thailand, where the government has supported language training for hospitality workers to meet the needs of international tourists (Thitiphan & Charoenrat, 2018). Furthermore, local educational institutions could collaborate with the tourism industry to offer tailored language courses that meet the specific needs of hospitality workers in Luang Prabang.

Conclusion

This research has explored the growing demand for Chinese-speaking staff in the guesthouse and hotel services sector in Luang Prabang, shedding light on the broader trends in the hospitality industry as it adapts to the needs of an increasingly international clientele. The findings confirm that the rising influx of Chinese-speaking tourists in Luang Prabang has created significant demand for bilingual employees, particularly in the context of providing enhanced customer service. The study revealed that the demand for Chinese-speaking staff is driven by the need for effective communication and personalized service, which are crucial in improving customer satisfaction and fostering repeat business.

While the demand for Chinese-speaking staff is clear, the research also highlighted several challenges faced by businesses in Luang Prabang. These include difficulties in finding qualified candidates, the high cost of language training, and the limited availability of language courses for local workers. The shortage of skilled bilingual staff reflects broader trends observed in other Southeast Asian countries, where the growing number of Chinese-speaking tourists has outpaced the availability of qualified workers. Smaller establishments, in particular, face financial constraints that prevent them from providing language training programs to their staff, which hinders their ability to fully capitalize on the growing Chinese tourist market.

Despite these challenges, the findings suggest that businesses in Luang Prabang are aware of the importance of addressing the language gap and are increasingly prioritizing the hiring of bilingual employees. This trend is supported by the positive correlation between the presence of Chinese-speaking staff and higher customer satisfaction ratings, with Chinese-speaking tourists reporting better experiences when they are able to interact with staff who speak their language. The research also indicated that hotel and guesthouse managers are planning to invest in the recruitment and training of more bilingual staff to meet the growing demand in the coming years, signaling optimism for future growth in the sector.

In light of these findings, it is clear that language proficiency, particularly in Chinese, has become a key factor in enhancing the quality of services in the hospitality industry. To address the staffing shortages, businesses in Luang Prabang, especially smaller establishments, would benefit from targeted workforce development programs, including government-supported language training initiatives. By investing in language skills and staff training, businesses can improve their competitiveness, increase customer satisfaction, and better meet the needs of the evolving tourist market.

Overall, this research contributes to the understanding of the shifting dynamics in the hospitality sector of Luang Prabang and offers valuable insights for both industry practitioners and policymakers. As the tourism industry continues to evolve, it is essential that the hospitality workforce adapts to the linguistic and cultural needs of a diverse, international customer base. The future of Luang Prabang's tourism sector, and its ability to thrive in an increasingly globalized market, will depend on the successful integration of multilingual staff into the workforce, ensuring that the city remains an attractive and welcoming destination for tourists from around the world.

Limitations

Several limitations were considered in this study. Firstly, the study's findings may not be generalizable to all regions in Laos, as it focuses specifically on Luang Prabang. Additionally, the study's sample size may be limited due to the time constraints and availability of participants. There may also be biases in the self-reported data from both tourists and staff, particularly regarding their perceptions of language barriers and satisfaction with services.

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Charting the course of cultural intelligence: A comprehensive review and analysis through the ADO framework

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Abstract

Cultural Intelligence (CQ) is a vital competency for navigating globalization and cross-cultural interactions. This study explores CQ research through bibliometric analysis of 275 articles (2005–2024) and a systematic review using the Antecedent-Decision-Outcome (ADO) framework. Findings reveal key antecedents (individual traits, cultural exposure), decisions (cross-cultural leadership strategies), and outcomes (job performance, leadership effectiveness, and innovation). Bibliometric insights reveal CQ’s thematic evolution and growing importance in virtual teams and digital environments. The study identifies gaps, including limited research on CQ development’s long-term impacts, and emphasizes the need for targeted initiatives to enhance adaptability, innovation, and performance in globalized contexts.

Keyword: cultural intelligence, ADO framework, bibliometric analysis

Introduction

Cultural Intelligence (CQ) has become a vital capability in today’s globalized environment, where individuals, teams, and organizations frequently operate across culturally diverse settings. As "a person's capability for successful adaptation to new cultural environments" (Ott & Michailova, 2018), CQ plays a central role in facilitating effective cross-cultural interactions and ensuring performance in international business contexts (Azevedo, 2018). As globalization continues to advance, the ability to manage cultural differences has become crucial for achieving organizational success, fostering team cohesion, and promoting individual adaptation.

Despite the expanding body of literature on CQ, there remains a lack of comprehensive mapping and synthesis that systematically examines the development of the field. This has left gaps in understanding the evolution of CQ research, its key themes, and potential future directions. To address these gaps, the present study employs a dual approach of bibliometric analysis and systematic review, offering a structured exploration of the CQ literature. This methodology enables both a macro-level view of the research landscape and a detailed investigation of key findings, debates, and emerging trends.

Objectives

- 1) To map the intellectual structure and evolution of CQ research using bibliometric methods, highlighting conceptual and methodological trends.
- 2) To synthesize the literature through a systematic review, providing detailed insights into the antecedents, decision processes, and outcomes of CQ.

Boundary

The study is framed using the Antecedent-Decision-Outcome (ADO) framework, which provides a valuable structure for analyzing CQ research. The ADO framework divides research into three dimensions: Antecedents, which explore the individual, situational, and organizational factors influencing CQ; Decisions, which examine how CQ-related choices, judgments, and strategies are made and implemented in multicultural contexts; and Outcomes, which assess the impact of CQ on performance, adaptability, and success in multicultural environments. By applying this framework, the research systematically traces the factors that shape CQ, the mechanisms through which it informs decision-making, and the broad implications of its outcomes.

Body

Literature review

CQ draws from Gardner (2011)'s *Multiple Intelligences Theory*, extending it to intercultural contexts, and Ang et al. (2007)'s Four-Dimensional Model, which identifies CQ's Metacognitive, Cognitive, Motivational, and Behavioral dimensions. Antecedents of CQ include traits such as openness to experience and emotional intelligence (EI), as well as situational factors like international exposure and cultural diversity (Crowne, 2008; K.-Y. Ng et al., 2012). CQ aligns with (Bandura, 1977)'s *Social Learning Theory*, which emphasizes learning through observation and interaction in diverse settings, and with intercultural competence frameworks that focus on effective communication across cultures (Deardorff, 2006). EI further influences CQ, as emotionally intelligent individuals are better equipped to manage emotions and adapt in multicultural environments (Alon & Higgins, 2005; Moon, 2010).

CQ development can be enhanced through interventions such as training, leadership programs, and immersive experiences. Unlike static traits, CQ is malleable and improves with exposure to diverse contexts and structured learning (Eisenberg et al., 2013). Training programs strengthen Cognitive and Behavioral CQ through cultural analysis and experiential learning (Erez et al., 2013; B. MacNab et al., 2012). Leadership initiatives develop Metacognitive and Motivational CQ by equipping leaders to manage diverse teams (Groves & Feyerherm, 2011; Pless et al., 2011). International assignments and extended cultural exposure promote adaptability and empathy across all CQ dimensions (Crowne, 2008; Takeuchi et al., 2005). Virtual platforms also contribute to CQ development by simulating cross-cultural scenarios and fostering collaboration in diverse virtual teams (Ramsey & Lorenz, 2016; Shokef & Erez, 2015).

CQ positively impacts individual, team, and organizational performance. At the individual level, it enhances job performance, cross-cultural communication, and expatriate adjustment, with Motivational CQ mitigating cultural shock and fostering adaptability (Ang et al., 2006; Rockstuhl et al., 2011; Templer et al., 2006). At the organizational level, CQ fosters collaboration, global strategies, and innovation. Culturally intelligent leaders enhance team

effectiveness by navigating cultural norms and integrating diverse perspectives, driving innovation and creative problem-solving in dynamic global markets (Chua et al., 2012; Groves & Feyerherm, 2011; Leung et al., 2014). Additionally, Cognitive CQ strengthens cross-cultural knowledge sharing, enhancing organizational adaptability and innovation (Kirkman et al., 2006).

Methodology

This study employs a combination of bibliometric analysis and systematic review to assess the intellectual structure and thematic evolution of CQ research. By integrating these approaches, it provides both a quantitative overview and a qualitative synthesis, facilitating a detailed examination of CQ's antecedents, decisions, and outcomes through the ADO framework.

The dataset was compiled by searching for articles using the keyword "Cultural Intelligence" and related terms like "cultural competence" and "intercultural effectiveness." The search, conducted via Web of Science, yielded 923 articles (2005–2024) from disciplines such as management, psychology, and international business. After screening with ASReview LAB, a machine learning tool for systematic reviews, the dataset was refined to 275 relevant documents, forming the basis for the analysis.

Bibliometric analysis, conducted using Biblioshiny and VOSviewer, explored publication trends, citation counts, and influential authors and institutions. Biblioshiny provided descriptive statistics on CQ research trends, while VOSviewer visualized co-authorship networks, co-citation patterns, and keyword co-occurrence. Key metrics included citation analysis to identify influential studies, co-authorship networks to examine collaborative dynamics, and keyword analysis to uncover dominant themes and emerging trends. This macro-level perspective mapped the intellectual foundations and highlighted significant gaps in CQ research.

A systematic review complemented the bibliometric analysis by providing qualitative insights through the ADO framework, categorizing articles into three dimensions: Antecedents (A), which include individual, situational, and organizational factors influencing CQ; Decisions (D), which examine CQ's role in shaping judgments and strategies in multicultural contexts; and Outcomes (O), which analyze CQ's effects on performance, adjustment, and organizational success. The categorization process was performed manually using Taguette to ensure consistent and accurate coding across the dataset.

Results

The dataset on CQ research from 2005 to 2024 reveals significant growth, with 275 documents from 141 sources and an annual growth rate of 16.76%. The field's youth is evident in an average document age of 5.6 years, while a high average of 25.44 citations per document highlights CQ's impact in cross-cultural studies. Authorship trends show contributions from 617 authors, averaging 2.8 co-authors per document, with 42.55% involving international collaboration. This reflects the global and interdisciplinary nature of CQ research, addressing challenges in multicultural contexts. Thematic diversity is demonstrated by 1405 Keywords Plus and 841 Author's Keywords, emphasizing topics such as cultural adaptation, global leadership, and cross-cultural training. Most studies (264 articles) are peer-reviewed journal articles, indicating strong academic rigor.

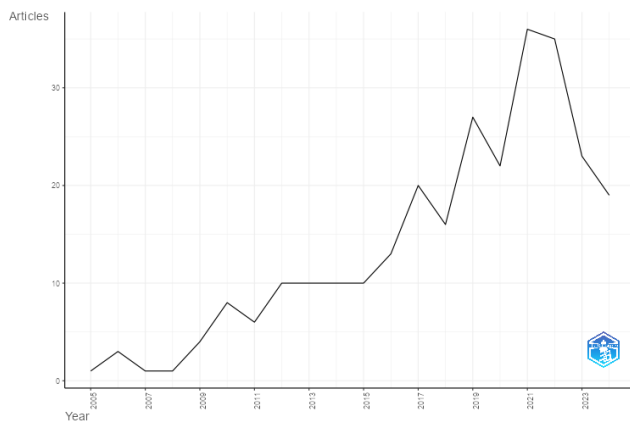


Figure 1. Annual Scientific Production

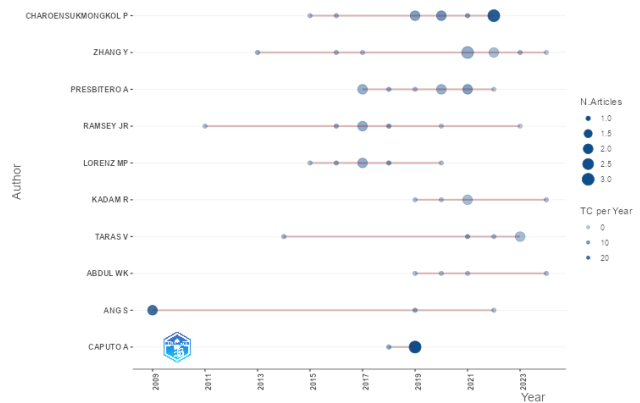


Figure 2. Authors' Production Over Time

Source: Compiled by the author

The dataset reveals a notable upward trend in CQ research from 2005 to 2024 (Figure 1). Between 2005 and 2010, CQ studies were sparse, with only 1 to 4 articles published annually, reflecting the infancy of the field. However, a significant rise began in 2011, driven by the increasing recognition of CQ's relevance to globalization and cross-cultural management. This culminated in a peak of 36 publications in 2021, coinciding with heightened interest in CQ's applications in multicultural leadership and international business. A decline in publications in 2023 (23 articles) suggests a stabilization in certain research areas or potential saturation. However, the 19 articles recorded in 2024 (not yet a full year) indicate that CQ remains a vibrant area of study, with emerging interests in digital and virtual team applications. This suggests that CQ research continues to evolve alongside shifts in the global economy and workplace dynamics.

From Figure 2, several key authors have significantly shaped CQ research over time. Pongsakorn Charoensukmongkol has been a prolific contributor, focusing on the application of CQ to leadership and team performance in multicultural contexts, particularly in expatriate management and organizational behavior (Charoensukmongkol & Phungsoonthorn, 2022; Guang & Charoensukmongkol, 2020). Ying Zhang's research has highlighted the role of CQ in knowledge management within multinational corporations and its impact on organizational outcomes, including post-COVID dynamics and organizational commitment (Zhang et al., 2022, 2023, 2024). Alfred Presbitero has provided important insights into CQ's relevance in virtual teams and remote work environments, reflecting its growing importance in digitally mediated settings (Presbitero, 2017, 2022). Additionally, Soon Ang, a pioneering figure in CQ research, remains highly influential through her foundational models, which continue to guide empirical studies.

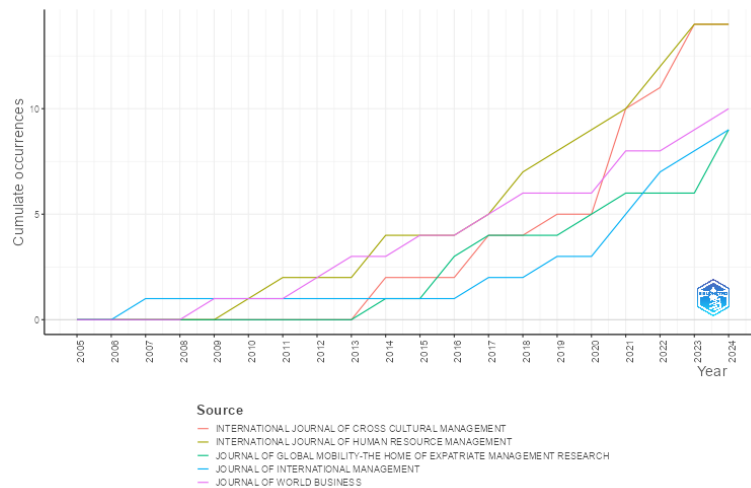


Figure 3. Sources’ Production Over Time

Source: Compiled by the author

Figure 3 provide insights into the leading academic outlets that have consistently published research on CQ. The *International Journal of Human Resource Management* has been particularly prolific, focusing on CQ’s applications in expatriate management, global HR practices, and workforce adaptability. The *Journal of World Business* has contributed significantly by examining how CQ enhances business performance in diverse cultural contexts, often linking CQ to global leadership strategies. The *Journal of Global Mobility* and *International Journal of Cross-Cultural Management* emphasize the practical implications of CQ in expatriate success and cross-cultural adjustment. These journals reflect the increasing demand for CQ in navigating international assignments and building culturally competent organizations. Their steady growth in publications, particularly since 2014, underscores CQ’s expanding relevance in management and leadership studies.

Figure 4 represents a VOSviewer network map that visualizes key themes, concepts, and relationships surrounding CQ research. This map is generated based on the co-occurrence of terms across the literature, highlighting the most frequently discussed antecedents, decisions, and outcomes associated with CQ. At the center of the map, CQ is positioned as the pivotal node, linking various key themes such as “organizational success”, “job performance”, “leadership effectiveness”, and “adjustment”.

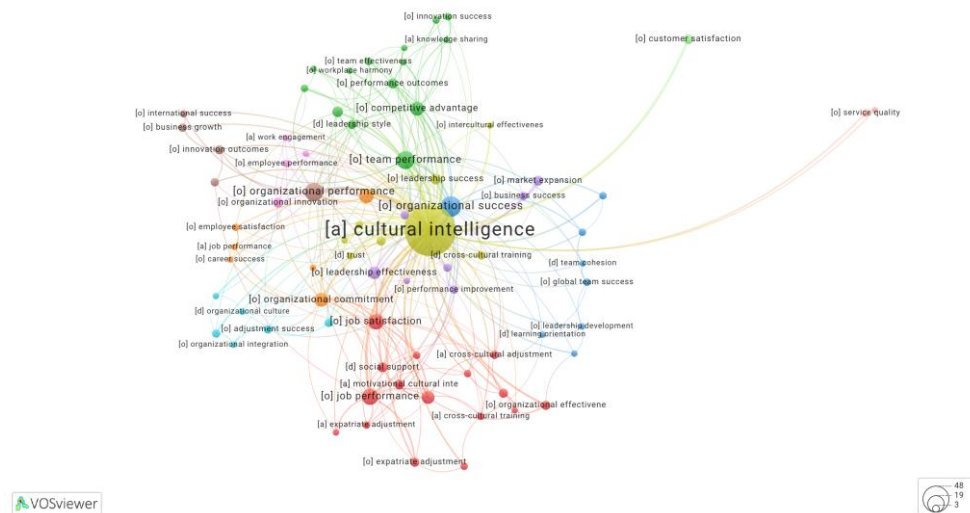


Figure 4. Comprehensive Network Visualization of CQ

Source: Compiled by the author

Building on this comprehensive analysis, these themes are further categorized into eight distinct areas, highlighting the multifaceted nature of CQ and its diverse implications across personal, organizational, and international contexts as shown in Figure 5.

Theme 1: Social Support and Expatriate Adjustment (Figure 5a). Expatriate adjustment is critical to the success of international assignments, with cross-cultural training and CQ enabling individuals to navigate new environments effectively (Ang et al., 2007; Koo Moon et al., 2012). High CQ facilitates interpreting social cues and adapting behaviors, improving adjustment and performance outcomes (Kour & Jyoti, 2022). Social support, including mentorship and informal networks, reduces psychological stress and enhances adaptation, leading to higher job satisfaction and performance (L. Lee et al., 2013; Shaffer et al., 2006). Expatriates with high CQ further benefit from these networks, increasing retention and reducing turnover costs (Akhal & Liu, 2019).

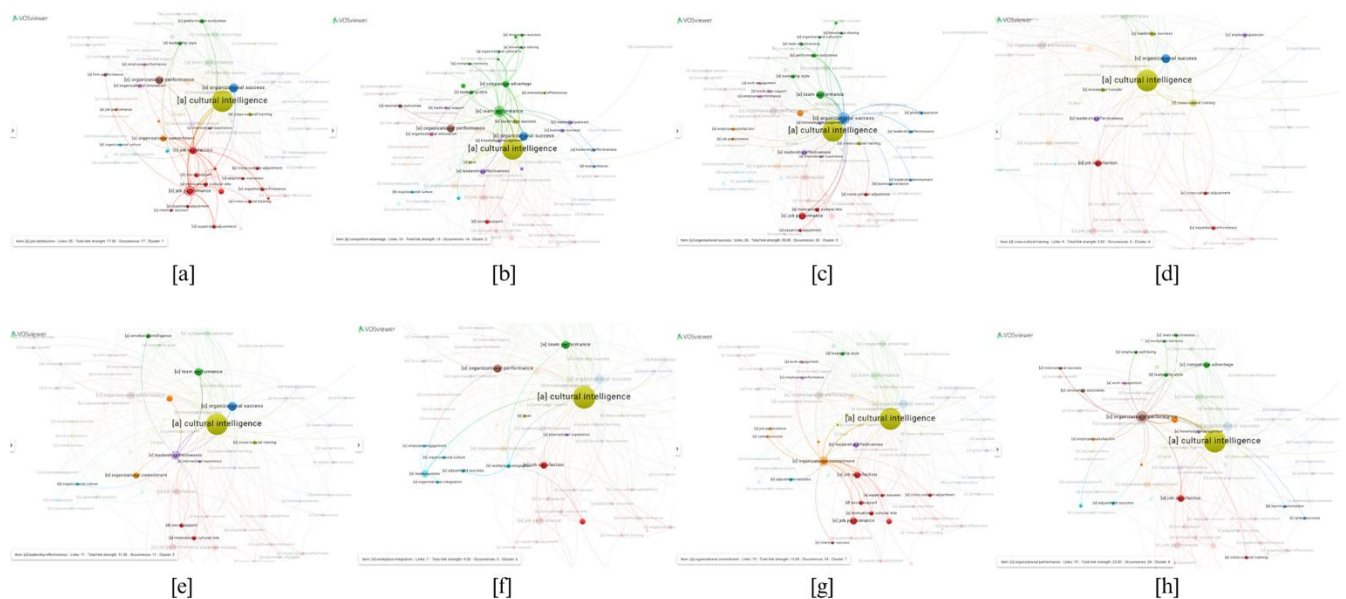


Figure 5. Detailed Visualization of CQ Themes

Source: Compiled by the author

Theme 2: Leadership Style and Organizational Performance (Figure 5b). Organizational CQ, the capability to function effectively in diverse settings, enhances adaptability and innovation (Ang & Inkpen, 2008). Knowledge sharing is pivotal in building organizational CQ, fostering collaboration and workplace harmony. Transformational leadership enhances these dynamics by promoting inclusivity and intellectual stimulation (Mittal & Dhar, 2015). Leaders with high CQ manage multicultural teams effectively, driving innovation and reducing cultural conflicts (Rockstuhl et al., 2011). Together, leadership and organizational CQ enable creative problem-solving and adaptability, securing a competitive edge in global markets (Liu et al., 2011).

Theme 3: Leadership Effectiveness and Learning Orientation (Figure 5c). Leadership effectiveness, supported by work engagement and learning orientation, is a key driver of organizational success. Effective leaders foster engagement characterized by vigor and dedication, boosting employee performance (Bakker & Schaufeli, 2008). Leaders with high CQ excel in diverse environments, promoting inclusivity and innovation (K.-Y. Ng et al., 2009). A learning-oriented culture further empowers employees to adapt and develop new skills, enhancing leadership effectiveness and organizational performance (Jyoti & Kour, 2017; Walumbwa et al., 2008).

Theme 4: Cross-Cultural Training and Leadership Success (Figure 5d). Cross-cultural training facilitates leaders' ability to adapt to diverse environments, enhancing CQ and communication across cultural boundaries (Earley & Ang, 2003). Leaders with high CQ navigate global complexities effectively, building strong stakeholder relationships and driving organizational competitiveness (Ang & Inkpen, 2008; Rockstuhl et al., 2011). Training also prepares leaders to capitalize on global opportunities, ensuring success in international ventures through improved adaptability and cultural sensitivity (Caligiuri & Tarique, 2012).

Theme 5: International Experience and Motivational CQ (Figure 5e). International experience and motivational CQ enhance leadership effectiveness by enabling leaders to navigate global environments and inspire multicultural teams (Ang et al., 2007; Takeuchi et al., 2005). Social support and cross-cultural training amplify these benefits by fostering adaptability and cultural sensitivity (Chen et al., 2010; K.-Y. Ng et al., 2009). Leaders with diverse experiences and high CQ bring unique perspectives, improving team performance and organizational commitment (Lisak & Erez, 2015).

Theme 6: Organizational Culture and Trust ((Figure 5f). A positive organizational culture valuing diversity and inclusivity enhances employee engagement and teamwork, with trust playing a central role in fostering collaboration (De Jong & Elfring, 2010; Schein, 2010). CQ is critical in building trust and navigating cultural complexities, strengthening workplace integration and team success (Ang et al., 2007; Rockstuhl et al., 2011). This environment drives alignment with organizational goals and improves overall performance (Costa et al., 2018).

Theme 7: Job Performance and Work Engagement (Figure 5g). Work engagement, characterized by vigor and dedication, leads to improved job performance, which in turn drives career success and organizational commitment (T. W. Ng et al., 2005; Schaufeli et al., 2006). High CQ enhances job performance and adjustment success by enabling employees to navigate diverse cultural contexts effectively (Ang et al., 2007). Organizations fostering engagement and CQ development benefit from reduced turnover and a more adaptable, productive workforce (Joo & Park, 2010).

Theme 8: Work Engagement, Knowledge Management, and Innovation (Figure 5h). Engaged employees actively participate in knowledge-sharing activities, fostering innovation and organizational performance (Cabrera & Cabrera, 2005; Schaufeli et al., 2006). Knowledge management enables the integration of diverse perspectives, driving adaptability and competitiveness in global markets (Andreeva & Kianto, 2011; Darroch, 2005). CQ plays a

crucial role by enhancing cross-cultural communication and collaboration, ensuring effective teamwork and innovation (Ang & Inkpen, 2008). The synergy between engagement, knowledge management, and CQ supports innovation and sustains organizational success (Škerlavaj et al., 2010).

Discussion

Figure 6 shows a thematic map that categorizes the key concepts of CQ research across four quadrants based on their density (development degree) and centrality (relevance degree).

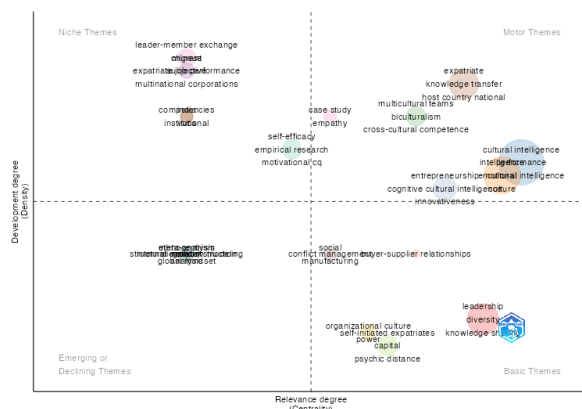


Figure 6. Thematic Map

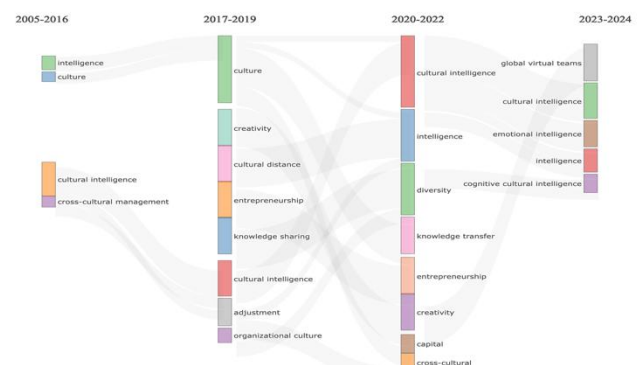


Figure 7. Thematic Evolution

Source: Compiled by the author

In terms of **Antecedents**, themes like "cognitive cultural intelligence," "motivation," and "self-efficacy" from the Basic and Motor quadrants reflect personal traits and competencies that are key drivers of CQ. These antecedents are shaped by individual attributes such as confidence, motivation, and prior cross-cultural experience, laying the foundation for CQ development. For example, themes like "self-efficacy" and "motivation" demonstrate the critical role that internal traits play in forming the base of CQ, aligning with well-documented research on the psychological precursors of intercultural adaptability (Earley & Ang, 2003).

With regard to **Decisions**, Motor and Basic themes such as "multicultural teams," "knowledge transfer," and "cross-cultural competence" illustrate the key mechanisms through which CQ influences choices and strategies in multicultural contexts. These decision-making processes often involve determining how to effectively engage in cross-cultural training, participate in multicultural teams, and leverage international exposure. Themes like "knowledge transfer" and "leadership development" reflect how decisions are made within organizational settings, reinforcing how CQ guides individuals in making informed choices and implementing strategies that enhance performance in global environments (Ang & Inkpen, 2008).

Outcomes of CQ are evident in the Niche and Motor quadrants, with themes like "job performance," "leadership effectiveness," and "organizational success" demonstrating CQ's broad impact on various outcomes. For example, "expatriate job performance" and "leader-member exchange" in the Niche quadrant, alongside "organizational success" and "job performance" in the Motor quadrant, underscore how CQ enhances individual and organizational outcomes, such as improving adaptability in global leadership and boosting team performance (Ang & Van Dyne, 2008). These outcomes emphasize how CQ fosters more effective intercultural interaction, benefiting both personal careers and organizational growth.

The evolution of CQ research reveals a shifting focus over time (Figure 7). Between 2005 and 2016, studies primarily addressed foundational concepts like "intelligence" and "culture," laying the groundwork for understanding CQ's role in cross-cultural management. From 2017 to 2019, research expanded to include themes like "creativity," "cultural distance," and "entrepreneurship," exploring how CQ influences innovative processes and global business. Key themes such as "knowledge sharing" and "adjustment" emerged, linking CQ to individual and organizational adaptability. In 2020-2022, research shifted towards practical applications of CQ in organizational settings, emphasizing themes like "cultural intelligence," "diversity," and "knowledge transfer." These studies highlighted CQ's role in driving performance, innovation, and adaptability in globalized environments, while maintaining a focus on "entrepreneurship" and "creativity". In the latest period, 2023-2024, the focus has expanded to themes like "global virtual teams" and "cognitive cultural intelligence," reflecting CQ's relevance in remote work and virtual collaboration. Themes such as "emotional intelligence" underscore the growing importance of managing cultural differences in virtual environments through emotional and cognitive capabilities.

Despite this progress, a gap remains in linking CQ development interventions, like cross-cultural training or global assignments, to measurable outcomes such as job performance and leadership effectiveness. While these interventions are recognized as critical, there is limited empirical evidence on their long-term impact, highlighting a need for future research to address these gaps (Lee et al., 2018; MacNab, 2012).

Conclusion

This study provides valuable insights into the development, impact, and strategic importance of CQ by integrating bibliometric analysis and a systematic review under the ADO framework. The bibliometric analysis highlights CQ's evolution from a niche concept to a central focus in cross-cultural management and global leadership, particularly over the past decade, with increasing emphasis on leadership, cross-cultural competence, and organizational effectiveness. The systematic review underscores the critical role of key antecedents, such as self-efficacy (Ang et al., 2006) and international experiences (Crowne, 2008), in driving CQ development, linking them to mechanisms like cross-cultural training and global assignments that lead to tangible outcomes, including innovation, high-performing multicultural teams, and global leadership effectiveness (Rockstuhl et al., 2011).

The findings emphasize CQ's pivotal role in addressing complex global challenges, highlighting its significance for organizational adaptability, collaboration, and innovation in diverse environments. Practically, this research underscores the need for organizations to embed CQ development into leadership and workforce strategies and for educators to integrate experiential learning into curricula to prepare students for globalized workplaces. Policymakers are also urged to champion cross-cultural education and exchange programs as tools to foster societal cohesion and reduce intercultural conflict.

By identifying gaps in the empirical validation of CQ's long-term development and its influence on innovation and organizational agility, the study sets a robust foundation for future research. It particularly calls for further exploration of CQ's role in virtual teams as cross-cultural interactions increasingly shift online. Despite certain limitations, this research contributes significantly to advancing both theory and practice, offering actionable insights to meet the demands of an interconnected world.

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The Effect of Liquidity and Asset Turnover on Profitability: The Moderating Role of Capital Structure

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Abstract

The Covid-19 pandemic has increased the use of telecommunications services. This condition has a significant impact on the financial performance of telecommunications companies in Indonesia. Therefore, this study analyzes the effect of liquidity and asset turnover on the profits of telecommunications companies in Indonesia for the period 2019 to 2023. This study also analyzes the role of capital structure as a moderating variable. Multiple regression using Ordinary Least Square (OLS) was applied to test the effect of liquidity and asset turnover on profitability and the role of capital structure as a moderating variable. The results of the analysis show that liquidity has a significant negative effect on profitability with a t-statistic value of -2.82 and is significant at 1%. On the other hand, asset turnover has positive and effect with a t-statistic value of 7.08 and is significant at 1%. Meanwhile, capital structure unsuccessful to moderate the effect of liquidity and asset turnover on profitability.

Keywords: debt, financial performance, capitalization

Introduction

Information technology is developing rapidly with the number of internet users in households reaching 87.09% in 2023. In addition, the number of people accessing the internet in the last three years has also increased from 53.73% in 2020 to 69.21% in 2023 (Badan Pusat Statistik, 2023). In 2023, there were 1,797 companies that had obtained permits to provide telecommunications services in Indonesia compared to 2022 which was only 1,615 companies (Badan Pusat Statistik, 2023). Therefore, telecommunications companies in Indonesia are expected to produce good financial performance.

Table 1. Financial Performance of Telecommunication Companies in Indonesia

Variable	2020	2021	2022
1. Liquidity (current ratio)	25.2%	62.3%	15.9%
2. Asset turnover (total asset turnover ratio)	25%	25.6%	24.6%
3. Profitability (return on assets)	2.1%	1.3%	1.2%
4.. Capital Structure (debt to equity ratio)	1.7%	10.3%	9.9%

Source: IDX and Author Calculation

Table 1 present the average of current ratio (CR), total asset turnover ratio (TATO), return on assets (ROA), and debt to equity ratio (DER) telecommunication companies in Indonesia. According to this table, average profitability tends to decrease from 2,1% in 2020 to 1.2% in 2022. This decreasing may be caused by fluctuation of liquidity and asset turnover. According to Table 1, CR as liquidity estimator decrease from 62.3% in 2021 to 15.9% in 2022. Moreover, asset turnover also decreases slightly from 25.6% in 2021 to 24.6% in 2022. Furthermore, the effect of liquidity and asset turnover on profitability may also affected by capital structure. Table 1 shows that DER as capital structure estimator decline slightly from 10.3% in 2021 to 9.9% in 2022.

Fluctuation in profitability may affected by liquidity. Companies that want high profitability must be willing to face low liquidity or increased risk of failure to pay short-term obligations (Septiano et al., 2022). Moreover, the higher the level of liquidity, the higher the company's ability to pay short-term debts and the higher the company's current assets (Setiawan & Suwaidi, 2022).

Asset turnover also become factor that mat affect profitability. The high asset turnover value that comes from the addition of assets sourced from debt has an impact on the company's obligation to pay interest, as a result this interest burden will reduce the company's profits (Novita et al., 2022). Fast asset turnover will affect the sales volume generated and the increase in profits that will be obtained (Dewi & Estiningrum, 2021).

Besides liquidity and asset turnover, capital structure may also affect profitability. Company profits are greatly influenced by DER which reflects funding policies. External funding will be used by the company to improve performance and expand which can have an impact on the level of profit as measured by ROA (Ardhefani et al., 2021). Companies that have increasing amounts of debt have the potential to experience a decrease in profit levels (Bintara, 2020).

Many previous studies discussed about the effect of liquidity on profitability (Dewi & Srihandoko, (2018); Septiano et al., (2022); Sipayung et al., (2023); Setiawan & Suwaidi, (2022); Ummah & Efendi, (2022); Wage et al., (2022))). Moreover, Previous researchers also examined the influence of asset turnover on profitability (Cahya et al., (2021); Fia Afriyani & Nurhayati, (2023); Dewi & Estiningrum, (2021); Novita et al., (2022) ; Suryaman et al., (2023); and Titisnamia & Puspita, (2023). However, these researches generate different results. Thus, this research will examine the effect of liquidity and asset turnover on profitability of telecommunication companies in Indonesia.

Many previous researchers had been examined about the effect of capital structure on profitability (Abdullah & Tursoy, (2021); Ardhefani et al., (2021); Bintara, (2020); Novita et al., (2022)). However, few studies discussed about capital structure as moderating variable of the effect of liquidity and asset turnover on profitability. Hence, this research not only analyze the effect of liquidity and asset turnover on profitability, but also examined the role of capital structure as moderating variable.

The first part of this paper discusses about introduction. The second part of this research will discuss about review of related literatures. The third part of this research presents about research methodology. Furthermore, the next part will present the result and discussion. In addition, the last part of this research will discuss about conclusion.

1. Research Objectives

- 1.1 To analyze the effect of liquidity and asset turnover on profitability of telecommunication companies in Indonesia.

- 1.2 To analyze the role of capital structure as moderating variable of the effect of liquidity and asset turnover on profitability of telecommunication companies in Indonesia.

2. Review of Related Literatures

Signaling Theory

This research applies signaling theory to explain the effect of liquidity and asset turnover on profitability and the role of capital structure as moderating variable. According to Spence, (1973) The owner of the information conveys signals in the form of information about the condition of the company that is useful for investors. Signaling theory is an information signal that needs to be considered and decided by investors to invest in a company, and shows how companies give signals to users of financial and non-financial reports (Setiawan & Suwaidi, 2022)

The Effect of Liquidity on Profitability

The effect of liquidity on profitability has been discussed by many researchers. Setiawan & Suwaidi, (2022) discussed about the impact of liquidity on profitability of transportation companies listed IDX from 2017-2020. Setiawan & Suwaidi, (2022) showed that liquidity has positive and significant impact on profitability. Sipayung et al., (2023) analyzed about the effect of liquidity on profitability of Indonesian cement companies from 2018 to 2022. Sipayung et al., (2023) found that liquidity has positive and significant effect on profitability. Ummah & Efendi, (2022) examined about the influence of liquidity on profitability of automotive companies in Indonesia from 2017 to 2020. Ummah & Efendi (2022) found that liquidity and profitability move in same direction. Wage et al., (2022) discussed about the impact of liquidity on profitability of companies listed in IDX from 2016 to 2020. Wage et al., (2022) found that liquidity has positive and significant impact on profitability. Based on some previous studies, increase in liquidity will increase profitability. Furthermore, in accordance with signal theory, an increase in liquidity may increase profitability, and this gives a positive signal for investors. Hence, the first hypothesis in this research is liquidity has positive and significant effect on profitability.

H1: Liquidity has positive and significant effect on profitability

The Effect of Asset Turnover on Profitability

Apriliana et al., (2023) examined the impact of asset turnover on profitability of consumer non-cyclical companies in Indonesia from 2019 to 2021. Apriliana et al., (2023) showed that asset turnover has positive and significant impact on profitability. Dewi & Estiningrum, (2021) discussed about the effect of asset turnover on profitability of food of beverages companies from 2017 to 2019. Dewi & Estiningrum, (2021) found also that asset turnover and profitability move in same direction. Matondang et al., (2022) analyzed the impact of asset turnover on profitability. Matondang et al., (2022) found that asset turnover has positive and significant impact on profitability. Moreover, referring to signal theory, increasing asset turnover indicates an increasing productivity in asset utilization. This condition can improve the company's financial performance and provide a positive signal for investors. Therefore, the second hypothesis of this research is asset turnover has positive and significant effect on profitability.

H2: Asset turnover has positive and significant effect on profitability

The Role of Capital Structure as Moderating Variable

Previous studies show that capital structure can affect profitability. Abdullah & Tursoy, (2021) examined the influence of capital structure and firm performance. Abdullah & Tursoy,

(2021) showed that capital structure and firm performance generate positive influence. Ardhefani et al., (2021) discussed about the effect of debt to equity ratio (DER) as one of capital structure indicator on profitability of cosmetics and household companies in Indonesia. Ardhefani et al., (2021) showed that DER has positive and significant effect on ROA as profitability ratio. Bintara, (2020) analyzed about the impact of DER as capital structure indicator on ROA as profitability ratio of property, real estate, and building construction companies in Indonesia. Bintara, (2020) found that DER and ROA has opposite impact.

Previous studies prove also that capital structure can affect liquidity. Dewi & Fachrurrozie, (2021) examined about the effect of liquidity on capital structure of property and real estate companies in Indonesia. Dewi & Fachrurrozie, (2021) found that liquidity has negative and significant effect on profitability. Martini et al., (2021) also discussed about the influence of liquidity on capital structure of food and beverages companies in Indonesia from 2015 to 2019. Martini et al., (2021) showed that liquidity and capital structure has negative influence. Zatira et al., (2020) discussed about the impact of liquidity on capital structure of automotive companies from 2014 to 2018. Zatira et al., (2020) showed that liquidity and capital structure have inverse impact.

Verry et al., (2020) examined about the influence of asset turnover on capital structure of basic industry and chemical companies in Indonesia from 2014 to 2018. Verry et al., (2020) showed that asset turnover has positive and significant influence on capital structure. Hakim & Santoso, (2022) discussed about the effect of asset turnover on capital structure of LQ 45 companies. Hakim & Santoso, (2022) shows that asset turnover has negative and significant effect on capital structure. Based on those previous studies, capital structure may moderate the impact of liquidity and asset turnover on profitability.

H3: Capital structure enhance the effect of liquidity on profitability

H4: Capital structure enhance the effect of asset turnover on profitability

Research Methodology

1. The Research Procedure Includes 5 Steps which are:

- 1.1 To test the effect of liquidity on profitability of telecommunication companies in Indonesia.
- 1.2 To test the effect of asset turnover on profitability of telecommunication companies in Indonesia.
- 1.3 To test the role of capital structure as moderating variable of the effect of liquidity and the asset turnover on profitability of telecommunication companies in Indonesia.
- 1.4. To analyze the effect of liquidity and asset turnover on profitability of telecommunications companies in Indonesia
- 1.5. To analyze the role of capital structure as moderating variable of the effect of liquidity and the asset turnover on profitability of telecommunication companies in Indonesia.

2. Research Instrument

This research applies secondary data of liquidity, asset turnover, profitability, and capital structure of telecommunication companies listed in Indonesian stock exchange from 2019 to 2023. The data is derived from financial report and balance sheet.

3. Populations and Samples

The population of this research is telecommunication companies in Indonesia. Moreover, the sample of this research is telecommunication companies listed in Indonesian stock exchange from 2019 to 2023

4. Statistics for Data Analysis

This research employs multiple regression analysis using Ordinary Least Square (OLS). Moreover, this research applies two regression equation: 1) $Profitability = \beta_0 + \beta_1 Liquidity_{it} + \beta_2 asset\ turnover_{it} + \varepsilon_{it}$; and 2) $Profitability = \beta_0 + \beta_1 Liquidity_{it} + \beta_2 NPM_{it} + \beta_3 NPL_{it} + \beta_4 Sukubunga_{it} + \beta_5 Sukubunga.CAR_{it} + \beta_6 Sukubunga.NPM_{it} + \beta_7 Sukubunga.NPL_{it} + \varepsilon_{it}$. The first regression equation explains the effect of liquidity and asset turnover on profitability. Furthermore, the second regression analysis explain the role of capital structure as moderating variable. This research also applies some test such as normality test, multicollinearity test, and heteroscedasticity using Breusch-Pagan test. Normality test is calculated by Shapiro-Wilk. The probability value of Shapiro-Wilk < 0.05 indicates the normal data. Multicollinearity test is calculated by variance inflation factor (VIF). The value of VIF lower than 0.05 indicates that regression model free from multicollinearity problem. Indeed, heteroscedasticity test also employed in this research. The value of Breusch-Pagan test higher than 0.05 indicates that regression model free from heteroscedasticity problem. This research use two independent variables consist of liquidity and profitability. Liquidity is measured by current ratio (CR) following Sipayung et al., (2023) and Wage et al., (2022). Asset turnover is calculated by total asset turnover ratio following Cahya et al., (2021) and Matondang et al., (2022). This research use return on assets as profitability measurement following Apriliana et al., (2023) and Titisnamia & Puspita, (2023). In addition, capital structure as moderating variable is calculated by debt to equity ratio following Martini et al., (2021).

Results

1. The Effect of Liquidity and Asset Turnover on Profitability

Table 2. Descriptive Statistics

Variable	Mean	Max	Min
1. Liquidity (current ratio)	1.9	14.53	0.193
2. Asset turnover (total asset turnover ratio)	0.25	0.102	0.63
3. Profitability (return on assets)	0.046	0.13	-0.107
4.. Capital Structure (debt to equity ratio)	0.53	6.91	0.073

Table 2 present the descriptive statistics result. According to this table, the mean value of liquidity which is estimated by current ratio is 1.9. The maximum value of liquidity is 14.53, while the minimum value is 0.193. The mean value of asset turnover is 0.25. The maximum value of asset turnover is 0.102. Meanwhile, the minimum value of asset turnover is 0.63. Moreover, the mean value of return on assets as profitability estimator is 0.046. The maximum value of profitability is 0.13, while the minimum value is -0.107. In addition, capital structure as moderator variable has mean value about 0.53. The minimum value of capital structure is 0.073, while the maximum value is 6.91.

The result of normality test using Shapiro-Wilk shows that all the variable has probability higher than 0.05. The probability value of Shapiro-Wilk for liquidity is 0.51. Moreover, the probability value of asset turnover is 0.76. Furthermore, the probability value of ROA as profitability indicator is 0.93. Indeed, the probability value of Shapiro-Wilk for DER as capital structure estimator is 0.32. Therefore, all these results show that all variables have normal distribution. In addition, the result of Breusch-Pagan test is about 0.08 or higher than 0.05. This result indicates that the regression model is free from heteroscedasticity problem.

Table 3. Variance Inflation Factor

Variable	VIF	1/VIF
1. Liquidity (current ratio)	1.01	0.987
2. Asset turnover (total asset turnover ratio)	1.00	0.998

Table 3 shows the variance inflation factor or the first regression equation, The VIF of liquidity is 1.01, Moreover, the VIF value of asset turnover is 1.00. Hence, these results show that the VIF value is lower than 10, or these results indicates that the regression model is free from multicollinearity problem.

Table 4. The Regression Result of The Effect of Liquidity and Asset Turnover on Profitability

Variable	Coefficient	t-statistics
C	-0.0035	-0.34
1. Liquidity (current ratio)	-0.004	-2.82***
2. Asset turnover (total asset turnover ratio)	0.229	7.08***
Adjusted R-Squared	0.578	

Table 4 shows the regression result of the effect of liquidity and asset turnover on profitability. According to Table 4, the coefficient value of liquidity is -0.04, while the t-statistics value is -2.82 and this value is significant at 1%. This result shows that liquidity has negative and significant effect on profitability. The higher the liquidity is, the lower the profitability. Moreover, the coefficient value of asset turnover is 0.229 and the t-statistics value is 7.08. This result indicates that asset turnover has positive and significant effect on profitability. The higher the asset turnover is, the higher the probability.

2. The Role of Capital Structure as Moderator Variable

Table 5. Variance Inflation Factor

Variable	VIF	1/VIF
1. Liquidity (current ratio)	1.04	0.96
2. Asset turnover (total asset turnover ratio)	1.09	0.91

3. Capital Structure (debt to equity ratio)	1.02	0.97
4. Liquidity*Capital Structure	1.08	0.92
5. Asset turnover*Capital Structure	1.17	0.86

The second regression of this result examined about the role of capital structure as moderating variable. According to Table 5, the VIF value for all variables are lower than 10. The VIF value of liquidity is 1.04. The VIF value of asset turnover is 1.09. Moreover, capital structure as moderating variable has VIF value about 1.02. Interaction between liquidity and capital structure generate VIF value about 1.08. Furthermore, interaction between asset turnover and capital structure generate VIF about 1.17. Indeed, the value of Breusch-Pagan test result is about 0.527 or higher than 0.05. This result indicates that there is no heteroscedasticity problem in the second regression model.

Table 6. The Regression Result of The Role of Capital Structure as Moderating Variable

Variable	Coefficient	t-statistics
C	-0.11	-0.92
1. Liquidity (current ratio)	-0.004	-2.98***
2. Asset turnover (total asset turnover ratio)	0.231	8.08***
3. Capital Structure	0.003	3.95***
4. Liquidity*Capital Structure	0.0006	0.11
5. Asset turnover*Capital Structure	-0.002	-0.49
Adjusted R-Squared	0.702	

Table 6 shows the regression result the role of capital structure as moderating variable. Referring to Table 6, liquidity has negative and significant value on profitability with coefficient value about -0.004 and this value is significant at 1%. Asset turnover has coefficient value about -0.231 and t-statistics value about 8.08. This result indicates that asset turnover has positive and significant effect on profitability. Moreover, capital structure as moderating variable has positive and significant effect on profitability with coefficient value about 0.003 and t-statistics value 3.95. Interaction between liquidity and asset turnover generate coefficient value about 0.0006 and t-statistics value about 0.11. Unfortunately, this value is not significant. Thus, this result shows that capital structure fails to moderate the relationship between liquidity and profitability. Furthermore, interaction between asset turnover and capital structure generates coefficient value -0.002, and t-statistics value about -0.49. In fact, this value is also not significant. In other words, capital structure also unsuccessful to moderate the relationship between asset turn over and profitability.

Discussion

The regression result in Table 4 shows that liquidity has negative and significant result on profitability. This result is contrary to the Setiawan & Suwaidi, (2022); Sipayung et al., (2023) and Wage et al., (2022). Moreover, this result also contrary to the signaling theory. If a company wants high profitability, it must be willing to face low liquidity or increased risk of

failure to pay short-term obligations (Septiano et al., 2022). The higher the company invests its funds in productive investments, the more liquidity will decrease, but the level of profit from the investment can increase.

Table 4 also presents that total asset turnover has positive and significant effect on liquidity. This result is in line with signaling theory. The higher the turnover asset illustrates the more efficient the company is in managing its assets which has an impact on the higher profit. This condition is a positive signal for investors to invest their funds in the company. Furthermore this result is in line with Apriliana et al., (2023), Dewi & Estiningrum, (2021), and Matondang et al., (2022). High total asset turnover illustrates the company's ability to be quite efficient in managing asset turnover. This condition can increase the company's profit (Dewi & Estiningrum, 2021).

Table 6 shows that capital structure fails to enhance the effect of liquidity on profitability. This can be caused by the excessive use of debt in its capital structure which results in high interest costs which can ultimately reduce profits. This can result in existing liquidity not being effective enough to increase profitability because most of the profits are used to pay debts.

Table 6 shows also that capital structure unsuccessful to enhance the effect of total asset turnover on profitability. The existence of an ineffective capital structure indicates that the company's assets are not being used optimally and can ultimately reduce the positive impact of total asset turnover on profitability.

Conclusion

The purpose of this study is to analyze the effect of liquidity and total asset turnover on profitability. Moreover, this research also examined the role of capital structure as moderating variable. The sample of this research is telecommunication companies listed in Indonesia stock exchange from 2019 to 2023. Moreover, this research use OLS and some test such as normality test, multicollinearity, and heteroscedasticity test for analysis the data. Furthermore, the result of analysis found that liquidity and profitability move in different direction. Meanwhile, asset turnover and profitability move in same direction. Furthermore, capital structure fails to enhance the effect of liquidity and asset turnover on profitability.

This research can be a reference for telecommunication companies in Indonesia for managing their liquidity, asset turnover, and capital structure. This research also can be a guidance for investors in determining their investments in telecommunications companies. Furthermore, this research also can be a reference for authorities in determining policies related to loan interest rates that can affect the company's capital structure. This research only employs internal factor (capital structure) as moderating variable. Thus, future research can use external factors such as inflation, interest rate, or foreign exchange as moderating variable.

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Sessions 5: Education, Pedagogy, and Learning Management Innovation

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The Conditions and Challenges of Primary School Teachers’ Professional Development in Integrating Learning Management Based on the Principles of the Sufficiency Economy Philosophy

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Abstract

This study aimed to 1) examine the conditions of professional development in integrating the Sufficiency Economy Philosophy (SEP) principles into the teaching and learning processes of primary school teachers, and 2) identify the challenges faced by primary school teachers in this integration. The target group consisted of administrators, teachers, and the school education committee members from Ban Dong Bak School, Renu Nakhon District, Nakhon Phanom Province, with 13 participants. This qualitative study utilized data collection tools such as interview forms and observation forms. The data were analyzed using content analysis. The findings revealed two aspects: 1) In terms of professional development conditions, both participating administrator and teachers expressed a willingness to cooperate in the study, recognizing the benefits of integrating the SEP principles and seeing it as an opportunity to enhance teachers' potential in learning management. The administrator and teachers were particularly interested in improving their abilities to apply the SEP principles in learning management in teaching mathematics and social studies subjects, in preparation for the assessment of sufficiency schools, and 2) Regarding challenges, the school has implemented the SEP principles through school project teaching. However, these principles have not yet been integrated into individual subjects. Teachers reported a lack of knowledge in creating learning management plans that incorporated the SEP principles and a lack of skills necessary for effectively managing integrated learning based on these principles.

Keywords: conditions and challenges, primary school teachers, integrating learning management, Sufficiency Economy Philosophy Principles.

Introduction

The 13th National Economic and Social Development Plan (2023-2027) (NESDP) acknowledges the status of the country and various changes in context, leading to the adoption and application of the principles of Sufficiency Economy Philosophy (SEP), which places people at the center of development (ONESDC, 2022). This aligns with the 20-Year National Strategy (2018-2037), which provides direction and goals for the nation’s development based on the SEP principles. These principles are grounded in moderation, reasonableness, and the creation of resilience while using two main conditions—knowledge and virtue—to guide the direction, with the well-being of society as the primary focus (National Strategy Committee, 2018). In addition, the National Education Plan (2017-2037) Strategy 5 focuses on education management to enhance the quality of life. It aims for individuals of all ages to develop an awareness of environmental conservation, possess moral integrity, and apply the SEP principles in practice. According to Section 23 of the Education Act, education management should prioritize learners, focusing on knowledge, morality, and learning processes. This approach promotes integrated learning based on appropriateness, fostering holistic knowledge that enables learners to connect what they have learned with new knowledge. Moreover, it reduces the teacher's burden in managing teaching and learning processes that meet learners’ needs. The integration should have key characteristics, including content integration, methodology, knowledge with learning processes, thoughts with morality, knowledge with practice, and integrating school knowledge with the real-life context of learners (Sumano, 2017).

The implementation of the SEP principles in Thai education commences with the strategic promotion and support of personnel across all levels of the educational system. The primary objective of implementing teaching and learning based on this philosophy is to cultivate students' awareness of sufficiency, fostering balanced development across economic, social, environmental, and cultural dimensions. Achieving this requires integrating the SEP principles’ concepts into various learning subjects. To achieve this goal, teachers must adopt instructional approaches that enable students and youth to recognize the interconnectedness of these dimensions, including the environment, culture, society, and economy (Khwanpetch et al.; Khun-inkeeree et al., 2023).

Consequently, it is imperative to prioritize teachers’ professional development in integrating the SEP principles into learning processes. Such development equips teachers with the knowledge and comprehension to implement teaching and learning strategies grounded in philosophy. Consequently, educational management will become more effective and aligned with real-world contexts, enabling learners to address challenges at individual, community, societal, and national levels in a balanced and sustainable manner.

As mentioned above, it is crucial to develop teachers to enhance their knowledge and understanding. This study examines the conditions and problems of integrated teaching and learning based on the SEP principles at a primary school under the jurisdiction of the Nakhon Phanom Primary Education Service Area. The outcomes of this study will contribute to improving the effectiveness of education by equipping students with the skills to improve their quality of life and address challenges faced by themselves, as well as those of their communities, society, and the country, fostering balance and sustainability.

1. Research Objectives

1.1 To examine the conditions of primary school teachers’ professional development in integrating the SEP principles into teaching and learning processes.

1.2 To examine the challenges of primary school teachers in integrating the SEP principles into teaching and learning processes.

2. Review of Literature

2.1 Reasons for Teacher Professional Development

Many researchers have defined professional development. In terms of education, the definitions of professional development focus on teacher development, which is the process of enhancing the teaching profession to meet high standards that are recognized by society. At the same time, it must keep pace with changes in knowledge, technology, values, and social culture. Teachers must be knowledgeable and skilled in their fields of expertise, continuously develop themselves, engage in further study and research, and innovate teaching methods, media, and tools to assist in teaching. This ensures that students are fully developed and that their individual needs are addressed. Therefore, it is essential to create and develop appropriate methods and approaches that align with the changing paradigms (Erawan, 2007)

Teacher professional development (TPD) has recently received a lot of attention in research and practice for several reasons. First of all, it is a critical and ongoing process that organizations must pursue, aiming to enhance knowledge, skills, and modern competencies to keep pace with advancements in technological and scientific changes. Such development helps accelerate learning, reduces task completion times, and minimizes performance errors. Moreover, it provides significant direct benefits to the organization by conserving resources, improving the quality and efficiency of human resources, and maintaining a highly capable workforce, which leads to the organization’s effectiveness (Intharaksa, 2017). Moreover, the Ministry of Education (2010) stated that teacher development is crucial in helping to implement the curriculum successfully, leading to effective teaching and learning management that impacts the development of students, which is the ultimate goal of education. Finally, Sanrattana (2012) states that teacher development is extremely important, as teachers must organize diverse teaching and learning activities with processes that develop their knowledge, skills, and attitudes, which in turn affect the development of students, the ultimate goal.

2.2 Challenges of professional development

The necessity for continuous development in school is universally acknowledged, yet its implementation remains challenging in many countries. For example, one important aspect is that teachers play a crucial role in developing and implementing the curriculum. Therefore, teachers must be continuously developed to keep up with new academic advancements, especially in terms of learning management that aligns with the objectives of the curriculum. This includes selecting teaching methods, teaching media and materials, assessment, and research to develop students, which is also a challenge. Another issue is the implementation of learning management by incorporating the SEP principles into the teaching and learning process. The final challenge is the integration of learning management based on the SEP principles.

Relevant research studies on professional problems are conducted at both national and international levels. In a study by Mahasuradej (2020), the teacher professional development for 21st-century learning management at Kotchapuakanusorn School under the Bangkok Metropolitan was overall rated at a high level. In terms of problems, teachers had a large workload that was out of balance with the use of analytical thinking techniques in the 21st century. These included too little time for teacher training and development, lack of allocation

of adequate budget for teacher development, and lack of constant supervision and teaching. The suggestions are consistent with all aspects of the problems, such as teacher training and development, which should be adjusted appropriately. There should be ongoing supervision and teaching, an adequate budget for teacher development, and teachers should be encouraged to organize team-based teaching to practice their analytical thinking skills.

Similarly, Buakhumkrot and Limmanee (2020) examined current conditions and established guidelines for developing teachers' learning management in the 21st century based on the Professional Learning Community (PLC) at a secondary school. The study found that the current and desired conditions of the teacher's development were determined at a high level by arranging in ascending order: learning activities management, instructional media and materials, learning evaluation and management, formulation of learning objectives, reflection on learning management, analysis of learners, and learning management and content regarding the 21st-century, respectively. Moreover, the desired conditions were overall ranked at the highest level. The guidelines for teacher professional development assessed by experts in terms of appropriateness and feasibility were at a high level.

2.3 Learning Management

Learning management can be defined in various ways. The concept of

Learning management has been defined and refined by various scholars over time. Good (1975) describes learning management as the act of educating and instructing students within an educational institution. Similarly, Hills (1982) defines it as the process of teaching students, emphasizing the importance of interaction between instructors and learners. Moore (1990) expands on this by characterizing learning management as the behaviors of an individual aimed at helping others develop holistically to reach their full potential. More recently, Thaophrom (2021) highlighted that effective learning management should prioritize learners' needs and interests. It should actively involve students in the learning process, enabling them to construct knowledge independently through real-life experiences. Thaophrom emphasizes the importance of action research and independent knowledge acquisition, fostering self-reliance and the ability to apply learning in everyday contexts while understanding their unique learning approaches. In addition, learning management should prioritize the needs and interests of learners by providing opportunities for active participation in the learning process. It focuses on empowering learners to independently construct knowledge through real-life experiences. Learners are encouraged to engage in action research and independently acquire knowledge, promoting self-reliance and the practical application of learning in everyday life, while fostering an understanding of their learning methods. This perspective aligns with Yoskhamlu (2021), who emphasized that learning management is an interactive process between teachers and learners, designed to enable learners to achieve the objectives set by the teacher and fulfill the goals of the curriculum effectively.

Many researchers at both national and international levels conduct relevant research studies in learning management. For example, Chitchirachan (2019) developed a learning model integrating the Sufficiency Economy Philosophy (SEP) for higher education students in northeastern Thailand. The model covered eight key areas, including self-assessment and critical thinking, with experts rating its components as highly effective. The current and desirable conditions revealed that teachers' current learning management practices were rated at a medium level, while desirable conditions were rated at the highest level. Likewise, Promma (2019) studied the implementation of SEP learning management in secondary education. The findings were: In terms of current and desirable conditions, teachers' current learning management practices were rated at a medium level, while desirable conditions were rated at the highest level. The guidelines for learning management based on the SEP principles included

four key areas, which were identified as learning units aligned with SEP (8 indicators), integration of SEP principles (8 indicators), evaluation of SEP learning management (6 indicators), and media and learning resources supporting SEP (5 indicators).

The guidelines were deemed both suitable and feasible at a good level.

Similarly, Sawaddee et al. (2019) developed an instructional management model for secondary schools in the Eastern Region using Participatory Action Research. The results revealed that the top three needs of teachers were research for improvement, leveling up students' academic gaps, and analyzing students' needs. In addition, the developed model consisted of ten steps: 1) Curriculum analysis and creation of learning units, 2) student analysis, 3) addressing student academic gaps, 4) learning designs, 5) learning management, 6) learning processing, 7) professional learning community activities, including knowledge sharing and supervision, 8) research for continuous improvement, 9) ongoing development, and 10) reporting. The results after the model implementation showed that the model was found to be highly suitable, applicable, reliable, and accurate across all aspects.

2.4 The Principles of the Sufficiency Economy Philosophy

The SEP principles comprise three core components: reasonableness, which involves making decisions that are justified through academic reasoning, legal standards, moral values, or societal norms; moderation, an Eastern concept advocating balanced actions that are neither excessive nor inadequate and are proportionate to one's resources; and self-immunity, which focuses on building resilience to environmental and situational changes through effective risk management. These principles are further supported by two essential conditions: knowledge, to ensure well-informed decisions, and ethics, to guide actions toward moral integrity and societal benefit. By embracing these principles, individuals can improve their quality of life and achieve enduring happiness (Ministry of Education, 2011).

The philosophy of sufficiency economy emphasizes self-reliance and balanced living at both individual and societal levels. Tantivejkul (1999) defines it as the capacity of a community or nation to meet its needs independently, minimizing reliance on external resources. At the individual level, it involves living within one's means and rejecting materialism, fostering independence and freedom. Lorkraileart (2004) highlights two perspectives: materialistic, focusing on having enough for basic needs, and subjective, centered on inner contentment, where sufficiency is defined by a personal mindset. Thaophrom (2021) expands the concept to include a way of thinking and acting that promotes collective well-being through virtues like diligence, patience, honesty, and integrity. The philosophy encourages moderation, reason, self-awareness, and caution, grounded in knowledge and thoughtful action.

Relevant research studies in PSEP integrated in learning management are conducted at both national and international levels. For example, Wichaakharawit (2018) conducted a study on integrating the Sufficiency Economy Philosophy (SEP) into basic education in Primary Educational Service Area 3, Chiang Mai Province. The findings identified three core components of SEP: sufficiency, logicity, and good immunity, supported by two conditions: knowledge and ethics. The results are as follows: The administration of Basic Education Institutions based on the SEP principles including, school management and administration, curriculum development and instruction, personnel development, student development activities, and school achievements. Moreover, the guidelines for implementing the SEP principles in schools involve establishing SEP-based policies as core school activities, providing professional development for school personnel, enhancing systems for supervision, evaluation, follow-up, and reporting, engaging school personnel and board members about the

SEP principles and encouraging practical application, developing projects, activities, strategies, and operational plans based on the SEP principles, updating and improving school curricula, implementing teaching practices according to revised curricula, creating a conducive learning environment, and enhancing parents and the community in all critical aspects of educational management.

Likewise, Chaoranong (2020) conducted a study on the development of innovations based on King’s Sufficiency Economy Philosophy within the context of teaching and learning in the course on human behavior and development. The findings reveal the following: The innovation, which integrates the King’s Sufficiency Economy Philosophy into teaching and learning management, focused on six key content areas: self-education, harmonious living according to Buddhist principles, living by the SEP principles, the application of the King’s science for self-development, and strategies for living a balanced life. The integration of the King’s science innovation into the course significantly improved students’ learning achievements, with post-study results showing higher performance at a statistical significance level of .05. Additionally, students expressed the highest levels of satisfaction with the innovation across all aspects of the course, including its relevance to human behavior and self-development. Similarly, Thaophrom (2021) conducted a study on integrating the SEP principles into teaching and learning management. The findings were as follows: The school had not incorporated the SEP principles as a fixed topic in the curriculum, preventing teachers from effectively including it in their teaching plans. Indicators and learning standards for the basic core curriculum were not established across all eight subject groups, except for the Social Studies, Religion, and Culture subject groups. In other subject groups, elements of the SEP principles were integrated into the learning content to develop students’ skills for practical application in daily life activities. The study highlights the need for systematic curriculum integration and standardization to enhance the effective application of the SEP principles in education.

Relevant research studies in the professional development of teachers are conducted by many researchers at both national and international levels. For example, Chotchum et al. (2017) conducted a study concerning a development model of learning management by integrating the SEP principles for teachers working under the Nakhon Ratchasima Provincial Administrative Organization. The research findings revealed that the appropriateness of the model was at a high level. Overall, the practical feasibility of the model was at a high level. In addition, the feasibility of the model was confirmed at over 80% which was above the criteria. Furthermore, Khanpetch et al. (2021) conducted a study on the development of teachers in teaching management using the SEP principles at a primary school in Suratthani Province. The research findings revealed that regarding conditions of learning management, teachers regularly applied the SEP principles in the school curriculum; however, some of the teachers did not, due to a lack of knowledge in creating learning management plans. The school used the integrated learning assessment and evaluation according to the SEP and prepared the learning assessment and evaluation tools which covered knowledge, process, and attitude aspects. In addition, the teacher professional was carried out through workshops focusing on writing learning management plans by using the SEP principles and classroom supervision. The research results regarding learning management plans, behavior observation, and learning management supervision and monitoring were at a high level. The participating teachers reported that their knowledge and understanding after attending the workshop were achieved at a higher level, and the learning management using the SEP principles was rated at a high level. In addition, teachers’ satisfaction with professional development was very high.

Similarly, a study by Rookha et al. (2022) revealed that the current conditions of learning management based on the SEP principles were at a medium level and the desired conditions of teachers in learning management according to the SEP principles were at a high level. Moreover, the guidelines for learning management based on the SEP principles included learning units, learning process integrating with the SEP principles, evaluation, media and learning resources, and evaluation and measurement.

2.5 Characteristics of Integrated Learning Management Based on the SEP Principles

According to Thaophrom (2021), integrating the SEP principles into the learning process involves three key strategies: 1) Curriculum Design: The curriculum should outline desirable traits rooted in SEP principles, such as moderation, reasonableness, self-reliance, and the integration of knowledge with ethics, 2) Learning Unit Integration: SEP principles, including its Three Pillars and Two Conditions, should be incorporated across all grade levels and learning areas, or established as standalone learning units. Examples include units like "Improving Quality of Life According to SEP," with age-appropriate activities tailored to students' experiences, local social contexts, and life conditions, and 3) Activity Formats: Learning activities should prioritize real-life, community-based projects that are student-centered. For instance, learners could engage in surveys or investigations addressing local issues, such as environmental challenges.

In addition, Nantachai (2005) states that education management based on the SEP principles involve the process of education management in the school system, which serves as the foundation and preparation for learning. This process aims to help children and youth live and develop their lives stably and sustainably, in balance and harmony with Thai lifestyles and culture. The implementation of the SEP principles in the learning process in schools can be carried out in the following ways: curriculum design, organizing learning units, conducting activities to promote moral and ethical values, and organizing teaching and learning activities. This also includes defining desirable characteristics based on the SEP principles. Furthermore, Khammani (2016) The implementation of the SEP principles in the learning process can be carried out in two ways: Integrating the SEP principles as a learning content in the curriculum. Integrating the SEP principles with various subject areas of the basic education core curriculum.

To investigate the development of teachers in integrating learning based on the SEP principles, the researchers conducted a comprehensive review of relevant concepts, theories, and studies. This review focused on teacher development, learning management, integration strategies, SEP principles, and satisfaction measures. Based on these insights, a conceptual framework for the study was developed, as outlined below.

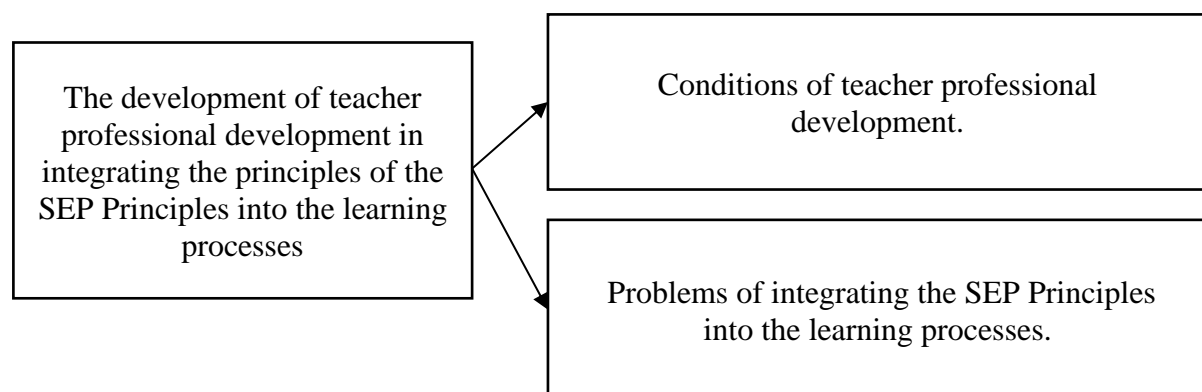


Figure 1 Research Conceptual Framework Research Methodology

This study employed a qualitative approach to examine conditions and challenges faced by teachers in integrating learning management based on the SEP principles. The data collected through interviews unstructured with 13 volunteer participants, including school committee members, teachers, and one administrator at Ban Dongbak School, Renu Nakhon District, Nakhon Phanom Province, under Nakhon Phanom Primary Education Service Area Office 1. The participants consisted of two school committee members, ten teachers represented various subject areas, including two Thai language teachers, three science teachers, two mathematics teachers, and three social studies teachers. The participating administrator, serving as the school director, was responsible for Academic Affairs and also taught Thai language. The interviews were designed to explore participants’ experiences and perspectives. The data were analyzed using content analysis to identify key themes and insights to the integration of the SEP principles in learning management.

Research Results

1. Conditions of teacher professional development

Interviews with two school committee members revealed a positive relationship between the school and the community. Overall, all school committee members expressed satisfaction and maintained a positive perception of the school. They also noted strong cooperation, with the community actively participating in school-organized activities and school staff engaging in return by supporting community events. However, regarding the school's implementation of the SEP principles, the participants were uncertain about the extent of its application, as collaboration between the school and community focuses primarily on other activities. The study also identified the needs of an administrator and teachers. Both groups demonstrated enthusiasm for participating in the research, recognizing its potential to enhance their capabilities. The administrator and teachers expressed a desire to improve their ability to apply the SEP principles in learning management. Specifically, teachers emphasized the need for support in developing lesson plans that integrated the SEP principles into mathematics and social studies instruction, particularly in preparation for the evaluation of the school as a sufficient economic school.

2. Challenges in integrating the SEP principles into the learning processes.

From the interviews with the administrator and ten teachers, it was found that the school has adopted the SEP principles by implementing it as a project, meaning it is part of the school's activities. However, it has not yet been applied in the teaching and learning process for each subject. Observations of the teaching and learning process revealed that teachers occasionally incorporate the sufficiency economy philosophy into some subjects, but it has not been written into the lesson plans and is only integrated into certain parts of the content. Document analysis showed that the curriculum, lesson plans, teaching activities, worksheets, and exercises do not yet include content related to the SEP principles in the subjects taught. Therefore, the administrator and teachers have expressed the need to develop teachers' potential, providing them with the knowledge and ability to apply the SEP principles in the learning process to ensure its sustainability.

Discussion

The results of the study on the integration of teaching and learning based on the SEP principles at the participating primary schools revealed that the school has applied the philosophy of sufficiency economy in the form of a project, making it part of the school's activities. However, it has not yet been integrated into the teaching and learning process for each subject. In addition, teachers lack knowledge in creating lesson plans based on the SEP principles and lack the skills to implement integrated teaching based on this philosophy. This may be because teacher development in integrating teaching based on the SEP principles is needed. The core ideas of the SEP principles can serve as a guide for living, assisting students adjust to society and living happily.

This is consistent with the study results of Chatchai Korkun (2019), who studied the development of teacher leadership in implementing teaching based on the SEP principles. The study found the need for teacher leadership development in curriculum development based on the SEP principles and the management of teaching and learning based on this philosophy. In the study by Suchada Sawadee et al. (2019), which investigated the development of a learning management model for secondary schools in the Eastern region using participatory action research, the study found that the top three needs of secondary school teachers in the Eastern region were research improvement, basic learner adjustment, and learner analysis. Additionally, Thaophrom (2021) studied the application of the SEP principles in the teaching and learning process. The study revealed that the school did not have specific study topics related to the SEP principles in its curriculum, preventing teachers from creating lesson plans. There were also no clear learning standards and indicators in the core curriculum for all eight subject areas, except for Social Studies, Religion, and Culture subject area. For other subject areas, the teaching and learning process was an integration of the sufficiency economy philosophy by incorporating it into the content and the integration efforts of each subject area teacher. Moreover, the school applied the SEP principles in student development activities to help students acquire skills, learning processes, and the ability to apply the concepts to their daily lives. This is also aligned with the research of Khwanphet et al. (2021), who studied teacher development in teaching according to the SEP principles at a primary school in Surat Thani. The study found that the school used the philosophy in curriculum design and development but teachers did not apply it in all subject areas. In addition, teachers lacked knowledge in creating lesson plans and lacked skills in teaching management. The school assessed and evaluated integrated learning based on the sufficiency economy philosophy and developed tools for assessment that covered knowledge, skills, and attitudes.

Conclusion

The current situation, challenges, and context in the integrated teaching and learning process based on the SEP principles reveal that most teachers still conduct traditional teaching activities, focusing on lectures, and do not follow learning principles that emphasize the learner. The SEP principles have not yet been integrated into the teaching process, and lesson plans do not incorporate the philosophy either. The main need for teacher development in integrating teaching based on the SEP principles is the necessity to develop teachers' skills in

creating lesson plans that integrate this philosophy. This study emphasizes the need for professional development programs to help teachers integrate SEP principles into subject-specific teaching. While SEP principles have been incorporated into broader school projects, there is a gap in their application in daily teaching. Training should focus on enhancing teachers' understanding of SEP principles and equipping them with the skills to design lesson plans that reflect these principles. Continued support and collaboration among administrators, teachers, and researchers are essential for successful implementation, promoting a more sustainable and self-reliant educational approach.

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Students Perspectives on English for Business Communication Curriculum: A Mixed-Method Evaluation from a Thai University

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Abstract

This study aimed to evaluate the English for Business Communication curriculum at a university in southern Thailand from students' perspectives across five key dimensions: curriculum content, teaching and learning management, assessment methods, management and facilities, and overall satisfaction. Using a mixed-methods approach, the study collected both quantitative and qualitative data in two phases. The quantitative sample consisted of 127 third and fourth-year students (96.21% response rate) from a total population of 198 students, determined using Yamane's (1967) formula and selected through stratified random sampling. The qualitative phase involved in-depth interviews with 10 selected participants who volunteered from the questionnaire respondents. The findings revealed varying levels of satisfaction across different aspects of the program. Teaching and learning management received the highest satisfaction rating ($\bar{x} = 3.71$), followed by assessment methods ($\bar{x} = 3.65$), while curriculum content received moderate satisfaction ($\bar{x} = 2.93$). Notable concerns emerged regarding the appropriateness of professional experience training ($\bar{x} = 1.67$) and specialization tracks ($\bar{x} = 1.85$). Interview data highlighted specific issues with the program's structure, particularly regarding the financial burden of multiple internship requirements and limited course selection options. These findings suggest that while the program demonstrates significant strengths in teaching methodology and assessment practices, there are substantial opportunities for improvement in curriculum content, specialization options, and facilities management. The results highlight the need for curriculum restructuring to better align with student needs and market demands, particularly in terms of internship requirements and course diversity. This comprehensive evaluation provides valuable insights for curriculum development and enhancement of business English education in the Thai context, contributing to the broader understanding of effective English for Specific Purposes (ESP) program design in Southeast Asian higher education.

Keywords: curriculum evaluation, business English, student perspectives, curriculum, and mixed-method study

Introduction

In today's globalized business environment, English language proficiency has become an essential skill for professional success, particularly in international business contexts. The demand for graduates with strong English communication skills has led many universities to develop specialized English for Business Communication (EBC) programs. These programs aim to equip students with English for business necessary for effective communication in various professional settings. As Youngyuensin (2015) noted in their study of Thai workplace communication, there is a significant need for business English communication skills among Thai professionals, particularly in multinational companies.

The English for Business Communication curriculum serves as a bridge between academic learning and real-world business applications, preparing students for the demands of the global workplace. Alqatawna & Alali (2023) emphasized that business English programs must address both linguistic competence and business knowledge to meet industry demands. This need for dual competency has shaped how universities structure their business English curricula. Thus, it is very important for the Thai context particularly in preparing students for the ASEAN Economic Community where English serves as the primary language of business communication.

The focus on examining students' perspectives in curriculum evaluation has gained increasing attention in Thai higher education. Kaewkunha (2021), in a study examining Needs Analysis of the English language for Thai employees in Service industry in Thailand, highlighted that understanding learners' needs and perspectives is crucial for developing effective English for Specific Purposes (ESP). This research specifically focuses on students enrolled in the English for Business Communication program at a university in southern Thailand, examining their perspectives on various aspects of the curriculum.

The comprehensive evaluation of the EBC curriculum encompasses five crucial aspects: curriculum content, teaching and learning management, assessment methods, management and facilities, and overall satisfaction. These dimensions align with the framework suggested by Forey and Cheung (2019) in their analysis of effective business English programs in Asia. The selection of these five aspects reflects the holistic approach needed to understand students' experiences with the curriculum, from content delivery to support systems.

The significance of this research lies in its potential to contribute to the improvement of business English education in Thailand. Previous research by Wiriyachitra (2002), though conducted earlier, established fundamental principles about English language teaching in Thailand that remain relevant today, particularly regarding the need for continuous curriculum evaluation and improvement. This study aims to build upon such foundational work while addressing the current needs of business English education in Thailand's southern region.

1. Research Objectives

To evaluate the curriculum content, teaching and learning management, assessment methods, management and facilities of English for Business Communication curriculum

2. Review of Related Literatures

Previous studies have emphasized the importance of curriculum evaluation in ensuring educational quality and effectiveness. Research by Jantarach (2011) found that regular curriculum assessment is crucial for maintaining program standards and making necessary

improvements to meet students' needs. The evaluation of educational programs should examine multiple aspects including context, input, process, and output to gain comprehensive insights. Several researchers have utilized Stufflebeam's CIPP model for curriculum evaluation due to its systematic and comprehensive approach. Nilphan (2012) applied the CIPP framework to evaluate a Master's curriculum and found it effective in identifying areas for enhancement across different program components. The model allows for assessment of both internal factors like course content and teaching processes, as well as external factors such as graduate employability and stakeholder satisfaction.

In terms of English language teaching programs specifically, studies have highlighted the need to balance theoretical knowledge with practical skills development. Research by Adipattaranan (2017) revealed that successful English teaching curricula should incorporate adequate opportunities for students to practice communication skills and gain hands-on teaching experience through internships. The study also emphasized the importance of having qualified instructors and appropriate learning resources.

Recent evaluation studies of education programs in Thailand have shown positive results while identifying areas for improvement. Taengnara (2020) found that graduates generally demonstrated strong teaching capabilities and professional competencies, though programs could be enhanced through increased active learning approaches and more emphasis on technology integration. Regular curriculum evaluation was recommended to ensure programs remain current with evolving educational needs and employment market demands.

Research Methodology

This research is a mixed-method study, collecting both quantitative and qualitative data. The researchers will conduct data collection and analysis in two phases: first collecting and analyzing quantitative data using questionnaires, followed by collecting and analyzing qualitative data through in-depth interviews.

1. Population and Sample

The population in this study consists of students in the Bachelor of Arts Program in English for Business Communication (revised curriculum 2020). The population included 198 third- and fourth-year students who were specifically chosen because they had already selected their specialization tracks and completed professional courses, making them well-positioned to provide informed insights about the curriculum. The sample size was determined using Yamane's (1967) formula. The quantitative samples were selected using stratified random sampling, resulting in 132 participants. Of these, 127 questionnaires were returned, representing a 96.21% response rate. The qualitative sample consists of 10 participants selected from questionnaire respondents who volunteered for interviews.

2. Research Tools

Two types of tools were used for data collection.

Questionnaire regarding curriculum evaluation in 5 aspects: the curriculum content, teaching and learning management, assessment methods, management and facilities of English for Business Communication curriculum, conducted online via Google Form. All of the items were written in Thai to avoid the participants' misunderstanding.

In-depth interview format designed to gather additional information beyond the questionnaire responses. The interviews took place in Thai, with each interview lasting around 20-30 minutes. The examples of the questions were: *What do you think about Curriculum Content?*, *Are you satisfied with the teaching and learning methods*, *What do you think about the provided specialization tracks (Hotel Business, Tourism Business, Airline Business)?*

3. Data Collection The researchers scheduled appointments with the sample group and explained the objectives and data collection methods. Participants were assured of confidentiality and anonymity. The questionnaire link was then sent to the sample group. After analyzing the questionnaire responses, the researchers contacted volunteers who agreed to participate in interviews. The researchers confirmed voluntary participation before scheduling interview appointments, each lasting approximately 10-15 minutes. Before each interview, researchers explained the research objectives and requested permission for audio recording.

4. Data Analysis Questionnaire responses were analyzed using mean and standard deviation. The results were interpreted using a 5-level rating scale following Likert's method (Srisa-ard, 2002) with the following criteria:

The mean score 4.51 – 5.00 refers to Highest satisfaction level

The mean score 3.51 – 4.50 refers to High satisfaction level

The mean score 2.51 – 3.50 refers to Moderate satisfaction level

The mean score 1.51 – 2.50 refers to Low satisfaction level

The mean score 1.00 – 1.50 refers to Lowest satisfaction level

The responses from open-ended questions and interviews were analyzed using content analysis and presented in descriptive form.

Results

Table 1. Level of Satisfaction on Curriculum Content

1	Curriculum Content	\bar{x}	SD	Level of Satisfaction
1.1	Ability to communicate and respond using academic and business English appropriately	3.23	0.94	moderate
1.2	Effective application of English in business service contexts	2.80	0.87	moderate
1.3	Effective application of English in hotel business contexts	3.04	1.14	moderate
1.4	Effective application of English in tourism business contexts	2.87	1.18	moderate
1.5	Effective application of English in airline business contexts	2.77	1.20	moderate
1.6	Ability to analyze and present information using English appropriately	3.28	0.85	moderate
1.7	Continuous learning and adaptability to technological changes	3.69	0.96	high
1.8	Discipline, honesty, patience, public-mindedness, expressiveness and appropriate problem-solving ability	3.43	0.96	moderate
1.9	Ability to work with others appropriately, understanding and respecting social and cultural differences	3.70	1.06	high
1.10	Appropriateness of total credit hours (131 credits)	3.60	0.95	high
1.11	Appropriateness of course structure	2.16	0.71	low
1.12	Appropriateness of specialization tracks (Hotel Business, Tourism Business, Airline Business)	1.85	0.84	low
1.13	Appropriateness of professional experience training (3 times)	1.67	0.76	low
	Over all	2.93	0.96	moderate

From Table 1, the analysis of curriculum content revealed an overall moderate level of satisfaction ($\bar{x} = 2.93$, $SD = 0.96$). Three areas demonstrated high levels of satisfaction: students' ability to work with others and understand cultural differences ($\bar{x} = 3.70$, $SD = 1.06$), continuous learning and adaptability to technological changes ($\bar{x} = 3.69$, $SD = 0.96$), and the appropriateness of total credit hours ($\bar{x} = 3.60$, $SD = 0.95$). However, several areas showed concerning low satisfaction levels, particularly the appropriateness of professional experience training ($\bar{x} = 1.67$, $SD = 0.76$), specialization tracks ($\bar{x} = 1.85$, $SD = 0.84$), and course structure

($\bar{x} = 2.16$, $SD = 0.71$). The remaining aspects, including various applications of English in business contexts, maintained moderate satisfaction levels.

Table 2. Level of Satisfactions on Teaching and Learning Management

2	Teaching and Learning Management	\bar{x}	SD	Level of Satisfactions
2.2	Adequate opportunities for questioning and class participation	3.85	0.89	high
2.3	Appropriateness of teaching methods (e.g., lectures, discussions)	3.84	0.8	high
2.4	Appropriateness of teaching materials for each course	3.84	0.89	high
2.5	Variety and appropriateness of teaching methods in each course	3.80	1.08	high
2.6	Adequacy and appropriateness of resources and personnel	3.82	0.96	high
2.7	Effectiveness of teaching equipment and technology in supporting students	3.08	1.37	moderate
	Over all	3.71	1.00	high

The teaching and learning management category demonstrated strong performance with an overall high level of satisfaction ($\bar{x} = 3.71$, $SD = 1.00$). Most aspects in this category received high satisfaction ratings, with particularly strong scores for opportunities for questioning and participation ($\bar{x} = 3.85$, $SD = 0.89$), and appropriateness of teaching methods ($\bar{x} = 3.84$, $SD = 0.80$) and materials ($\bar{x} = 3.84$, $SD = 0.89$). The only area showing moderate satisfaction was the effectiveness of teaching equipment and technology ($\bar{x} = 3.08$, $SD = 1.37$).

Table 3. Level of Satisfactions on Assessment

3	Assessment	\bar{x}	SD	Level of Satisfactions
3.1	Alignment of tests and exercises with course content	3.92	0.84	high
3.2	Clarity and effectiveness of learning assessment processes	3.98	0.9	high
3.3	Curriculum's relevance to current labour market needs	3.41	1.09	moderate
3.4	Alignment of curriculum content with learner needs and expectations	3.28	1.11	moderate
	Over all	3.65	0.99	high

The assessment category achieved an overall high level of satisfaction ($\bar{x} = 3.65$, $SD = 0.99$). The highest satisfaction levels were observed in the clarity of learning assessment processes ($\bar{x} = 3.98$, $SD = 0.90$) and alignment of tests with course content ($\bar{x} = 3.92$, $SD = 0.84$). Moderate satisfaction levels were found in the curriculum's relevance to labor market needs ($\bar{x} = 3.41$, $SD = 1.09$) and alignment with learner expectations ($\bar{x} = 3.28$, $SD = 1.11$).

Table 4. Level of Satisfactions on Management and Facilities

4	Management and Facilities	\bar{x}	SD	Level of Satisfactions
4.1	Appropriateness of curriculum scheduling	2.94	1.42	moderate
4.2	Conduciveness of classroom environment to learning	3.21	1.33	moderate
4.3	Adequacy and modernity of teaching equipment and media	3.02	1.52	moderate
	Over all	3.06	1.42	moderate

This category showed moderate overall satisfaction ($\bar{x} = 3.06$, $SD = 1.42$). All aspects within this category received moderate satisfaction ratings: classroom environment ($\bar{x} = 3.21$, $SD = 1.33$), teaching equipment and media ($\bar{x} = 3.02$, $SD = 1.52$), and curriculum scheduling ($\bar{x} = 2.94$, $SD = 1.42$). The relatively high standard deviations suggest considerable variation in student opinions regarding these facilities and management aspects.

Table 5. Level of Satisfactions on Overall Satisfaction

5	Overall Satisfaction	\bar{x}	SD	Level of Satisfactions
5.1	Overall satisfaction with the curriculum	2.94	0.92	moderate
5.2	Alignment of curriculum outcomes with personal needs and goals	3.25	1.14	moderate
5.3	Alignment of graduate skills with labour market needs	3.28	1.16	moderate
5.4	Adequacy of student support and counselling	3.63	1.18	high
5.5	Graduates' ability for self-development and career growth	3.40	1.26	moderate
	Over all	3.30	1.13	moderate

The overall satisfaction category achieved a moderate satisfaction level ($\bar{x} = 3.30$, $SD = 1.13$). Student support and counseling received the highest rating in this category ($\bar{x} = 3.63$, $SD = 1.18$), achieving a high satisfaction level. The remaining aspects, including graduates' ability for self-development, alignment with labor market needs, and alignment with personal goals, all received moderate satisfaction ratings. The overall curriculum satisfaction ($\bar{x} = 2.94$, $SD = 0.92$) indicates room for improvement in meeting student expectations.

Discussion

The evaluation results reveal several important insights about the curriculum's effectiveness across multiple dimensions. Regarding curriculum content, the overall satisfaction was at a moderate level ($\bar{x} = 2.93$). While students showed high satisfaction with continuous learning and ability to work with others ($\bar{x} = 3.69$, $SD = 3.70$), there were concerns about course structure ($\bar{x} = 2.16$) and professional experience training ($\bar{x} = 1.67$). The survey results align with the interview findings, which revealed that participants felt that having three professional experience training sessions was excessive and caused financial burden issues. As one interviewee stated, “*The internship expenses were very high because the training took place in tourist cities. We had to spend money on dormitory fees and food. Having 3 training sessions is too much. (Student 2)*”

Additionally, the participants mentioned that limiting the course selection to only three areas is too restrictive. Students should have the freedom to study subjects based on their interests. Moreover, there is overlapping content in the current course modules, so additional courses should be offered according to students' interests. As reported by Student 10 “*I'm actually very interested in export business, but the program only offers courses in tourism, hotels, and aviation. This means I couldn't study what I'm truly interested in. The internship also had to be done at hotels, which I wasn't interested in to begin with, so I feel like I didn't gain much from it. (Student 8)*”

Teaching and learning management received high overall satisfaction ($\bar{x} = 3.71$). This corresponds with Adipattaranan's (2017) findings where teaching processes and instructional

quality also received high ratings. As reported by one participant: *“In the classroom, teachers provide many opportunities for us to join classroom activities. The role-playing tasks are good. Hmm. I like discussions activities because I have more confident in speaking and expressing my opinions. Even in the research course, although our research advisor didn't have much time for us, we could consult with another lecturer who was very helpful and provided lots of guidance. (Student 3)”* However, while Adipattaranan found technology integration to be satisfactory in supporting instruction, the current study showed moderate satisfaction with technological support ($\bar{x} = 3.08$), suggesting an area for improvement. As reported by one participant, *“It would be better if the university provided the working space with high-speed Internet or advanced technology like other big universities. (Student 3)”*

Assessment aspects showed positive results ($\bar{x} = 3.65$), though curriculum relevance to market needs received moderate ratings ($\bar{x} = 3.41$). This echoes findings by McKay (2002) who emphasized that English language programs must evolve to meet changing societal and professional demands. The moderate alignment with learner expectations ($\bar{x} = 3.28$) also reflects Kirkpatrick's (2010) argument that English teaching curricula need continuous adaptation to serve ASEAN's linguistic landscape.

Facilities and overall satisfaction ratings were moderate ($\bar{x} = 3.06, 3.30$ respectively), with concerns about curriculum scheduling and resources. The following are the report from one of the participants, *“Overall, the program is good, but I'd like to see some adjustments to the excessive internship requirements and the module structure. Everything else is fine. The teachers are caring and approachable for any consultation. (Student 1)”* These results align with findings from Jantarach (2011) where physical resources and learning facilities were identified as key areas needing enhancement in English education programs. The current findings reinforce the importance of maintaining adequate learning infrastructure while adapting to changing educational needs as emphasized in previous CIPP model evaluations.

Conclusion

This study aimed to evaluate the curriculum content, teaching and learning management, assessment methods, management and facilities of the English for Business Communication curriculum from the perspective of current third and fourth-year students. The data collection tools were a questionnaire regarding curriculum evaluation in five aspects: curriculum content, teaching and learning management, assessment methods, management and facilities, and in-depth interviews. The sample consisted of 127 current students from the English for Business Communication program who completed the questionnaire, and 10 students who participated in interviews.

The findings are presented according to the measured aspects and their corresponding satisfaction levels. Teaching and Learning Management demonstrated the highest satisfaction rating among all aspects evaluated. This high satisfaction level suggests that participants were particularly pleased with the instructional methods and classroom management practices implemented in the program. Assessment practices also received high satisfaction ratings ($\bar{x} = 3.65$), indicating that participants responded favorably to the evaluation methods employed within the program. The relatively low standard deviation suggests consistency in participants' positive experiences with assessment procedures.

Management and Facilities received moderate satisfaction ratings ($\bar{x} = 3.06$). The higher standard deviation in this aspect indicates more varied responses from participants, suggesting diverse experiences with the program's administrative and infrastructural components. Curriculum Content recorded the lowest mean score ($\bar{x} = 2.93$), though still maintaining a

moderate satisfaction level. This finding suggests that while the curriculum meets basic requirements, there may be opportunities for enhancement to better align with participant expectations.

The Overall Satisfaction measure yielded a moderate rating ($\bar{x} = 3.30$), reflecting a generally positive but mixed response to the program as a whole. This composite score suggests that while certain aspects of the program excel, others may benefit from targeted improvements to enhance the overall educational experience. These findings highlight the program's strengths in teaching methodology and assessment while identifying potential areas for development in curriculum content and facilities management. The variation in satisfaction levels across different aspects provides valuable insights for program evaluation and improvement initiatives.

Recommendations for further research

Due to time constraints, this research collected data only from current students. Future studies should include other stakeholder groups, such as alumni or instructors, to obtain broader perspectives.

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Thai EFL Undergraduate Students' Attitudes and Preferences Toward Different English Accents: A Mixed-Method Study

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Abstract

This study investigated Thai EFL undergraduate students' attitudes toward different English accents and their accent preferences in English language learning. The research employed a mixed-method approach, combining quantitative and qualitative data collection methods to gain comprehensive insights into students' perceptions of various English accents, including British, American, Thai, Filipino, Indian, and Chinese accents. The study focused on examining these attitudes across multiple dimensions: satisfaction with English accents, comprehension, acceptance, credibility, motivation, and attitudes toward their own accent. Data were collected from 91 second-year undergraduate students majoring in English for Business Communication at a public university in southern Thailand through an online questionnaire. Additionally, semi-structured interviews were conducted with ten volunteers from the participant pool to gather in-depth qualitative data. The questionnaire assessed participants' reactions to different English accents using a four-point Likert scale, while the interviews explored the underlying reasons for their preferences and attitudes. The findings revealed a clear hierarchy in accent preferences, with American and British accents consistently receiving the highest ratings across all measured dimensions. Participants showed the strongest preference for teachers with American accents ($\bar{x}=3.37$), followed by British ($\bar{x}=3.15$) and Thai accents ($\bar{x}=3.12$). These native speaker varieties were perceived as more credible, professionally advantageous, and socially acceptable compared to other accents. The American accent was rated as the most comprehensible ($\bar{x}=3.31$), followed by Thai ($\bar{x}=3.18$) and British accents ($\bar{x}=2.75$). Notably, while participants expressed moderate acceptance of Thai-accented English, particularly in terms of teaching effectiveness and comprehensibility, they showed concerns about potential miscommunication when using Thai-accented English ($\bar{x}=2.88$). The study also found that participants strongly associated native speaker accents with increased career opportunities and positive self-image. However, they demonstrated lower acceptance of other Asian varieties of English, particularly Indian and Chinese accents, which consistently received the lowest ratings across all categories. This hierarchy in accent preferences reflects the ongoing influence of traditional language ideologies and raises important questions about preparing students for international communication in an increasingly globalized world. These findings have significant implications for English language teaching in Thailand and similar

EFL contexts. They suggest the need for a more balanced approach to accent education that acknowledges the practical value of widely recognized varieties while fostering appreciation for accent diversity. The results also highlight the importance of addressing linguistic insecurity among EFL learners and developing pedagogical strategies that promote confident communication regardless of accent.

Keywords: English accents, EFL learners, accent attitudes, Thai students

Introduction

Globalisation of English has contributed significantly to the development of different English varieties, which are characterized by specific linguistic features (Crystal, 2003). Such varieties, often referred to as "World Englishes," are shaped by the particular sociolinguistic and cultural contexts in which speakers use them (Kachru, 1992). These varieties include not only well-established forms like Indian English and Singaporean English but also emerging varieties like Vietnamese English and Indonesian English, each reflecting unique cultural and linguistic characteristics. In Thailand specifically, the development of Thai English demonstrates how globalization can actually lead to a creation of a much localized version of the language. Thai English contains all the of the Thai culture and language that include phonological features influenced by Thai tones and syntactic features reflective of Thai grammar (Kirkpatrick, 2007).

However, attitudes towards Thai English remain ambivalent. While some scholars and educators recognise it as a legitimate variety of English that reflects the evolving global diversity of the language, others continue to perceive it as inferior or "non-standard" compared to native varieties like British or American English (Jenkins, 2009; Ambele & Boonsuk, 2021). This disparity in perceptions reflects the broader sociolinguistic challenge of recognising and validating localised English varieties. The idea of linguistic superiority associated with native English varieties stems from entrenched ideologies of standardisation and native-speaker norms (Holliday, 2006). Such biases often marginalise speakers of World Englishes, including Thai English, and can perpetuate linguistic insecurity among learners (Canagarajah, 1999). When individuals speak English, one of the most immediately noticeable features is their accent, a key marker of linguistic identity (Derwing & Munro, 2015). Accents are influenced by stress patterns, rhythm, and intonation, all of which vary across linguistic backgrounds (Thomson & Derwing, 2018). Two primary factors contribute to accent variation. First, research shows that individuals who acquire English after adolescence often retain phonological features of their first language, a phenomenon attributed to the critical period hypothesis in second language acquisition (Flege, 1995; Saito & Plonsky, 2019). Second, accents are shaped by regional and cultural influences, reflecting the speaker's geographical and social origins (Levis, 2018; McCrocklin & Link, 2016). These influences result in different accents that serve as identifiers of linguistic and cultural heritage. Accents also play a vital role within communicative contexts, revealing interpersonal relationships. Listeners often make judgments about speakers based on their accents, associating some with intelligence, professionalism, or competence, while others are less prestigious or harder to understand (Derwing & Munro, 2015). Such biases may reinforce stereotypes and perpetuate inequalities since accents are often associated with perceptions of social class, ethnicity, and cultural identity (Levis & Zhou, 2021).

For instance, prejudice is commonly associated with professional settings, in which native-speaker accents are generally considered the norm (Kang et al., 2018). In

communicative settings, too, accents often lay the ground for interpersonal relationships. For instance, studies have found that one's accent can serve as a cue to perceptions about an individual's social group membership, personality, or emotional warmth/trustworthiness (Sung, 2016; Subtirelu, 2017). Such accent-related biases may lead to more unemployment, social exclusion, or even linguistic discrimination (Derwing, 2019; Lippi-Green, 1997). With the increasing development of English as an international lingua franca, more and more recognition has emerged regarding the validity of different varieties of English (Seidlhofer, 2011). Increasingly, there have been calls for a shift away from the standard norms of native speakers and toward a more inclusive approach to valuing diversity in using English around the world (Baker & Matsuda, 2017; Jenkins, 2015; Rose et al., 2020). An approach like this adopts an EIL stance, which privileges functional and communicative uses of English within multilingual contexts (McKay, 2002).

Therefore, it is essential for English teachers to be aware of students' attitudes and perceptions towards English accents, as existing biases may affect their confidence in English communication, which directly impacts their success in learning English. Additionally this study addresses several critical challenges faced by Thai EFL learners in today's globalized context. These include anxiety about accent intelligibility in international communication, concerns about professional opportunities related to accent perception, and the complex relationship between linguistic identity and perceived communicative effectiveness. Understanding these challenges is crucial for developing appropriate pedagogical approaches and supporting learners in navigating the diverse landscape of World Englishes.

1. Research Objectives

1.1 To explore Thai EFL undergraduate students' attitudes towards different English accents.

1.2 To investigate Thai EFL undergraduate students preferred English accent.

2. Review of Related Literatures

Over the past three decades, globalisation has significantly influenced the spread of English speakers and the multifaceted roles the language plays in international domains such as business, tourism, technology, science, politics, and education (Jenkins, 2007). The far-reaching influence of English has led to the emergence of distinct varieties collectively referred to as "World Englishes." These include well-established forms such as American and British English, as well as newer and locally adapted varieties like Chinese English, Indian English, and Thai English. Each variety is marked by unique differences in vocabulary, spelling conventions, syntax, pragmatics, and phonology, with accents often serving as the most immediately recognisable distinction. The rise of these varieties fundamentally challenges the traditional view of English as a monolithic language with a single “correct” form. Instead, it highlights the adaptability and richness of the language in diverse cultural and linguistic contexts. English has evolved into a global lingua franca, a tool that belongs to all its users, regardless of whether they are native speakers. This transformation underscores the importance of inclusivity in understanding and teaching English. To better conceptualise the global spread of English, Kachru (1992) proposed a model comprising three concentric circles: the Inner Circle, the Outer Circle, and the Expanding Circle. The Inner Circle includes countries where English is spoken as a native language, such as the United Kingdom, the Republic of Ireland, the United States, Australia, New Zealand, and Canada. These nations historically set the standard for what was considered “proper” English, influencing its teaching and learning globally.

The Outer Circle consists of countries where English functions as a second language, often due to colonial legacies. In these contexts, English is integrated into official domains such as government, education, and media. Countries in this category include India, Nigeria, the Philippines, South Africa, and Singapore. English in these regions reflects significant localisation, blending with indigenous languages and cultures to create distinct varieties. The Expanding Circle, by contrast, comprises countries where English is primarily taught and learned as a foreign language. These nations, including EU member states, Turkey, China, and Thailand, use English mainly for international communication rather than internal governance or daily interaction. The English spoken in the Expanding Circle is often shaped by the learners' linguistic and cultural backgrounds, further contributing to the language's diversity. This model underscores the dynamic and multifaceted roles English plays across the globe.

2.1 English as a Foreign Language (EFL)

In the context of the Expanding Circle, English is not the primary or official language of communication, but it holds a significant place as a foreign or additional language (Kachru, 1985). Countries like Thailand exemplify this dynamic, where English serves as a crucial tool for international communication, education, and professional advancement. However, the way English is taught, learned, and perceived in these contexts comes with its own set of challenges and nuances. In Thailand, English was introduced into the education system early, often when it became compulsory in primary schools; notwithstanding, many learners have varied levels of proficiency. This is partly due to several factors that relate to the availability of qualified teachers, resources, and methods employed in teaching. In many cases, traditional approaches, such as rote learning and grammar-focused instruction, may dominate the classrooms and not prepare students well enough for practical communicative use of the language. Cultural factors also affect how English is taught and learned in Thailand. In a culture of great respect for authority and one that wishes to avoid public embarrassment, students will be reluctant to participate or speak out in English out of their fear of committing mistakes. This can prevent them from gaining confidence and effectively acquiring speaking and listening skills. In addition, local accents and pronunciation styles often can create a self-conscious feeling among learners when comparing their speaking to other English speakers or more skillful peers. On the positive side, the globalisation of media, technology, and travel has no doubt increased possibilities for Thai learners to use English outside formal classroom contexts. Social media, online learning tools, and exposure to international cultures have increased access to authentic English input essential in making the improvement in fluency and comprehension. Government policy initiatives and private sector investments in English education provide further indications of the growth in recognition of its importance to equip the workforce for competition in the ASEAN region and beyond. While English in Thailand is still a foreign language, its use is increasingly evinced, and this testifies to larger global trends. The difficulty, however, now is one of connecting the gap between the classroom and real life to ensure that learners not only achieve grammatical competence but assured and effective users of English. This requires a continued move towards learner-centered, communicative teaching methodologies that take into consideration the peculiar needs and challenges of EFL students within the Expanding Circle.

2.2 Accent Prestige Theory

Accent prestige highlights not only the social but also the psychological impact of accents on perception and decision-making. For instance, British Received Pronunciation (RP) and General American are often recognised as prestigious due to their association with reliability, authority, and high status (Panthong & Rattanawaropas, 2023). These accents are frequently idealised as "pure" and regarded as the standards for proper English. Conversely,

local or non-standard accents tend to carry low prestige and may be linked with lower social status, particularly in settings where standard accents dominate public and professional discourse. Nevertheless, speakers of non-standard accents are often perceived as more friendly, approachable, and relatable (Samarasinghe et al., 2019). This duality presents challenges for learners in countries such as Thailand, where a standard accent, especially British or American, is highly favoured in education and employment. Educational policies and societal attitudes often perpetuate the belief in the superiority of these accents. As a result, many learners in Thailand and other countries within the Expanding Circle feel pressured to emulate native speaker norms, sometimes at the expense of their own linguistic identity.

Research Methodology

1. Population and Sample

To investigate Thai EFL undergraduate students' preferred English accents and their attitudes towards different English accents, this study employed a purposive sampling method and recruited 100 second-year students majoring in English for Business Communication at one public university in the south of Thailand. These second-year students were specifically selected because they had completed fundamental English courses and were actively engaged in advanced language courses, providing them with sufficient exposure to various English accents through their coursework and learning materials. Additionally, at this stage in their academic journey, they had developed more informed perspectives about language learning while still having time to adjust their learning strategies based on research findings.

2. Research Tools

This research employed a mixed-method design to gain comprehensive insights into participants' attitudes towards different English accents. The study utilized two research instruments: an online questionnaire for collecting quantitative data and semi-structured interviews for gathering qualitative data, allowing for a deeper understanding of accent-related perceptions and patterns. The questionnaire was adapted from Panthong & Rattanawaropas (2023). The semi-structured interviews were used to gain further insights into the participants' preferred English accents and to further investigate their English accent attitudes. Both the questionnaire and the interviews were conducted in Thai to prevent language barriers.

3. Data Collection

All participants in this research were informed about the research objectives and their rights to withdraw from the study. The online questionnaire link was then sent to all participants. They were allowed approximately 30 minutes to complete it. If they were interested in participating further in the interviews, they were asked to fill in their contact information at the end of the questionnaire. After the survey completion, 10 participants who volunteered to join the interviews were randomly chosen. They were also informed of the research objectives. Each participant was interviewed for 15-20 minutes.

The descriptive statistical approach was used to analyse the quantitative questionnaire data, while qualitative content analysis was used to analyse the interview data. In presenting the interview as a tool that offers in-depth information to understand the participants' attitudes, it was anticipated that some salient and implicit biases towards the participants' accents would be addressed.

4. Data Analysis

The data from the questionnaire were analysed using descriptive statistics to present the mean scores, standard deviation, and interpretation levels of the participants' reactions to different English accents. The interpretation of the results used a 4-level rating scale following Likert's method (Srisa-ard, 2002) with the following criteria:

The mean score 3.26-4.00 refers to Strongly Agree

The mean score 2.51-3.25 refers to Agree

The mean score 1.76-2.50 refers to Disagree

The mean score 1.00-1.75 refers to Strongly Disagree

The 4-point Likert scale was deliberately chosen over the more common 5-point scale to encourage participants to take a clear position on their accent preferences and attitudes. This forced-choice format eliminates the neutral middle option, which can sometimes be overused when respondents are uncertain or unwilling to express a definitive opinion. This approach was particularly valuable for this study as it helped capture more decisive attitudes toward different English accents.

Content analysis was used to analyse the interview data. The interview data were presented as supportive in-depth information to understand the participants' attitudes.

Results

1. The results of Thai EFL undergraduate students' attitudes towards different English accents

In this section, how the participants rated the English accents in terms of Satisfaction with English Accents, Comprehension, Acceptance, Credibility, Motivation, Familiarity, and Attitudes Toward Own Accent are discussed as shown in Table 1

Table 1. Satisfaction with English Accents

1. Satisfaction with English Accents	\bar{x}	SD	Interpretation
1.1 I prefer learning with teachers who have a British accent	3.15	0.84	Agree
1.2 I prefer learning with teachers who have an American accent	3.37	0.88	Strongly Agree
1.3 I prefer learning with teachers who have a Thai accent	3.12	0.88	Agree
1.4 I prefer learning with teachers who have a Filipino accent	2.63	0.99	Agree
1.5 I prefer learning with teachers who have an Indian accent	2.02	1.03	Disagree
1.6 I prefer learning with teachers who have a Chinese accent	1.66	0.79	Strongly Disagree
1.7 It is essential for teachers to have a British accent to help students better understand English	3.30	0.71	Strongly Agree
1.8 It is essential for teachers to have an American accent to help students better understand English	3.25	0.81	Agree
1.9 It is essential for teachers to have a Thai accent to help students better understand English	2.85	0.95	Agree
1.10 It is essential for teachers to have a Filipino accent to help students better understand English	2.41	0.99	Disagree
1.11 It is essential for teachers to have an Indian accent to help students better understand English	1.74	0.77	Strongly Disagree
1.12 It is essential for teachers to have a Chinese accent to help students better understand English	1.69	0.76	Strongly Disagree
Over all	2.60	0.87	Agree

The findings revealed that participants showed the strongest preference for teachers with American accents (\bar{x} =3.37, SD=0.88), followed by British accents (\bar{x} =3.15, SD=0.84) and

Thai accents ($\bar{x}=3.12$, $SD=0.88$). Filipino-accented English received moderate acceptance ($\bar{x}=2.63$, $SD=0.99$), while Indian ($\bar{x}=2.02$, $SD=1.03$) and Chinese accents ($\bar{x}=1.66$, $SD=0.79$) were less preferred. Participants strongly agreed that having teachers with British accents ($\bar{x}=3.30$, $SD=0.71$) and American accents ($\bar{x}=3.25$, $SD=0.81$) was essential for better English comprehension. The overall satisfaction score ($\bar{x}=2.60$, $SD=0.87$) indicated general agreement with the importance of accent in English learning.

Table 2. Comprehension

2. Comprehension	\bar{x}	SD	Interpretation
2.1 I find the British accent the easiest to understand compared to others	2.75	0.90	Agree
2.2 I find the American accent the easiest to understand compared to others	3.31	0.84	Strongly Agree
2.3 I find the Thai accent the easiest to understand compared to other accents	3.18	0.92	Agree
2.4 I find the Filipino accent the easiest to understand compared to others	2.44	0.93	Disagree
2.5 I find the Indian accent the easiest to understand compared to others	1.67	0.79	Strongly Disagree
2.6 I find the Chinese accent the easiest to understand compared to others	1.73	0.82	Strongly Disagree
Overall	2.51	0.87	Agree

Regarding comprehension, participants found the American accent most easily understandable ($\bar{x}=3.31$, $SD=0.84$), followed by Thai accent ($\bar{x}=3.18$, $SD=0.92$) and British accent ($\bar{x}=2.75$, $SD=0.90$). Filipino-accented English was rated as somewhat difficult to understand ($\bar{x}=2.44$, $SD=0.93$), while Indian ($\bar{x}=1.67$, $SD=0.79$) and Chinese accents ($\bar{x}=1.73$, $SD=0.82$) were reported as the most challenging to comprehend. The overall comprehension score ($\bar{x}=2.51$, $SD=0.87$) suggested a moderate level of understanding across different accents. The relatively high comprehension rating for Thai-accented English suggests that familiarity with local pronunciation patterns plays a significant role in understanding. This finding challenges the assumption that native speaker accents are always the most comprehensible and highlights the importance of exposure and linguistic familiarity in comprehension.

Table 3. Acceptance

3. Acceptance	\bar{x}	SD	Interpretation
3.1 I consider the British accent to be socially acceptable	3.62	0.59	Strongly Agree
3.2 I consider the American accent to be socially acceptable	3.68	0.63	Strongly Agree
3.3 I consider the Thai accent to be socially acceptable	2.91	0.78	Agree
3.4 I consider the Filipino accent to be socially acceptable	2.89	0.86	Agree
3.5 I consider the Indian accent to be socially acceptable	2.40	0.99	Disagree
3.6 I consider the Chinese accent to be socially acceptable	2.29	0.99	Disagree
Overall	2.97	0.81	Agree

The data showed highest social acceptance for American ($\bar{x}=3.68$, $SD=0.63$) and British accents ($\bar{x}=3.62$, $SD=0.59$). Thai ($\bar{x}=2.91$, $SD=0.78$) and Filipino accents ($\bar{x}=2.89$, $SD=0.86$) received moderate acceptance levels. Indian ($\bar{x}=2.40$, $SD=0.99$) and Chinese accents ($\bar{x}=2.29$, $SD=0.99$) were rated as less socially acceptable. The overall acceptance score ($\bar{x}=2.97$, $SD=0.81$) indicated general positive acceptance of different English accents.

Table 4. Credibility

4. Credibility	\bar{x}	SD	Interpretation
4.1 I believe the British accent is more credible and formal than others	3.42	0.76	Strongly Agree
4.2 I believe the American accent is more credible and formal than others	3.37	0.77	Strongly Agree
4.3 I believe the Thai accent is more credible and formal than others	2.34	0.79	Disagree
4.4 I believe the Filipino accent is more credible and formal than others	2.47	0.86	Disagree
4.5 I believe the Indian accent is more credible and formal than others	1.71	0.78	Strongly Disagree
4.6 I believe the Chinese accent is more credible and formal than others	1.66	0.76	Strongly Disagree
4.7 I think having a British accent creates a positive self-image	3.50	0.66	Strongly Agree
4.8 I think having an American accent creates a positive self-image	3.49	0.74	Strongly Agree
4.9 I think having a Thai accent creates a positive self-image	2.41	0.73	Disagree
4.10 I think having a Filipino accent creates a positive self-image	2.49	0.84	Disagree
4.11 I think having an Indian accent creates a positive self-image	1.79	0.74	Disagree
4.12 I think having a Chinese accent creates a positive self-image	1.63	0.68	Strongly Disagree
Over all	2.52	0.76	Agree

British (\bar{x} =3.42, SD=0.76) and American accents (\bar{x} =3.37, SD=0.77) were perceived as most credible and formal. Both accents were strongly associated with creating a positive self-image (British: \bar{x} =3.50, SD=0.66; American: \bar{x} =3.49, SD=0.74). Thai and Filipino accents received moderate credibility ratings, while Indian and Chinese accents were perceived as least credible. The overall credibility score (\bar{x} =2.52, SD=0.76) suggested a moderate perception of credibility across accents.

Table 5. Motivation

5. Motivation	\bar{x}	SD	Interpretation
5.1 Having a British accent increases opportunities for well-paying jobs	3.56	0.67	Strongly Agree
5.2 Having an American accent increases opportunities for well-paying jobs	3.52	0.70	Strongly Agree
5.3 Having a Thai accent increases opportunities for well-paying jobs	2.41	0.65	Disagree
5.4 Having a Filipino accent increases opportunities for well-paying jobs	2.45	0.76	Disagree
5.5 Having an Indian accent increases opportunities for well-paying jobs	1.74	0.74	Strongly Disagree
5.6 Having a Chinese accent increases opportunities for well-paying jobs	1.69	0.75	Strongly Disagree
Over all	2.56	0.71	Agree

Participants strongly agreed that having British (\bar{x} =3.56, SD=0.67) or American accents (\bar{x} =3.52, SD=0.70) increased opportunities for well-paying jobs. Thai (\bar{x} =2.41, SD=0.65) and Filipino accents (\bar{x} =2.45, SD=0.76) were perceived as having moderate impact on job opportunities, while Indian (\bar{x} =1.74, SD=0.74) and Chinese accents (\bar{x} =1.69, SD=0.75) were seen as least advantageous. The overall motivation score (\bar{x} =2.56, SD=0.71) indicated moderate agreement with accent influence on career prospects.

Table 6. Attitudes Toward Own Accent

6. Attitudes Toward Own Accent	\bar{x}	SD	Interpretation
6.1 I feel embarrassed or less confident when speaking English with a Thai accent	2.45	0.97	Disagree
6.2 I worry that my Thai accent might lead to misunderstandings	2.88	1.00	Agree
6.3 I believe English major students should be able to speak with a British accent	2.76	0.91	Agree
6.4 I believe English major students should be able to speak with an American accent	2.87	1.00	Agree
6.5 I practice to achieve a British accent	3.02	0.88	Agree
6.6 I practice to achieve an American accent	3.26	0.81	Strongly Agree
Over all	2.87	0.93	Agree

Participants showed mixed feelings about their Thai accent. While they disagreed about feeling embarrassed when speaking English with a Thai accent ($\bar{x}=2.45$, $SD=0.97$), they expressed concern about potential misunderstandings ($\bar{x}=2.88$, $SD=1.00$). They showed strong motivation to achieve an American accent ($\bar{x}=3.26$, $SD=0.81$) and moderate interest in acquiring a British accent ($\bar{x}=3.02$, $SD=0.88$). The overall attitude score ($\bar{x}=2.87$, $SD=0.93$) indicated generally positive attitudes toward accent development.

Discussion

The findings revealed a clear hierarchy in how Thai EFL undergraduate students perceive different English accents, with American and British accents consistently rated most favorably across all measured dimensions. This preference aligns with traditional views of these varieties as prestigious and standardized forms of English (Crystal, 2003; Jenkins, 2009). The high ratings for American and British accents in terms of credibility, job opportunities, and social acceptance reflect deeply embedded ideologies about native speaker norms in English language teaching and learning (Holliday, 2006). These perceptions demonstrate how accent prestige theory manifests in the Thai EFL context, where native speaker accents are often associated with professional success and positive self-image (Panthong & Rattanawaropas, 2023).

Interestingly, while participants showed strong preference for native speaker accents, they also expressed relatively positive attitudes toward Thai-accented English, particularly in terms of comprehensibility and teaching effectiveness. This finding suggests a growing acceptance of local varieties of English, supporting the broader trend toward recognizing World Englishes (Kachru, 1992; Kirkpatrick, 2007). However, the data also revealed participants' concerns about potential miscommunication when using Thai-accented English, indicating a persistent tension between linguistic identity and perceived communicative effectiveness (Derwing & Munro, 2015; McCrocklin & Link, 2016). This anxiety about accent-related misunderstandings reflects broader issues of linguistic insecurity among EFL learners (Canagarajah, 1999).

The notably lower ratings for Indian, Filipino, and Chinese accents suggest the presence of hierarchical attitudes toward different non-native varieties of English. This finding is particularly significant given that these varieties represent important business partners and fellow ASEAN members. The lower acceptance of these accents may pose challenges for international communication and collaboration (Ambele & Boonsuk, 2021). These attitudes might be influenced by limited exposure to these varieties and prevailing social stereotypes,

highlighting the need for greater awareness of World Englishes in EFL education (Levis, 2018; Thomson & Derwing, 2018). The lower acceptance of these accents could potentially impact various aspects of international engagement. In the business sphere, as Thai businesses increasingly collaborate with partners from India, China, and ASEAN nations, accent biases might create communication barriers and affect professional relationships. This concern extends to regional integration, particularly within the ASEAN Economic Community, where English serves as the working language. Negative attitudes toward regional English varieties could hinder effective collaboration and mobility among member nations. Furthermore, in the educational sector, with growing academic partnerships across Asia, these accent preferences might affect student and faculty exchange programs and collaborative research initiatives. These implications suggest a need for interventions to address accent biases and promote greater acceptance of diverse English varieties in professional and academic contexts.

Conclusion

This study provides valuable insights into Thai EFL undergraduate students' attitudes toward different English accents, revealing both traditional preferences for native speaker varieties and emerging acceptance of local English forms. The findings highlight the complex interplay between globalization, linguistic identity, and language learning attitudes in the Thai EFL context (Jenkins, 2009; Kirkpatrick, 2007). These insights can inform pedagogical approaches that balance the practical need for intelligible communication with the recognition and validation of diverse English varieties.

The persistent influence of accent prestige and its impact on learners' self-perception and professional aspirations suggests the need for more inclusive approaches to English language teaching. As English continues to evolve as a global lingua franca, educational institutions and language teachers should work toward fostering appreciation for accent diversity while helping students develop the confidence to use English effectively in international contexts (Derwing & Munro, 2015; Saito & Plonsky, 2019). This balanced approach can help prepare students for the linguistic diversity they will encounter in real-world communication while maintaining their cultural and linguistic identity.

Recommendations for further research

Future research could explore several important directions to build upon the findings of this study. Longitudinal research would be valuable to track how students' attitudes toward different English accents evolve throughout their academic careers, providing insights into the developmental nature of accent perceptions. Additionally, comparative studies investigating accent attitudes among different stakeholders - including teachers, employers, and professionals - could offer a more comprehensive understanding of how accent preferences affect various aspects of academic and professional life. Research could also examine effective pedagogical approaches for developing accent awareness and fostering appreciation of World Englishes in the classroom. Furthermore, with the increasing role of digital media in language exposure, studies investigating how media consumption and technology use influence students' attitudes toward different English accents could provide valuable insights for curriculum development and teaching methodology. These future research directions would contribute to a deeper understanding of accent attitudes in EFL contexts and help develop more inclusive and effective English language teaching approaches.

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Perceptions and Attitudes Toward Using ChatGPT Among English for Business Communication Students: A Case Study of Prince of Songkla University, Surat Thani Campus

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Abstract

This study investigated the perceptions and attitudes toward using ChatGPT among English for Business Communication students at Prince of Songkla University, Surat Thani Campus. The research employed a mixed-method approach, combining quantitative and qualitative data collection methods to gain comprehensive insights into students' experiences with ChatGPT. The study involved 140 participants from first-, second-, and third-year Business English Communication programs, with fifteen students voluntarily participating in follow-up interviews. Data were collected through an online questionnaire using a 5-point Likert scale and semi-structured interviews. The questionnaire examined three main aspects: perceptions of using ChatGPT, challenges in using ChatGPT, and attitudes toward ChatGPT integration in education. Results revealed generally positive perceptions toward ChatGPT as a learning tool, with an overall mean score of 3.77 (SD = 1.04). Students particularly valued ChatGPT for learning English ($\bar{x} = 4.05$, SD = 0.93), vocabulary expansion ($\bar{x} = 3.88$, SD = 1.01), and improving various communication skills ($\bar{x} = 3.82$, SD = 1.07). Regarding challenges, students showed a neutral stance ($\bar{x} = 3.19$, SD = 1.18), with the primary concern being potential over-reliance on AI instead of developing their own skills ($\bar{x} = 3.68$, SD = 1.18). The findings also indicated positive attitudes toward AI integration in education ($\bar{x} = 3.54$, SD = 1.05), with strong support for using ChatGPT alongside traditional learning methods ($\bar{x} = 3.62$, SD = 1.00) and its role in promoting independent learning ($\bar{x} = 3.63$, SD = 1.00). The study aligns with theoretical frameworks including Vygotsky's Zone of Proximal Development and Kolb's experiential learning theory, demonstrating how AI tools can provide scaffolding for language learning while promoting autonomous skill development. The findings suggest that students view ChatGPT as a valuable complementary tool rather than a replacement for conventional learning methods. They also highlight the importance of structured integration and proper training in AI tools within business English curricula. This research contributes to the growing body of knowledge about AI integration in language education and provides practical insights for educational institutions planning to incorporate AI tools into their teaching methodologies. The findings suggest that successful implementation of ChatGPT in business English education requires a balanced approach that maximizes its benefits while

addressing concerns about over-reliance and maintaining the development of independent language skills.

Keywords: ChatGPT; English for Business Communication; AI

Introduction

The rapid growth of artificial intelligence has significantly transformed modern communication, particularly in the domain of Business English. ChatGPT, developed by OpenAI, is a leading AI communication tool widely adopted in education and business (Brown et al., 2020). For students of Business English Communication, effective communication is essential for addressing the challenges of globalised markets. Tools like ChatGPT are reshaping how learners interact, draft messages, and overcome language barriers. Business English is a variety of English specialised to cater for the needs of commerce, negotiation, and collaboration in international contexts (Nickerson, 2005). Proficiency in Business English encompasses not only linguistic competence but also cultural awareness and strategic communication skills (Bargiela-Chiappini et al., 2013). Within this framework, AI tools such as ChatGPT introduce new paradigms in language learning and professional communication. By assisting with tasks like drafting emails, summarising reports, and generating conversational scripts, ChatGPT enhances productivity and fosters more efficient communication processes. These factors that influence students' perceptions include experience with AI, perceived usefulness, and trust in the technology. Many students consider ChatGPT to be an effective learning aid that saves time and boosts their confidence when working on business writing tasks (Huang et al., 2021). The tool helps students develop their communication skills and navigate the complexities of business language by transforming text into contextually relevant and grammatically accurate content. However, challenges remain. Some students remain doubtful about the reliability of the content generated by AI, citing occasional inaccuracies and limitations regarding ChatGPT's ability to understand nuanced cultural or contextual elements (Bender et al., 2021). Furthermore, with students using AI more frequently in their learning process, ethical issues concerning originality of work and intellectual property also become increasingly relevant (Floridi et al., 2018). The theoretical application of ChatGPT in Business English aligns with socio-cognitive theories of language learning. The concept of Vygotsky's Zone of Proximal Development explains how ChatGPT and similar tools provide the "scaffolding" by which learners can operate beyond their current linguistic capability through suggestion, correction, and alternative (Vygotsky, 1978). Theories on communicative competence also pinpoint the importance of linguistic and pragmatic, strategic competence--all functionalities that are indeed supported by ChatGPT itself (Canale & Swain, 1980). On the level of practice, ChatGPT's role can be considered multifunctional for students of Business English. While it helps with composing business emails, writing proposals, and drafting content for presentation, all in appropriate style, tone, and grammatically accurate, according to Brown et al. (2020), it helps bridge the linguistic gaps and makes the messages more understandable in cross-cultural learning environments when English often serves as the lingua franca. This feature relieves anxiety for non-native English-speaking students, who are more confident in their ability to communicate professionally. Another strong point of ChatGPT is that it has the potential to foster iterative learning. Through user interactions, ChatGPT incorporates feedback to refine its responses, aligning with Kolb's experiential learning theory, which emphasizes a cycle of experience, reflection, and refinement (Kolb, 1984). As students engage in communication tasks with ChatGPT, they also develop their own language proficiency through this process.

The perceptions of ChatGPT in English for Business Communication students are one of the many instances illustrating the dynamic interplay between technology and language learning. Maximal benefits could only come with a balance of opportunities and challenges in the integration of AI tools to address a number of ethical and pedagogical concerns, according to Floridi et al., 2018. With more research and refinement, the ChatGPT promises the revision of the teaching method in Business English for ease of access, efficiency, and relevance to meet today's global professional challenges.

1. Research Objectives

1.1 To investigate the perceptions and attitudes towards using ChatGPT among Business English Communication students at Prince of Songkla University, Surat Thani Campus.

2. Review of Related Literatures

Artificial intelligence integrated into modern communication has deeply influenced the learning of languages, especially in the specialised domain of Business English. Among the prominent AI tools, ChatGPT by OpenAI is widely recognised for its transformative potential in language education and professional communication. In Business English, learners have to be effectively communicative to meet the challenges of globalized markets, which require clarity, precision, and cross-cultural competence. AI tools, like ChatGPT, are increasingly driving developments in Business English instruction, helping learners engage with the language in improving their writing and mitigating linguistic and cultural difficulties.

Business English is a variety of English that has been oriented toward commerce, negotiation, and collaboration in international contexts. It differs in its focus on professional lexis, formal communication, and pragmatic language use (Louhiala-Salminen & Kankaanranta, 2011). The ability to handle Business English exceeds the limits of linguistic competencies and involves cultural knowledge and strategic skills of communication in various business contexts (Charles, 2007). In this regard, the integration of AI tools like ChatGPT heralds a new frontier, enabling the automation of routine tasks and enhancing learners' ability to communicate in a contextually appropriate and grammatically correct manner

The increased dependence on AI in Business English is due to its use in drafting emails, summarizing reports, and even conversational script creation. These functionalities save time and enhance productivity by enabling learners to focus on developing higher-order communication skills. Tools like ChatGPT instil confidence in business writing, enabling students to navigate the complexities of professional language. According to Mahapatra (2024), this is particularly helpful for non-native speakers of English, who often struggle to produce text that meets professional standards and cultural expectations.

Effectively, ChatGPT can become an actual learning aid for Business English depending mainly upon students' subjective attitude towards such AI, which is viewed based on experience, perceived usefulness, and confidence in it. Many students perceive ChatGPT as a valuable tool for enhancing productivity in business writing, as it provides immediate and actionable suggestions. The tool's ability to generate coherent, contextually appropriate content aligns well with the communicative requirements of international business and has been widely appreciated.

On the other hand, some students have raised concerns over the credibility of the content provided by AI. Bender et al. (2021) note that AI lacks the capacity to understand subtle cultural

or contextual features; hence, inaccuracies may arise. Such challenges reveal the importance of human judgment when using AI tools, particularly in contexts where cultural sensitivity and context-specific knowledge matter. Besides, frequent use of AI in academic and professional tasks raises ethical concerns of originality and intellectual property, as noted by Floridi (2019). In dealing with these issues, clear guidelines and a balanced approach to integrating AI into language education are imperative.

The application of ChatGPT in Business English instruction aligns with several key theories of language learning. Vygotsky’s Zone of Proximal Development (ZPD) provides a useful framework for understanding how AI tools act as scaffolding, enabling learners to operate beyond their current linguistic capabilities through suggestion, correction, and alternatives (Daniels, 2001). By providing tailored support, ChatGPT helps learners bridge gaps in their knowledge and develop greater linguistic proficiency.

Approaches to communicative competence have theoretically emphasized linguistic, pragmatic, and strategic competencies, for example. These were suggested by Canale and Swain 1980. The support which the ChatGPT has had in terms of the development of texts on professional standard of tone and style along with grammatical accuracy serves to assist students in creating appropriate and effective communications for the global market. Additionally, the iterative nature of the interactions with ChatGPT resonates with Kolb’s experiential learning theory, emphasizing a cycle of experience, reflection, and refinement (Kolb & Kolb, 2005). With repeated use, learners develop not only improved immediate outputs but also deeper insights into the structure and conventions of language.

Pragmatically, ChatGPT serves for a student of Business English as some kind of multitool that helps them be more successful in composing business letters, proposals, or presentations with their linguistic accuracy and cultural appropriateness retained. This feature is immediately welcomed in cross-cultural learning environments where English very often is the lingua franca. That is what contributes to diminishing linguistic anxiety and encouraging more active participation of a non-native speaker in professional communication.

The integration of AI into language learning, however, does not go without its fair share of challenges. First, there are ethical issues related to overdependence on AI and issues of academic integrity that need to be put into consideration to ensure that these technologies are used responsibly. Floridi (2019) appeals for robust frameworks in the management of these concerns as a means of balancing technological benefits against ethical and pedagogical principles.

The interplay between AI and Business English instruction epitomizes how technology could transform language teaching. In enhancing productivity, confidence, and scaffolding, ChatGPT and similar resources will doubtless be of value for learners tackling the challenges of professional communication. However, if the full potential of AI in this context is to be realized, consideration of its limitations, the ethical implications of its use, and further research in the area will be required. This field is one that keeps evolving, and as such, the integration of AI tools should be informed by the commitment to fostering linguistic competence and critical thinking in ways that will have the learner meeting the challenges of globalized markets both confidently and professionally.

Research Methodology

1. Population and Sample

The population in this study were 351 the first, second-, and third-year English for Business Communication students in the academic year 2024. To determine the sample size of a group of Thai students, the Sample Size Determination table of Yamane’s (1967) formula

was employed; therefore, 190 students from the population of 351 were the participants of the study. The participants were selected using stratified random sampling to ensure representation across all year groups. After the completion of the survey, only 140 students returned the survey to the researchers. From these, fifteen students were purposefully selected for interviews based on variation in their survey responses to ensure a balanced representation of perspectives. Interviews were conducted in Thai to prevent language barriers and allow participants to express their views comfortably.

2. Research Tools

This research employed a mixed-method design to gain comprehensive insights into participants' perceptions and attitudes towards using ChatGPT in studies. Two research instruments: questionnaire and semi-structured interviews were used for both quantitative and qualitative data respectively. The questionnaire was in Thai and consisted of 2 parts. The semi-structured interviews were used to gain more information on how the participants used ChatGPT for their studies. The interviews were also conducted in Thai to prevent language barriers.

3. Data Collection

The researchers asked for the permission from the lecturers to collect data of the participants. Then, participants who volunteered for the research were asked to complete an online questionnaire. They were allowed to take as much time as needed to complete it. If they were interested in participating further in the interviews, they were asked to fill in their contact information at the end of the questionnaire. After the questionnaire administration, 15 participants who volunteered to join the interviews were randomly chosen. Each participant was interviewed for 15-20 minutes.

4. Data Analysis

The data from the questionnaire were analysed using descriptive statistics to present the mean scores, standard deviation, and interpretation levels of the participants' perceptions and attitudes towards using ChatGPT. The interpretation of the 5-point Likert scale responses followed the guidelines established in previous research (Joshi et al., 2015; Sullivan & Artino, 2013), using the following intervals:

The mean score 4.51-5.00 refers to Strongly Agree

The mean score 3.51-4.50 refers to Agree

The mean score 2.51-3.50 refers to Neutral

The mean score 1.51-2.50 refers to Disagree

The mean score 1.00-1.50 refers to Strongly Disagree

Content analysis was used to analyse the interview data. The interview data were presented as supportive in-depth information to understand the participants' perceptions and attitudes towards using ChatGPT.

Results

The results of the participants’ perceptions and attitudes toward using ChatGPT

Table 1. Perception of Using ChatGPT

	Questions	\bar{x}	SD	Interpretation
1.	I believe ChatGPT is a useful tool for learning English.	4.05	0.93	Agree
2.	I see ChatGPT as a creative way to improve various communication skills, such as writing, speaking, listening, and presenting in a business context.	3.82	1.07	Agree
3.	I feel confident using ChatGPT for assignments and tasks.	3.66	1.03	Agree
4.	I believe ChatGPT can help expand my vocabulary in English effectively.	3.88	1.01	Agree
5.	I think ChatGPT makes learning English more engaging.	3.61	1.12	Agree
6.	I find ChatGPT helpful for understanding English grammar.	3.64	1.11	Agree
7.	I believe ChatGPT encourages self-directed learning and independence in English studies.	3.73	1.02	Agree
	Total	3.77	1.04	Agree

From Table 1, the findings reveal that students generally had positive perceptions toward ChatGPT, with an overall mean score of 3.77 (SD = 1.04), indicating agreement. Students most strongly believed that ChatGPT is a useful tool for learning English (\bar{x} = 4.05, SD = 0.93). They also showed notable agreement that ChatGPT can help expand their English vocabulary (\bar{x} = 3.88, SD = 1.01) and saw it as a creative way to improve various communication skills in business contexts (\bar{x} = 3.82, SD = 1.07). While still positive, students showed slightly lower agreement with ChatGPT making learning more engaging (\bar{x} = 3.61, SD = 1.12) and helping with complex grammar (\bar{x} = 3.64, SD = 1.11).

Table 2. Challenges in Using ChatGPT

	Questions	\bar{x}	SD	Interpretation
1.	Sometimes, I find ChatGPT creates incorrect or illogical content.	3.40	1.02	Neutral
2.	I worry about the security of information when using ChatGPT.	3.21	1.14	Neutral
3.	I feel ChatGPT might make me rely too much on it instead of improving my own skills.	3.68	1.18	Agree
4.	I think ChatGPT is difficult and complicated to use at times.	2.56	1.25	Neutral
5.	I have trouble accessing ChatGPT due to restrictions or costs.	3.10	1.23	Neutral
6.	I think having a guide or template for writing prompts would make using ChatGPT easier.	3.46	1.12	Neutral
7.	Using ChatGPT makes me procrastinate instead of working on tasks directly.	2.95	1.29	Neutral
	Total	3.19	1.18	Neutral

Regarding challenges, students showed a neutral overall stance with a mean score of 3.19 (SD = 1.18). The most significant concern was their potential over-reliance on ChatGPT instead of developing their own skills (\bar{x} = 3.68, SD = 1.18). Students were neutral about issues like incorrect content generation (\bar{x} = 3.40, SD = 1.02) and information security (\bar{x} = 3.21, SD

= 1.14). Notably, they showed the least concern about ChatGPT being difficult to use ($\bar{x} = 2.56$, $SD = 1.25$), and were relatively neutral about procrastination issues ($\bar{x} = 2.95$, $SD = 1.29$).

Table 3. Attitudes Toward Using ChatGPT

	Questions	\bar{x}	SD	Interpretation
1.	I believe AI (ChatGPT) can improve English learning quality.	3.46	1.00	Neutral
2.	I think AI (ChatGPT) will be an important part of English learning in higher education in the future.	3.58	1.05	Agree
3.	I worry AI (ChatGPT) might replace interactions between teachers and students in English learning.	3.40	1.13	Neutral
4.	I think ChatGPT should be used alongside traditional English learning methods for the best results.	3.62	1.00	Agree
5.	I support universities providing training on how to use ChatGPT	3.55	1.07	Agree
6.	I believe ChatGPT can help bridge the gap for students who struggle with learning English.	3.53	1.07	Agree
7.	I think using AI (ChatGPT) encourages students to be more independent in their learning.	3.63	1.00	Agree
	Total	3.54	1.05	Agree

The findings indicate an overall positive attitude toward AI in English learning, with a mean score of 3.54 ($SD = 1.05$). Students particularly agreed that ChatGPT encourages independent learning ($\bar{x} = 3.63$, $SD = 1.00$) and should be used alongside traditional methods ($\bar{x} = 3.62$, $SD = 1.00$). They also showed agreement that ChatGPT will play an important role in future higher education ($\bar{x} = 3.58$, $SD = 1.05$). Interestingly, students were neutral about AI potentially replacing teacher-student interactions ($\bar{x} = 3.40$, $SD = 1.13$), while supporting university-provided training for effective ChatGPT use ($\bar{x} = 3.55$, $SD = 1.07$).

Discussion

The research findings reveal several important insights about how Business English Communication students perceive and use ChatGPT in their studies. Three main themes emerged from the results: positive perceptions of ChatGPT as a learning tool, concerns about over-reliance on AI, and generally positive attitudes toward AI integration in education.

First, students showed strong agreement that ChatGPT is useful for learning English, particularly for vocabulary expansion and improving various communication skills. The survey results align with the interview findings, many students reported that they have learned English from using ChatGPT. As reported by Student 4 “*I think it is the great tool for everyone to develop English language skills. For me, I can ask the meaning of vocabulary that I want to know and I can get the answer within a minute*”. Student 8 also reported, “*When I have got to create roleplay scripts for my exams, I always use it to create the dialogue in which I can learn and improve my communication skills*”.

This aligns with previous research suggesting that AI tools can enhance productivity and foster more efficient communication processes in business contexts (Bargiela-Chiappini et al., 2013). The students' positive response to ChatGPT as a learning aid supports the theoretical framework of Vygotsky's Zone of Proximal Development, where the AI acts as scaffolding to help learners operate beyond their current capabilities (Daniels, 2001).

However, the most significant concern expressed by students was the potential over-reliance on ChatGPT instead of developing their own skills. As reported by one student, *“I admit that sometimes I just copied and pasted the results from ChatGPT and submitted them to the teacher without checking or learning anything. It made me lazy. I know it's not a good idea to do that”*. This worry reflects broader discussions in the field about balancing technological assistance with autonomous learning (Floridi et al., 2018). Interestingly, while students expressed this concern, they also agreed that ChatGPT encourages independent learning, suggesting a complex relationship between AI assistance and learner autonomy.

The findings also showed that students were relatively neutral about technical challenges such as incorrect content generation and information security. This contrasts with previous research by Bender et al. (2021), who highlighted significant concerns about AI's limitations in understanding cultural and contextual elements. The students' more neutral stance might suggest that they have developed strategies to navigate these limitations or that they use ChatGPT primarily for tasks where such limitations are less critical.

Students strongly supported integrating ChatGPT alongside traditional learning methods rather than replacing them entirely. By combining artificial intelligence with conventional teaching methods, we can transform education, offering customized learning experiences that benefit educators and learners alike. (Fernández, 2024). The students' preference for a blended approach suggests they view ChatGPT as a complementary tool rather than a replacement for conventional learning methods.

The research also revealed strong support for university-provided training in effective ChatGPT use. This finding reflects the growing recognition that digital literacy and AI tool competency are becoming essential skills in business communication, as noted by Louhiala-Salminen and Kankaanranta (2011). As one student noted in the interview, *“I think our university choose provide the course how to use AI in language learning. It would be good for us to know how to learn from AI”*. The desire for formal training suggests students understand the importance of using AI tools effectively and ethically in their academic and future professional lives.

Conclusion

This study provides valuable insights into how English for Business Communication students at Prince of Songkla University, Surat Thani Campus perceived and used ChatGPT. The findings demonstrate that students generally view ChatGPT positively as a learning tool while maintaining awareness of its limitations and potential risks. Students recognize ChatGPT as a valuable tool for enhancing their English language learning, particularly in business communication contexts, and they demonstrate a mature understanding of the need to balance AI assistance with independent skill development. The research reveals strong support for integrating ChatGPT into formal education, particularly when combined with traditional learning methods and proper training. Notably, students show relatively low concern about technical challenges, suggesting they have adapted to using AI tools effectively in their learning process.

These findings have important implications for educational institutions and language educators, pointing to the need for structured integration of AI tools into business English curricula, accompanied by proper training and guidelines for effective use. Future research could explore specific strategies for implementing AI tools in business English education while maintaining a balance between technological assistance and autonomous learning. The study highlights the evolving nature of business English education in the AI era, where tools like ChatGPT are becoming increasingly important for preparing students for the global

professional environment. As AI technology continues to develop, educational institutions will need to adapt their approaches to ensure students can effectively utilize these tools while developing their own language and communication skills. This research ultimately suggests that with proper guidance and implementation, ChatGPT can serve as a valuable complement to traditional business English education, helping prepare students for the increasingly digital and AI-integrated professional world.

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Needs Assessment to Enhance Financial and Health Literacies for Pre-Service Teachers in The Digital Era

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Abstract

The purpose of this research is to assess the need for enhancing financial and health literacy for pre-service teachers in the digital era. The sample groups used in this research include: 1) Pre-service teachers in the field of primary education, Faculty of Education, Chiang Mai Rajabhat University, years 1-4, academic year 2024, were obtained by random sampling (Cluster Random Sampling) by dividing students into years. Then, lots were drawn to obtain a representative sample of 45 students per year, totaling 180 students. 2) Lecturer under the Faculty of Education Chiang Mai Rajabhat University Obtained through purposive sampling by having knowledge and experience in the teaching profession or financial or health, not less than 2 years, a total of 10 people. The tools used in the research include: 1) Needs assessment form for enhancing financial and health literacy for pre-service teachers in the digital era. 2) Interview form to assess the need for enhancing financial and health literacy for pre-service teachers in the digital era. Statistics used in data analysis include mean, standard deviation, Modified Priority Needs Index (PNI_{Modified}).

The results of the research were found: 1) The results of the assessment of the need to enhance financial and health literacy for pre-service teachers in the digital era found that current conditions in enhancing financial and health literacy for pre-service teachers in the digital era Overall, it is at a moderate level ($\bar{X} = 3.43$). Expectations for enhancing financial and health literacy for pre-service teachers in the digital era Overall, it is at the highest level ($\bar{X} = 4.70$). And there is a need to enhance financial and health literacy for pre-service teachers in the digital era (PNI_{Modified} = 0.37). 2) The results of the interview to assess the need for enhancing financial and health literacy for pre-service teachers in the digital era found that enhancing financial and health literacy for pre-service teachers in the digital era is a huge need for pre-service teachers. The content for enhancing financial and health literacy should start with basic content and progress to more complex content. Learning activities should focus on learners and advanced thinking processes that are consistent with the current world situation. Learning media should be easy to understand, interesting and modern. Measurement and evaluation of learning should have a variety of formats and emphasize measurement and evaluation according to actual conditions.

Keywords: Financial and Health Literacy, Pre-Service Teachers, Digital Era

Introduction

The 21st century is an era in which technology has been continuously developed and advanced. Especially information technology and this technological advancement brings new inventions and innovations that help make human life more convenient. The way of life of people in society has begun to change from the past and changes more and more as technology advances. Therefore, this era is called the digital era. In an era where the world has rapid technological changes. How quickly can people adapt and prepare to meet the changes occurring in the future world? There will only be a great advantage. Having a good educational foundation and educational innovation Therefore, it is considered the key to preparing the country's youth and personnel for the digital era.

Financial literacy is one skill that is important in the digital era. However, if a person has good financial skills, that person will have the ability to make good financial decisions in various areas. And it results in that person having a good life. In 2013, for the first time, the Bank of Thailand and the National Statistical Office surveyed the financial skills of Thai people. We surveyed the financial skills of Thai people throughout the country, all ages and various occupations. The Bank of Thailand survey uses the same guidelines as the OECD (Organization for Economic Co-operation and Development) financial skills survey. Measures 3 areas of financial skills: financial knowledge financial behavior and financial attitude the results of the survey found that Thai people have an average financial skills score of 58.5 percent, which is lower than the average of 14 countries participating in the OECD survey project (Bank of Thailand, 2013). Consistent with the Government Pension Fund's Financial Intelligence Survey (2019), it was found that many Thais still lack financial knowledge. Therefore, creating financial intelligence is a skill that is necessary for the development of education for stability in life. This is a principle under the policy of "Study well, be happy" of the Ministry of Education. It is considered an important educational concept to inculcate. and provide financial knowledge to students. Because this financial skill will stay with the learner forever. And no matter what age you are or what situation you encounter, you can use these financial skills and knowledge throughout your life. It is considered a competency that is consistent with and appropriate for the context of changes in the world and society at present and in the future (Permpoon Chidchob, 2024).

From the situation of emerging disease outbreaks that the world has experienced. It causes impacts in every aspect, whether economic, social, political, including the way of life of people in society that has changed greatly. Therefore, health literacy and being able to take care of your own health is very important and necessary. Changing lifestyles reflect important future trends arising from behavior and attitudes towards life that are no longer the same. And at present, Thai public health is paying more attention to the health intelligence of the people. This can be seen from the 20-year national strategic plan 2017-2036 for public health. Has laid the framework and direction for the work of the Ministry of Public Health in the future. With the goal of "good health of the people the officials are happy. and sustainable health systems" (Ministry of Public Health, 2016). This is consistent with the goals of the National Health Development Plan No. 12, one of which states that "people, communities, localities, and network partners have more health literacy. As a result, illness and death from preventable diseases will decrease" (Ministry of Public Health, 2017).

Therefore, in the era of the digital age Giving importance to education for stability in life to be a mechanism for developing people's potential is therefore important. Because access to quality education will enable humans to develop and fulfill their highest potential in every aspect. Especially promoting development for student teachers have knowledge and understanding about financial and health literacies. This knowledge and understanding can be

further developed to organize the teaching and learning process in the classroom to become skills that can be used in real life for students. and is an extension of good practices in that educational community as well.

1. Research Objective

To assess the need for enhancing financial and health literacy for pre-service teachers in the digital era

2. Review of Related Literatures

Financial literacy

The Bank of Thailand (2013) has defined financial literacy according to the Organization for Economic Co-Operation and Development: OECD as being aware, knowledge and understanding. Expertise, expertise, attitude, and behavior in a manner that results in people making good financial decisions. and, in the end, it will help result in good financial health for individuals. Arunee Nusit and colleagues (2014) stated that financial literacy refers to basic knowledge and understanding of economics and finance, consisting of knowledge about interest. Knowledge about inflation and risk knowledge This is considered a factor that affects financial behavior. Kamonchanok Sakonthawat and Charinee Treewaranyu (2020) stated that financial literacy is the ability to use financial skills. To make financial decisions related to planning and managing money Within the appropriate personal financial context. Garman and Forgue (2000) stated that financial literacy is when a person has financial knowledge. Understand principles for money management Until being able to successfully solve a person's financial problems. Mason and Wilson (2000) stated that financial literacy is a person's ability to use skills to make informed financial decisions. Organization for Economic Co-Operation and Development: OECD (2011) Organization for Economic Co-Operation and Development said that financial literacy is the ability to combine awareness, knowledge, attitude, and behavior to make effective financial decisions within a financial context that is appropriate to one's environment. Atkinson and Messy (2012) stated that financial literacy is the combination of financial awareness, knowledge, expertise, attitudes, and important financial behaviors. So that individuals can make financial decisions. which will result in Individuals achieve the goal of financial well-being.

Therefore, it can be concluded that financial literacy refers to the ability to combine financial knowledge (Financial Knowledge), financial behavior (Financial Behavior) and financial attitude (Financial Attitude) to use them in making financial decisions efficiently and appropriately. Your own context consists of 1) Financial knowledge means the ability to identify, analyze, and interpret data and information related to finance. 2) Financial attitude refers to feelings, beliefs, and personal opinions regarding finances. 3) Financial behavior refers to actions or expressions of financial persons, including financial planning, saving, earning income, managing expenses, and investing.

Health literacy

Division of Health Education, Department of Health Service Support the Ministry of Public Health (2010) has defined health literacy as: Ability and skills to access information, knowledge, and understanding for analysis Evaluate your practice and manage yourself. Including being able to give advice on personal, family and community health for good health. Department of Health, Ministry of Public Health (2017) stated that health literacy refers to intellectual capacity (thinking, considering, reflecting, choosing one's own) and society at the individual level that is well-versed in health. until able to filter Evaluate and choose to receive Leads to decision-making with clarity in selecting health products, changing behavior, and selecting health services that are appropriate for oneself. Chonlatit Urairerkkul (2020) stated

that health literacy refers to intellectual or social skills in creating motivation or the ability to access, understand, evaluate, and apply knowledge and understanding. that have been received into practice (Apply) and the results of practice are beneficial to health. The World Health Organization (1998) defines health literacy as: “Health literacy represents the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand and use information in ways which promote and maintain good health”. Nutbeam (2000, 2008) defines health literacy as: (1) knowledge, understanding, and social skills that determine a person's motivation and ability to access, understand, and use information to achieve good health. including knowledge development and understanding it in the health context. Changing attitudes and motivation to create appropriate health behaviors on your own. (2) Competency of people who can access, understand, evaluate, use knowledge, and communicate about health information according to their needs. To promote and maintain good health throughout life. (3) social and critical thinking skills that determine a person's motivation and ability to access, understand, and use information to promote and maintain health. Ishikawa et al. (2008) defined health literacy as an individual's ability to access, understand, and use health information. To make appropriate health decisions. Pleasant & Kuruvilla (2008) defined health literacy as: Ability to find, understand, analyze, and use health information to make accurate decisions. To have good health and reduce health inequalities.

Therefore, it can be concluded that Health literacy refers to the ability to combine skills to access health information and services (access), health knowledge and understanding (cognitive), health communication (communication skill), health decision-making (decision skill) and health self-management (self-management). To be used to change health behaviors and choose health services that are appropriate for oneself. 1) Access to health information and services means the ability to search, filter, and examine health information. and choose to receive information from reliable sources. 2) Health knowledge and understanding means the ability to identify, analyze, and interpret data and information related to health. 3) Health communication means the ability to exchange data, information, and transfer information. and communication between people regarding health. 4) Health decision-making refers to the ability to consider alternatives or courses of action to maintain good health. 5) Health self-management refers to the ability to take care of oneself and practice good health.

Research Methodology

1. The Research Procedure Includes 4 Steps which are:

1.1 To study and analyze basic information, documents, concepts, theories, and research related to assessing the needs for enhancing financial and health literacy for pre-service teachers in the digital era.

1.2 To design and create needs assessment to enhance financial and health literacy for pre-service teachers in the digital era. and designed interviews to assess the needs for enhancing financial and health literacy for pre-service teachers in the digital era.

1.3 To carry out data collection by (1) writing a request for permission to collect data for use in research (2) Send a letter requesting assistance in collecting data. and submit a needs assessment form go to sample (3) Wait to receive the needs assessment form. which is returned on the specified date and time (4) Conduct interviews and collect data from interviews.

1.4 To collect and analyze data from needs assessments and interviews.

2. Research Instruments

2.1 Needs assessment form for enhancing financial and health literacy for pre-service teachers in the digital era.

2.2 Interview form to assess the need for enhancing financial and health literacy for pre-service teachers in the digital era.

3. Sample Group

3.1 Sample group was pre-service teachers in the field of elementary education, Faculty of Education, Chiang Mai Rajabhat University, years 1-4, academic year 2024, obtained by random sampling (Cluster Random Sampling) by dividing students into years. Then, lots were drawn to obtain a representative sample of 45 students per year, totaling 180 students

3.2 Sample group was Lecturer under the Faculty of Education. Chiang Mai Rajabhat University Obtained through purposive sampling by having knowledge and experience in the teaching profession or financial or health, not less than 2 years, a total of 10 people.

4. Statistics for Data Analysis

Qualitative data uses content analysis and quantitative data uses data analysis by averaging, standard deviation and finding the Modified Priority Needs Index (PNI_{Modified})

$PNI_{Modified} = (I - D) / D$		
PNI (Priority needs index)	mean	Index of essential needs
I (Important)	mean	Average of what the condition should be or what is expected.
D (Degree of success)	mean	Average of actual conditions

Research results

Results of the needs assessment for enhancing financial and health literacy for pre-service teachers in the digital era.

1. Assessing the needs for enhancing financial and health literacy for pre-service teachers in the digital era.

The results of the needs assessment for enhancing financial and health literacy for pre-service teachers in the digital era are as follows:

1.1 General data analysis results appear as shown in Table 1

Table 1. Results of general data analysis (n=180)

General information		Frequency	Percentage
1. sex	1.1 men	15	8.33
	1.2 women	165	91.67
	1.3 Not specified	0	0
	Total	180	100.00
2. Bachelor's degree level	2.1 year 1	45	25
	2.2 year 2	45	25
	2.3 year 3	45	25
	2.4 year 4	45	25
	Total	180	100.00
3. Cumulative Grade Point Average (GPAX)	3.1 level 3.51-4.00	112	62.22
	3.2 level 3.01-3.50	59	32.78
	3.3 level 2.51-3.00	9	5.00
	3.4 level 2.00-2.50	0	0

General information		Frequency	Percentage
4. Number of times attending training/seminars related to enhancing financial and health literacy in the past 1 year	3.5 level below 2.00	0	0
	Total	180	100.00
	4.1 Never attended a training/seminar	89	49.44
	4.2 1-2 times	91	50.56
	4.3 3 or more times	0	0
	Total	180	100

From Table 1, the results of general data analysis, it was found that the respondents to the assessment were 180 pre-service teachers in the field of elementary education, Faculty of Education, Chiang Mai Rajabhat University, with general information as follows.

There were 15 males, accounting for 8.33 percent, and 165 females, accounting for 91.67 percent.

Studying in various years of the bachelor's degree, including 1st year, 45 people, accounting for 25 percent, 2nd year, 45 people, accounting for 25 percent, 3rd year, 45 people, accounting for 25 percent. and 4th year, 45 people, accounting for 25 percent.

Cumulative Grade Point Average (GPAX) level 3.51–4.00, 112 people, accounting for 62.22 percent, level 3.01–3.50, 59 people, accounting for 32.78 percent, level 2.51–3.00, 9 people, accounting for 5.00 percent.

Number of times attending training/seminars related to enhancing financial and health literacy in the past 1 year. It was found that 89 people had never attended training/seminars, accounting for 49.44 percent, and attended training/seminars. 1-2 times, 91 people, accounting for 50.56 percent

1.2 Results of analysis of current conditions and expectations for enhancing financial and health literacy for pre-service teachers in the digital era. Appears as shown in Table 2.

Table 2. Results of analysis of current conditions and expectations for enhancing financial and health literacy for pre-service teachers in the digital era. (n=180)

Enhancing financial and health literacy		current conditions (D)			expectations (I)			PNI _{Modified}	number
		<u>X</u>	S.D.	results	<u>X</u>	S.D.	results		
1. Contents	1.1 Financial planning	3.12	0.91	moderate	4.66	0.58	highest	0.49	5
	1.2 Earning money	3.46	0.67	moderate	4.61	0.62	highest	0.33	11
	1.3 Expense management	3.46	0.54	moderate	4.63	0.62	highest	0.34	10
	1.4 Saving money	3.56	0.53	high	4.71	0.47	highest	0.32	13
	1.5 Investment	2.89	0.69	moderate	4.59	0.63	highest	0.59	3
	1.6 Financial danger	2.69	0.65	moderate	4.43	0.53	high	0.65	1
	1.7 Financial technology	2.85	0.61	moderate	4.59	0.62	highest	0.61	2
	1.8 Health according to age	3.29	0.64	moderate	4.74	0.44	highest	0.44	6
	1.9 Nutrition	3.53	0.66	high	4.69	0.51	highest	0.33	11
	1.10 Exercise	3.33	0.70	moderate	4.63	0.58	highest	0.39	7
	1.11 First aid	3.13	0.59	moderate	4.28	0.80	high	0.37	9
	1.12 Disease prevention and	3.07	0.69	moderate	4.24	0.77	high	0.38	8

Enhancing financial and health literacy		current conditions (D)			expectations (I)			PNI _{Modified}	number
		<u>X</u>	S.D.	results	<u>X</u>	S.D.	results		
	avoidance of risky behavior								
	1.13 Using technology for health care	3.04	0.47	moderate	4.61	0.60	highest	0.52	4
Total of the contents		3.19	0.64	moderate	4.57	0.60	highest	0.43	1
2. Learning activities	2.1 Learning activities are diverse.	3.14	0.72	moderate	4.71	0.50	highest	0.50	3
	2.2 Focusing on students is important and hands-on practice	3.79	0.94	high	4.58	0.49	highest	0.21	5
	2.3 Give an opportunity to ask questions. Doubts and exchange of opinions.	3.68	0.87	high	4.53	0.62	highest	0.23	4
	2.4 The atmosphere in organizing learning activities is fun, relaxed, and not boring.	2.92	0.77	moderate	4.75	0.43	highest	0.63	1
	2.5 Instructor/Speaker have expert knowledge.	3.92	0.74	high	4.72	0.45	highest	0.20	6
	2.6 The duration of the activity is appropriate.	3.05	0.62	moderate	4.60	0.58	highest	0.51	2
	Total of the learning activities	3.42	0.78	moderate	4.65	0.51	highest	0.36	3
	3.1 Learning media is diverse.	3.65	0.60	high	4.73	0.44	highest	0.30	3
	3.2 The learning materials are creative, challenging and interesting.	3.40	0.49	moderate	4.91	0.29	highest	0.44	1
	3.3 The learning media is modern. Keep up with current events.	3.74	0.44	high	4.84	0.36	highest	0.29	4
3. Learning media	3.4 The learning media is clear and easy to understand.	3.93	0.33	high	4.82	0.39	highest	0.23	5
	3.5 Learning media are of the appropriate size and quantity for the learner.	3.43	0.63	moderate	4.79	0.41	highest	0.40	2
	Total of the learning media	3.63	0.50	high	4.82	0.38	highest	0.33	4

Enhancing financial and health literacy		current conditions (D)			expectations (I)			PNI _{Modified}	number
		<u>X</u>	S.D.	results	<u>X</u>	S.D.	results		
4. Measuring and evaluating learning outcomes	4.1 Measuring and evaluating learning through a variety of methods.	2.92	0.53	moderate	4.67	0.47	highest	0.60	1
	4.2 Measurement and evaluation of learning outcomes are consistent with learning objectives and content.	3.67	0.47	high	4.83	0.37	highest	0.32	3
	4.3 The tools used to measure and evaluate learning are of a quality appropriate to the learner.	3.58	0.49	high	4.80	0.40	highest	0.34	2
	4.4 Criteria for measuring and evaluating learning outcomes Is correct and appropriate	3.75	0.43	high	4.77	0.50	highest	0.27	4
	Total of the measuring and evaluating learning outcomes	3.48	0.48	moderate	4.77	0.44	highest	0.37	2
Total		3.43	0.60	moderate	4.70	0.48	highest	0.37	

From Table 2, the results of the analysis of the current conditions and expectations for enhancing financial and health literacy for pre-service teachers in the digital era found that The first essential needs index is In terms of content (PNI_{Modified} = 0.43), the second is In terms of measuring and evaluating learning outcomes (PNI_{Modified} = 0.37), the third is in learning activities (PNI_{Modified} = 0.36) and the last one is In terms of learning media (PNI_{Modified} = 0.33)

When analyzed separately, it was found that Content aspect There is the first index of essential needs: Financial danger (PNI_{Modified} = 0.65) is next in order. Financial technology (PNI_{Modified} = 0.61) and the third is investment (PNI_{Modified} = 0.59). Measuring and evaluating learning outcomes There is the first index of essential needs: Measuring and evaluating learning through a variety of methods (PNI_{Modified} = 0.60), followed by the tools used to measure and evaluate learning are of a quality appropriate to the learner (PNI_{Modified} = 0.34). And the third is Measurement and evaluation of learning outcomes are consistent with learning objectives and content (PNI_{Modified} = 0.32). Learning activities There is the first index of essential needs: The atmosphere in organizing learning activities is fun, relaxed, and not boring (PNI_{Modified} = 0.63). The duration of the activities is appropriate (PNI_{Modified} = 0.51) and the third is Learning activities are diverse (PNI_{Modified} = 0.50). Learning media There is the first index of essential needs: Learning media is creative, challenging and interesting (PNI_{Modified} = 0.44), followed by the learning media are of the appropriate size and quantity for the students (PNI_{Modified} = 0.40) and the third is Learning media is diverse (PNI_{Modified} = 0.30)

2. Interview to assess needs for enhancing financial and health literacy for pre-service teachers in the digital era.

Lecturer interview results Under the Faculty of Education Chiang Mai Rajabhat University, 10 people, to assess the need for enhancing financial and health literacy for pre-service teachers in the digital era. The details are as follows.

2.1 In terms of contents, it was found that there should be an emphasis on basic financial and health content first, including financial planning, saving money, calculating income-expenses, knowing about fraudsters to prevent financial harm, protecting yourself from infectious diseases, health care and exercise, avoiding addictive substances and knowing how to protect yourself from accidents. Then, when students have basic knowledge Therefore gradually adding more complex content such as investment, interest calculation, using a credit card, calculating the worthiness of purchasing various insurances, etc.

2.2 In terms of learning activities, it was found that there should be designed learning activities that focused on students, were hands-on, and could be applied to students' real life immediately. Allow students to develop advanced thinking processes. Focus on learning that is consistent with the current world situation.

2.3 In terms of learning media, it was found that there should be an emphasis on learning media that was easy to understand, stimulating interest, and modern.

2.4 In terms of measurement and evaluation of learning, it was found that there was a need to design measurement and evaluation in a variety of formats. Emphasis on evaluating according to actual conditions. Choose quality measurement tools that are appropriate for students.

Conclusion

From this research study the researcher summarizes the results of the assessment of the needs needed to enhance financial and health literacy for pre-service teachers in the digital era as follows.

1. Modified Priority Needs Index (PNI_{Modified}) in enhancing financial and health literacy for teaching students in the digital age. The demand index can be arranged in order as follows: No. 1 is the content aspect, No. 2 is the learning measurement and evaluation aspect, No. 3 is the learning activity aspect, and No. 4 is the learning media aspect. When considering each aspect separately, it was found that Content aspect There is the first index of essential needs: financial danger. Measuring and evaluating learning outcomes There is the first index of essential needs: Measuring and evaluating learning through a variety of methods. Learning activities There is the first index of essential needs: The atmosphere in organizing learning activities is fun, relaxed, and not boring. And learning media is the first index of essential needs: The learning materials are creative, challenging and interesting.

2. Opinions and needs for enhancing financial and health literacy for pre-service teachers in the digital era were found content to enhance financial and health literacy should begin with basic content that is easy to understand first. Then it gradually progresses to more complex levels of content. For learning activities, the focus should be on students. Really got to practice and can be used in everyday life. In addition, there should be emphasis on advanced thinking processes that are consistent with the current world situation. Learning media should be easy to understand, interesting, and modern. In addition, there should be a variety of formats in measuring and evaluating learning outcomes. Emphasis on measurement and evaluation according to actual conditions. and choose quality measurement tools suitable for students.

Discussion

From the assessment of the need to enhance financial and health literacy for pre-service teachers in the digital era. The researcher can discuss the results as follows.

1. The results of the assessment of the need for enhancing financial and health literacy for pre-service teachers in the digital era found that current conditions in enhancing financial and health literacy for pre-service teachers in the digital era Overall, it is at a moderate level. expectations for enhancing financial and health literacy for pre-service teachers in the digital era Overall, it is at the highest level. And there is a need to enhance financial and health literacy for pre-service teachers in the digital era ($PNI_{Modified} = 0.37$).

2. The results of the interview to assess the need for enhancing financial and health literacy for pre-service teachers in the digital era found that strengthening financial and health literacy for pre-service teachers in the digital era There is a huge need for pre-service teachers. The content for enhancing financial and health literacy should start with basic content and progress to more complex content. Learning activities should focus on learners and advanced thinking processes that are consistent with the current world situation. Learning media should be easy to understand, interesting, and modern. Measurement and evaluation of learning should have a variety of formats and emphasize measurement and evaluation according to actual conditions.

Therefore, enhancing financial and health literacy for student teachers in the digital age is very important and necessary. Moreover, it is to be basic knowledge for living and leading to the development of one's own quality of life. Financial literacy is one thing that is inevitably important. If a person has good financial literacy, it will enable that person to make good financial decisions in various areas. and resulting in a good quality of life. In addition, enhancing health literacy is equally important. Health literacy should be inclusive of all types of people, occupations and age groups, and should not be focused only on people working in health professions. In addition, health literacy should be promoted from a young age to instill and raise awareness of the importance of health care, disease prevention, and sustainable good health.

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Transforming Traditional EFL Pedagogy with Gamified Techniques: A Teacher's Guide

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Abstract

The purpose of this article is to provide EFL (English as a Foreign Language) teachers with a comprehensive guide to transforming traditional pedagogical approaches through gamified techniques. With today's learners being digital natives who thrive on interactive and dynamic experiences, traditional EFL methods often fail to engage and motivate them effectively. This article is intended for EFL educators, curriculum developers, and institutional leaders seeking innovative strategies to enhance language acquisition and learner engagement.

Gamification, defined as the application of game mechanics and dynamics in non-gaming contexts, has emerged as a promising approach in education. By leveraging intrinsic and extrinsic motivational theories, gamification transforms passive learning into an engaging, participatory process. The article explores the theoretical foundations of gamification, including key principles such as points, badges, leaderboards, quests, and challenges, and how they impact language learning behaviors.

Traditional EFL pedagogy faces numerous challenges, including limited engagement, lack of adaptability to modern learners' preferences, and insufficient focus on collaborative and interactive methods. This article addresses these limitations and highlights how gamified techniques can bridge these gaps. It presents practical, classroom-ready activities such as storytelling, role-playing, and the integration of digital platforms like Duolingo, Kahoot, and Quizizz, alongside non-digital tools like board games and card games.

The guide emphasizes the benefits of gamification, including increased learner motivation, enhanced language skills across listening, speaking, reading, and writing, and the promotion of collaboration and social learning. It also provides strategies for seamlessly integrating gamification into existing curricula, ensuring that educational rigor is maintained.

Recognizing potential challenges, the article discusses strategies for overcoming resistance to change among educators and institutions, balancing entertainment with educational outcomes.

The article concludes by summarizing the transformative potential of gamification in EFL contexts, offering a call to action for educators to experiment with these innovative methods. It envisions future directions for research and practice, encouraging further exploration of gamified strategies to advance EFL teaching.

Keyword Gamification, EFL Pedagogy, Learner Engagement, Innovative Teaching

1. Introduction

Gamification, defined as the integration of game-like elements into non-game contexts, has gained significant traction in educational settings, particularly in English as a Foreign Language (EFL) instruction. It typically involves the use of points, levels, leaderboards, badges, and feedback mechanisms to enhance student engagement and motivation (Zhang & Hasim, 2023; Toda, 2023). The relevance of gamification in education lies in its ability to transform traditional pedagogical approaches into more interactive and enjoyable learning experiences. This transformation is crucial in EFL contexts, where student motivation and engagement are often cited as significant challenges (Asanza, 2024; Simbaña-Simbaña, 2023).

In the realm of EFL, gamification serves as a powerful pedagogical tool that can facilitate language acquisition and skill development. For instance, studies have shown that gamified learning environments can significantly improve students' speaking and writing skills, as they encourage active participation and provide immediate feedback (Díaz, 2023; Simbaña-Simbaña, 2023). Furthermore, gamification has been found to foster a positive learning atmosphere, making the process of learning English more enjoyable and less intimidating for students (Mila & Mahbub, 2022; Phuong, 2020). This is particularly important in EFL settings, where learners may feel anxious about using a foreign language in front of peers (Asanza, 2024; Hersi, 2024).

The rationale for incorporating gamified approaches into EFL pedagogy is multifaceted. First, gamification can enhance intrinsic motivation by making learning tasks more appealing and rewarding (ZEYBEK & Saygı, 2023; Jiménez-Sánchez & Gargallo-Camarillas, 2020). For example, the use of competitive elements such as leaderboards can stimulate a healthy competitive spirit among students, thereby increasing their willingness to engage with the material (Dindar et al., 2020; Biçen & Kocakoyun, 2018). Additionally, gamification can cater to diverse learning styles and preferences, allowing for a more personalized learning experience (Pilař et al., 2019; Spathopoulou, 2024). This adaptability is crucial in EFL classrooms, where students often come from varied linguistic and cultural backgrounds.

Moreover, the implementation of gamification in EFL instruction aligns with contemporary educational trends that emphasize student-centered learning and the integration of technology in the classroom (Shortt et al., 2021; Sari et al., 2021). As digital tools become increasingly prevalent in education, gamified platforms like Duolingo exemplify how technology can be harnessed to create engaging language learning experiences (Shortt et al., 2021). The positive reception of gamified learning by students, particularly in contexts like Vietnam, underscores the growing demand for innovative teaching methodologies that resonate with learners' preferences (Phuong, 2020; Asanza, 2024).

The purpose of this article is to serve as a practical guide for EFL teachers interested in incorporating gamification into their teaching practices. By delving into the theoretical foundations of gamification, including its core principles and the dynamics of intrinsic and extrinsic motivation, the article provides a foundation for understanding how gamified approaches can enhance language learning. It also examines the challenges and limitations of traditional EFL pedagogy, shedding light on why conventional methods may fail to engage modern learners and how shifts in learner preferences necessitate innovative strategies. Furthermore, the article offers detailed insights into gamified techniques, from game mechanics to activity examples. It also introduces practical tools and resources, both digital and non-digital, for seamlessly blending gamification with existing curricula. Additionally, the benefits

of gamification, including enhanced motivation, improved language skills, and collaborative learning opportunities, are explored, along with strategies to overcome challenges in implementation. This comprehensive approach aims to empower EFL teachers to transform their classrooms into dynamic and engaging environments that resonate with today’s learners.

2.Theoretical Foundations of Gamification in EFL

2.1 Core Principles of Gamification: Game mechanics, dynamics, and motivational theories.

Gamification in English as a Foreign Language (EFL) education is grounded in the integration of game mechanics, dynamics, and motivational theories, which collectively enhance learner engagement and educational outcomes. Game mechanics encompass the structured elements of games, such as points, badges, leaderboards, and levels, which provide clear objectives and measurable progress for learners. These elements are essential for creating a framework that guides learners through their educational journey, allowing them to visualize their achievements and set goals for improvement (Pavlas et al., 2010). Game dynamics, in contrast, focus on the emotional and behavioral responses elicited by these mechanics, such as competition, cooperation, curiosity, and achievement. These dynamics are crucial for sustaining learner engagement and commitment to the learning process, as they foster a sense of community and shared purpose among learners (Akman & Ađakır, 2019).

The theoretical underpinnings of gamification are further enriched by motivational theories, particularly Self-Determination Theory (SDT) and Flow Theory. SDT posits that intrinsic motivation is fostered through the fulfillment of three basic psychological needs: autonomy, competence, and relatedness (Reeves, 2017). In EFL contexts, gamification can enhance these needs by allowing learners to make choices in their learning paths, achieve mastery through gamified tasks, and connect socially with peers. This creates an environment conducive to deep engagement and sustained interest in language learning (Duncan & West, 2018). Flow Theory, introduced by Csíkszentmihályi, emphasizes the importance of balancing challenge and skill levels to immerse learners in enjoyable experiences. Gamified tasks designed to maintain this balance can keep learners in an optimal state of engagement, where they are fully absorbed in the learning process (Rosas et al., 2022; , Perttula et al., 2017).

The Role of Intrinsic and Extrinsic Motivation

In terms of motivation, gamification effectively influences both intrinsic and extrinsic motivational pathways in language learning. Extrinsic motivation, driven by external rewards such as badges or leaderboards, can initially capture learners' attention and encourage participation. However, as learners experience progress and mastery, intrinsic motivation may take precedence, leading to personal satisfaction in their language learning achievements (Katuk et al., 2014). This transition is critical, as it fosters a deeper commitment to learning and encourages learners to pursue language acquisition for its own sake rather than for external rewards alone.

Moreover, gamification leverages the psychological effects of reward systems to promote persistence and resilience among learners. Immediate feedback, a core component of gamification, enables learners to identify areas for improvement and fosters a growth mindset (Sedlák et al., 2022). Social elements, such as team challenges and cooperative tasks, enhance relatedness, creating a supportive learning environment where learners feel connected and valued (Perttula et al., 2017). Ultimately, the thoughtful design of gamified activities can positively impact learners’ attitudes, behaviors, and outcomes, making language learning a more engaging and effective process (Zahari et al., 2020).

In summary, the theoretical foundations of gamification in EFL are deeply rooted in the interplay of game mechanics, dynamics, and motivational theories. By understanding and applying these principles, educators can create engaging and effective language learning experiences that foster both intrinsic and extrinsic motivation, ultimately leading to improved learner outcomes.

3. Traditional EFL Pedagogy: Challenges and Limitations

3.1 Limitations of Conventional Methods

Traditional English as a Foreign Language (EFL) pedagogy is often characterized by a reliance on teacher-centered instruction, rote memorization, and textbook-driven curricula. These conventional methods frequently fail to address the diverse needs and preferences of modern learners, particularly in a globalized context where effective communication is crucial. The emphasis on repetitive grammar drills and vocabulary lists can lead to disengagement, as students may find these approaches monotonous and uninspiring. Research indicates that such methods can stifle learners' confidence in their communicative abilities, as they often prioritize accuracy over fluency, which is essential for real-world language use (Ahmed & Akyildiz, 2022). This disconnect between traditional pedagogical practices and the actual needs of learners highlights the inadequacies of conventional EFL methods in fostering a meaningful and engaging learning environment.

Moreover, traditional EFL classrooms often lack interactivity and fail to promote learner autonomy, which are vital for effective language acquisition. The rigid nature of these methods limits opportunities for personalization and does not incorporate multimodal resources that align with learners' varying learning styles and technological inclinations. Studies have shown that EFL teachers face challenges related to inadequate resources and support, which further exacerbates the limitations of conventional methods (Ahmed & Akyildiz, 2022). In a rapidly changing educational landscape, where critical thinking, creativity, and cultural competence are increasingly important, traditional approaches often fall short in developing these essential skills among learners. As a result, there is a pressing need for EFL educators to explore more innovative and flexible teaching strategies that can better engage students and meet their diverse needs.

3.2 Shifts in Learner Preferences

The emergence of digital natives—learners who have grown up in an environment saturated with technology—has significantly influenced preferences in language learning. These learners are accustomed to engaging with content that is interactive, immediate, and visually appealing. Unlike previous generations, digital natives expect to access information on-demand and participate in collaborative digital platforms. This shift underscores a growing preference for dynamic, learner-centered approaches that integrate technology into the learning process. Tools such as language apps, virtual reality experiences, and online collaborative platforms resonate more deeply with these learners, offering interactive and immersive experiences that traditional EFL pedagogy often lacks (Selwyn, 2010; Muslimin, 2023). Consequently, the static, one-size-fits-all nature of conventional methods struggles to capture the attention of modern learners, necessitating a reevaluation of pedagogical practices.

Furthermore, the integration of technology into EFL teaching has been shown to enhance student engagement and motivation. Research indicates that when technology is effectively implemented by digitally literate teachers, it can positively impact the learning experience for both teachers and students (Ahmed & Akyildiz, 2022; Zhao, 2023). The potential of technology to facilitate personalized learning experiences aligns with the

preferences of digital natives, who thrive in environments that allow for exploration and creativity. As educators recognize the importance of adapting to these shifts in learner preferences, there is an increasing emphasis on developing digital literacy skills among both teachers and students. This focus on technology integration not only addresses the limitations of traditional methods but also prepares learners for the demands of a rapidly evolving global landscape (Zhao, 2023; Batubara, 2021).

In conclusion, traditional EFL pedagogy faces significant challenges and limitations that hinder its effectiveness in meeting the needs of modern learners. The reliance on teacher-centered instruction, rote memorization, and rigid curricula fails to engage students and foster essential skills necessary for success in a globalized context. As learners increasingly seek dynamic and interactive educational experiences, EFL educators must reevaluate their pedagogical approaches, integrating technology and promoting learner autonomy to create more engaging and effective language learning environments. By embracing innovative teaching methods that cater to the diverse needs of students, educators can better prepare learners for the complexities of communication in an interconnected world.

4. Gamified Techniques in EFL Classrooms

4.1. Game Mechanics in Language Teaching: Points, badges, leaderboards, quests, and challenges.

The integration of game mechanics in English as a Foreign Language (EFL) classrooms is designed to transform traditional learning activities into engaging and interactive experiences. Key elements such as points, badges, leaderboards, quests, and challenges play a crucial role in encouraging active participation and sustained motivation among learners. Points can be awarded for completing tasks, answering questions, or achieving specific milestones, creating a system of instant feedback that allows students to track their progress effectively. Badges serve as tangible representations of achievements, fostering a sense of accomplishment and competence among learners. Research indicates that these gamified elements can significantly enhance motivation and engagement in language learning contexts, as they provide clear goals and rewards that resonate with students' intrinsic motivations (Díaz, 2023; Zhang & Hasim, 2023).

Leaderboards introduce a competitive aspect to the learning environment, motivating learners to strive for higher performance while fostering a sense of camaraderie among peers. This competitive element can be particularly effective in promoting engagement, as students often feel encouraged to improve their skills to climb the ranks. Quests and challenges, on the other hand, mimic real-world scenarios or thematic storylines, engaging learners in problem-solving and critical thinking while applying language skills in meaningful contexts. For instance, students might embark on a quest that requires them to write dialogues or solve riddles, thereby enhancing their language proficiency in an enjoyable manner. These mechanics not only enhance motivation but also provide opportunities for learners to develop autonomy, collaboration, and resilience in their language acquisition journey (Mila & Mahbub, 2022; Phuong, 2020).

4.2 Examples of Gamified Activities in EFL Classrooms

Gamified activities in EFL classrooms effectively utilize these mechanics to make language learning both enjoyable and productive. Vocabulary-building applications such as Quizlet and Duolingo exemplify this approach, employing point systems and streak tracking to encourage daily practice and consistency. These platforms not only make learning more

engaging but also allow learners to see their progress in real-time, reinforcing their commitment to language acquisition. Interactive storytelling activities can take the form of quests, where learners navigate a narrative by completing tasks that require them to use their language skills creatively. Such activities not only enhance vocabulary and grammar but also foster critical thinking and collaboration among students (Hope et al., 2022).

In collaborative settings, team-based challenges might include escape room-style activities where students decode clues in English to "unlock" the next stage of the game. This format encourages teamwork and communication, essential components of language learning. Classroom-wide leaderboards can track participation in speaking activities or quiz competitions, fostering healthy competition and motivating students to engage more actively in their learning. Additionally, awarding badges for milestones such as "Best Pronunciation" or "Grammar Guru" adds a layer of recognition that boosts learner confidence. By embedding these gamified elements into lesson plans, educators create an immersive environment that aligns with the preferences and learning styles of modern students, ultimately enhancing language acquisition and retention (Pinto et al., 2021; Trinidad et al., 2021).

In conclusion, the integration of gamified techniques in EFL classrooms presents a promising approach to enhancing learner engagement and motivation. By incorporating game mechanics such as points, badges, leaderboards, quests, and challenges, educators can transform traditional language learning into dynamic and interactive experiences. These elements not only foster a sense of accomplishment and competition but also encourage collaboration and critical thinking among students. As research continues to support the effectiveness of gamification in language education, it is essential for EFL educators to embrace these innovative strategies to meet the diverse needs of their learners and create a more engaging and effective language learning environment.

5. Practical Tools and Resources for Gamified EFL Learning

5.1 Digital Platforms for Gamification: Duolingo, Kahoot, Quizizz, and other tools.

Gamification in English as a Foreign Language (EFL) learning has gained significant traction through both digital and non-digital platforms, enhancing student engagement and language acquisition. Digital platforms such as Duolingo, Kahoot, and Quizizz have transformed traditional language learning by integrating game-like elements that foster motivation and competition among learners. For instance, Liu's research highlights that digital gamified language learning significantly improves language achievement and enjoyment among EFL learners, outperforming non-digital methods (Liu, 2024). Similarly, Pham's study indicates that tools like Quizizz enhance grammar achievement and increase student motivation and comprehension of English concepts (Pham, 2023). The competitive features of these platforms, such as points, leaderboards, and rewards, create an engaging environment that encourages learners to practice language skills independently, as noted by Kamsik, who emphasizes the effectiveness of Duolingo in developing language skills through instant feedback and varied tasks (Kamsik, 2023).

5.2 Non-Digital Approaches: Board games, card games, and classroom challenges.

In addition to digital tools, non-digital gamification strategies, including board games and classroom challenges, play a crucial role in EFL learning. These methods promote face-to-face interaction, which is essential for developing speaking and listening skills in a supportive environment. Hashim's research suggests that non-digital approaches, such as board games, can facilitate language use in a low-pressure context, reinforcing vocabulary and grammar in a fun and engaging manner (Hashim, 2023).

5.3 Blending Gamification with Existing Curricula

To effectively integrate gamification into existing curricula, educators can align gamified activities with established learning objectives. This approach allows for the reinforcement of traditional teaching methods while enhancing student engagement. For example, using a Kahoot quiz for lesson reviews or incorporating a vocabulary card game as a warm-up activity can maintain curricular consistency while promoting active learning (Pham, 2022). Research by Boudadi supports this notion, indicating that gamification can lead to improved learning outcomes when effectively aligned with educational goals (Boudadi, 2020). By focusing on measurable outcomes, such as vocabulary retention and grammatical accuracy, educators can ensure that gamified elements serve as valuable tools for reinforcing language skills rather than replacing conventional teaching practices.

In conclusion, the integration of gamification into EFL learning through both digital and non-digital platforms offers a multifaceted approach to enhancing language acquisition. The combination of engaging digital tools and interactive non-digital strategies provides a comprehensive framework that caters to diverse learning environments and student needs. As educators continue to explore these innovative methods, the potential for improved language outcomes and increased student motivation remains promising.

6. Benefits of Gamification in EFL Contexts

6.1 Enhanced Engagement and Motivation

The integration of gamification into EFL classrooms has been shown to significantly boost student engagement and motivation. By incorporating game elements such as points, badges, and leaderboards, educators create a stimulating learning environment that captivates students' interests. Research indicates that gamified learning experiences can lead to increased student participation and enthusiasm, as evidenced by Zhang and Hasim's systematic review, which highlights the positive impact of gamification on student engagement (Zhang & Hasim, 2023). Furthermore, studies have demonstrated that gamification not only incentivizes active participation but also cultivates a sense of achievement, which is crucial for maintaining motivation in language learning (Asanza, 2024). For instance, activities like "Kahoot" and vocabulary-building games have been shown to enhance students' attention spans and foster a more positive attitude towards learning English (Mila & Mahbub, 2022; Membrive & Armie, 2020).

6.2 Improved Language Skills

Gamification also serves as an effective method for enhancing various language skills, including listening, speaking, reading, and writing. Games often simulate real-life scenarios, providing learners with opportunities to practice their language skills in meaningful contexts. For example, role-playing games encourage students to engage in authentic dialogues, thereby improving their speaking abilities (Aguilar et al., 2023). Additionally, story-based games like "Duolingo Stories" enhance reading comprehension through narrative-driven tasks (Reis et al., 2023). Empirical evidence supports the effectiveness of gamified activities in language proficiency assessments, indicating that students engaged in these activities consistently outperform their peers (Demirbilek et al., 2022). Moreover, gamification can facilitate listening skills through activities that involve deciphering audio clues or following spoken instructions, while writing skills can be reinforced through collaborative story creation (Hassan et al., 2023).

6.3 Collaboration and Social Learning

One of the most profound benefits of gamification in EFL contexts is its ability to foster collaboration and build a sense of community among learners. Many gamified activities require students to work in teams or compete in a respectful manner, which enhances language practice and encourages peer learning (Krishnan et al., 2021). For instance, team-based challenges such as "Escape Room" games necessitate that students pool their linguistic knowledge and problem-solving skills to achieve common goals, creating a supportive environment where learners feel confident to take risks and practice new language constructs (Asiri, 2019). This collaborative aspect not only enhances the overall learning experience but also contributes to a more cohesive classroom dynamic, ultimately leading to improved language acquisition outcomes (Putra & Priyatmojo, 2021).

In conclusion, the benefits of gamification in EFL contexts are manifold, encompassing enhanced engagement and motivation, improved language skills, and increased collaboration among learners. As educators continue to explore and implement gamified strategies, the potential for transformative learning experiences in language education becomes increasingly evident.

7. Addressing Challenges in Implementing Gamification

7.1 Overcoming Resistance to Change

Implementing gamification in English as a Foreign Language (EFL) context presents several challenges, particularly in overcoming resistance to change among educators and institutions. Educators often exhibit reluctance to adopt gamified approaches due to their familiarity with traditional pedagogical methods and a lack of confidence in utilizing technology effectively. This resistance can be compounded by institutional hesitance to invest in gamification tools or training, often stemming from perceived risks and budget constraints. To address this resistance, it is crucial to emphasize professional development and showcase the tangible benefits of gamification. Workshops and training sessions can equip educators with the necessary skills and confidence to integrate game-based strategies effectively into their teaching practices (Mila & Mahbub, 2022; Helvich et al., 2023). Furthermore, sharing evidence-based success stories and outcomes from pilot programs can demonstrate the potential of gamification to enhance learning outcomes, thereby fostering institutional support (Zhang & Hasim, 2023; Spathopoulou, 2024).

7.2 Avoiding Common Pitfalls: Balancing fun and educational rigor.

In addition to overcoming resistance, educators must also navigate common pitfalls associated with gamification. While gamification can significantly enhance student engagement and motivation, an overemphasis on entertainment can dilute educational objectives, ultimately undermining the effectiveness of the approach (Hellberg & Moll, 2023; Park & Kim, 2022). For instance, excessive focus on rewards and competition might distract students from the core language skills being developed. To mitigate these risks, educators should design gamified activities that align closely with curriculum goals and emphasize meaningful learning experiences (Díaz, 2023). Incorporating reflective components, such as post-game discussions or analyses, can help students connect their in-game achievements with language development, reinforcing the educational purpose of the gamified activities (Nitiasih & Budiarta, 2021). Moreover, continuous monitoring and careful planning of gamified

activities can help maintain a productive balance, ensuring that the focus remains on fostering long-term language acquisition (Rodrigues et al., 2022).

In summary, addressing the challenges of implementing gamification in EFL contexts requires a multifaceted approach that includes professional development for educators, strategic planning to align gamified activities with educational objectives, and ongoing evaluation of the effectiveness of these strategies. By fostering a supportive environment and ensuring that gamification is purposefully integrated into the curriculum, educators can enhance student engagement and improve language learning outcomes.

8. Conclusion

The integration of gamification into English as a Foreign Language (EFL) teaching has demonstrated remarkable potential to transform traditional learning environments. By leveraging game-based elements, educators can significantly enhance learner engagement, motivation, and language acquisition across listening, speaking, reading, and writing skills. Moreover, the collaborative and social aspects of gamified activities create a supportive community, fostering both academic and interpersonal growth among students. Addressing challenges, such as resistance to change and maintaining educational rigor, underscores the importance of thoughtful implementation and continuous adaptation.

EFL educators are encouraged to explore the possibilities of gamification as a dynamic and effective pedagogical tool. Starting small, such as incorporating gamified quizzes or role-playing scenarios, can provide valuable insights and build confidence in this approach. Collaboration with peers and participation in professional development opportunities can further enhance teachers' ability to design and implement impactful gamified learning experiences. By embracing innovation and experimenting with gamification, teachers can unlock new pathways to inspire and empower their students.

The future of gamified EFL teaching offers exciting opportunities for exploration and innovation. Advancements in technology, such as augmented reality (AR) and artificial intelligence (AI), can create even more immersive and personalized learning experiences. Additionally, research into the long-term impacts of gamification on language proficiency and learner autonomy could provide valuable guidance for educators and policymakers. As the field continues to evolve, the integration of gamification with other emerging pedagogical trends promises to shape a vibrant and engaging future for EFL education.

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Mini Riview: Assessment in education

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Abstract

Assessment in education is an important part of the teaching process. This article presents an overview of assessment in education and its development trends in the world. This emphasizes the importance of having more in-depth research on assessment in education to improve the quality of the teaching process. The method used in this study is: Feces Analyze, synthesize and compare information to evaluate and make conclusions considered valuable. The research results are useful for new researchers on assessment in education, helps them have an overview and direction for their work his research.

Keyword Assessment, Education, Development Trends, Teaching Process

1. Introduction

Assessment is a critical and integral part of education and continuous improvement. Effective educational systems must use reliable, valid, fair and relevant assessments that convey accurate information about student learning to educators and other stakeholders.

Assessment is commonly discussed as a matter of teaching and learning. However, assessment carries a more profound social function. Through assessment, students become known. Assessment provides students with the means to know themselves (Barrow, 2006).

Assessment is a powerful learning tool that can enhance learning and education. The process of student assessment should align with curricular goals and educational objectives. Identifying the assessment strategies necessary for the proper evaluation of students' progress within individual programs is as important as establishing curricular content and delivery methods (Carmen Fuentealba, 2011).

This short review article aims to provide readers with an overview of the role of assessment in education. The article will also emphasize to the trend of assessment innovation in education in countries around the world.

2. Materials and Methods

- Synthesis method: The study uses this method to collect data and information on assessment in education and trends in innovation in assessment activities in education from countries around the world, which are synthesized from research published in prestigious scientific journals around the world.

- Analytical techniques: This study analyzes previously published documents on assessment in education. This allows us to assess the current state of research, focusing on complex problems, unresolved issues in this topic.

3. Findings and discussion

3.1. Concepts of assessment

Currently, there are many concepts about assessment in education. Some of the following concepts can be mentioned:

(i) Assessment involves the use of empirical data on student learning to refine programs and improve student learning (Allen, 2004).

(ii) Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning (Huba and Freed, 2000).

(iii) Assessment is the systematic basis for making inferences about the learning and development of students. It is the process of defining, selecting, designing, collecting, analyzing, interpreting, and using information to increase students' learning and development (Erwin, 1991).

(iv) Assessment is the systematic collection, review, and use of information about educational programs undertaken for the purpose of improving student learning and development (Palomba and Banta, 1999).

Although assessments used in various contexts and for differing purposes often look quite different, they share certain common principles. One such principle is that assessment is always a process of reasoning from evidence. By its very nature, moreover, assessment is imprecise to some degree. Assessment results are only estimates of what a person knows and can do (James W. Pellegrino, Naomi Chudowsky, and Robert Glaser, 2001).

3.2. Classification of assessment in education

Currently, in documents and research there are many ways to classify values in education. According to Mhiri McAlpine (2002), based on the purpose of assessment, we will design assessments accordingly. Some of the main types of assessments include the following:

(i) Formative or Summative

Formative assessment is designed to assist the learning process by providing feedback to the learner, which can be used to highlight areas for further study and hence improve future performance. Self and diagnostic assessment are types of formative assessment with specific purposes. Summative assessment is for progression and/or external purposes, given at the end of a course and designed to judge the students' overall performance

(ii) Formal or Informal

Formal assessments are where the students are aware that the task that they are doing is for assessment purposes. With informal assessment the judgements are integrated with other tasks.

(iii) Final or Continuous

Final (terminal) assessment is that which takes place only at the end of a course while continuous assessment is scattered throughout the course.

(iv) Process or Product

With the rapidly changing nature of modern society, increased emphasis is being placed on skills and abilities rather than knowledge. It is therefore important to consider whether you wish to assess the product of student learning, or the process undertaken

(v) Convergent or Divergent

Convergent assessments are those which have one correct answer that the student is trying to reach. Divergent assessments appreciate a range of answers based on informed opinion and analysis.

According to Tran Trung Tinh (2020), there are six types of assessment in education including:

- Classification based on assessment purpose: (i) Placement assessment; (ii) Diagnostic assessment; (iii) Change assessment.

- Classification based on the time of assessment: (i) Formative assessment; (ii) Summative assessment.

- Classification based on control objects: (i) norm - referenced assessment; (ii) referenced assessment.

- Classification based on assessment scale: (i) Large scale assessment; (ii) Classroom assessment;

- Classification based on assessment participants: (i) self assessment; (ii) peer assessment; (iii) group assessment.

- Classification based on assessment type: (i) Paper Testing; (ii) Authentic assessment.

Although there are many different types of assessment in education. However, the choice of assessment form will depend greatly on the assessment objective. As we know, no type of assessment has absolute advantages. Therefore, to increase the reliability and value of assessment results, it is necessary to coordinate many different forms of assessment.

3.3. Trends in assessment

a) Expansion of educational assessment in school systems

(i) Increased prominence of assessment in education policy

It is apparent that education policy is increasingly conferring a central strategic role to assessment as indispensable tools for improvement, accountability, educational planning and policy development. In the last two decades, most countries have introduced a wide range of measures intended to improve assessment at all levels from the student to the school system itself. These have done much to stimulate public awareness of assessment and to develop an evaluation culture within school systems.

(ii) Creation of dedicated agencies as part of new approaches to govern assessment

In many, the greater importance of assessment in education policy has involved the creation of specifically dedicated agencies which assume a central role in the governance of the assessment framework

b) Greater variety of assessment activities

The expansion of educational evaluation was accompanied by considerable diversification of assessment activities. Although educational evaluation within school systems is not a recent concern, it has traditionally focussed mostly on the assessment of students. As will be evident in subsequent chapters of this report, in recent years, countries are increasingly developing more comprehensive assessment frameworks with more resources devoted to assessment components other than student assessment.

c) The rise of educational measurement and indicators development

(i) Student outcomes as the focal point for analysis

A major benefit of the stronger emphasis on evaluation and assessment has been the greater focus on improving student outcomes and achieving student learning objectives. This is reflected in the growing importance of student outcomes for system evaluation (increasingly relying on results of standardised student assessment and the international assessment of students), school evaluation (with school accountability increasingly tied to student outcomes) and teacher appraisal (with the exploration of direct links to student progress); the requirements for reporting publicly on student results; and the establishment of education national targets for student achievement including for particular groups of students. Performance in schools is increasingly judged on the basis of effective student learning outcomes. This is part of the general shift to outcome measures in the public sector. There is a greater emphasis on the use of student achievement data both to understand the balance between school, student and contextual data and to look at the school processes that appear to support improved achievements (Campbell and Levin, 2009).

(ii) The growing emphasis on measuring student outcomes

The introduction of national standardised assessments for students in a large number of countries reflects the stronger focus on measuring student outcomes. These make data on student learning outcomes available, providing a picture of the extent to which student learning objectives are being achieved, and they grant the opportunity to compare student learning outcomes across individual schools, regions of the country and over time. As put by Kellaghan and Greaney (2001), “The most remarkable development in assessment towards the end of the 20th century has probably been the growth in its use to measure the achievement outcomes of national systems of education, either considered uniquely (in national assessments) or in the context of the performance of other education systems (in international comparative studies of achievement).”

(iii) The proliferation of education indicators

For the purpose of monitoring education systems and evaluating school performance, data are increasingly complemented by a wide range of education indicators based on demographic, administrative and contextual data collected from individual schools. Datasets typically include information on students (type of enrolment, completion, absenteeism, age, gender, marks, socio-economic background), teachers (functions, qualifications, career status, age, gender, areas taught, teaching hours, absenteeism, remuneration), non-teaching staff (qualifications, age, gender, category), and schools (financial management, use of technology, organisation of learning). The emphasis is increasingly on output measures.

d) Larger and more varied uses of assessment results

Countries are giving a more varied use to evaluation and assessment results, including as a tool for understanding better how well students are learning, for providing information to parents and society at large about educational performance and for improving school and teaching practices. As will be analysed below, an increasingly marked focus is the use of evaluation and assessment results to hold policy makers, school leaders and teachers accountable. There is also a growing use of evaluation as a system steering tool. As put by Broadfoot and Black (2004), “In recent years the importance of assessment as a policy tool has grown enormously as governments have increasingly come to realise its powerful potential as a mechanism of state control.” Evaluation procedures are now increasingly being considered as potential levers of change that can assist with decision making, resource allocation or school improvement.

e) The growing prominence of accountability as a purpose of assessment

Countries are increasingly using evaluation and assessment for accountability purposes. A central assumption in accountability is that substantial improvement necessitates that the school agents are held accountable for the outcomes they generate. By measuring student outcomes and holding teachers, schools and policy makers responsible for results, accountability systems intend to create incentives for improved performance and identify underperformance within school systems. Hargreaves and Shirley (2009), in their analysis of educational reforms, maintain that countries have gradually shifted from local and sampled assessments to high-stakes census testing for accountability purposes. Klenowski and Wyatt-Smith (2012) point to the political appeal of school-based accountability policies, in the sense of the clear need for politicians to be seen to deliver improved outcomes in education. Broadfoot and Black (2004) note, for example, that “decisions about assessment procedures – particularly those concerning high-stakes testing of various kinds – are as often based on perceived political appeal as they are on a systematic knowledge on the scientific evidence concerning fitness for purpose” (as cited in Klenowski and Wyatt-Smith, 2012).

f) Greater reliance on educational standards

The focus on student learning outcomes has, in many countries, driven the establishment or underlined the importance of educational standards for the quality of the work of schools and school agents, and encouraged means for monitoring progress towards those standards. Educational standards refer to descriptions of what students should know (content standards) and be able to do (performance standards) at different stages of the learning process. In many countries, there is growing emphasis on the development and use of ambitious educational standards as the basis of assessment and accountability. By creating a set of standards against which student performance can be measured, countries aim to assess students against a desired measurable outcome. Examples of countries which implemented national educational standards are Australia, Austria, Belgium, Denmark, France, Luxembourg, Norway, the United Kingdom and the United States. By setting national or common standards, student outcomes can be more easily controlled for quality and they are more comparable (Wang et al., 2006). The movement towards comparing student outcomes to standards also has had a role in motivating countries to administer national standardised assessments.

g) Internationalisation of assessment

National education debates are increasingly shaped by international comparisons, particularly of student performance in international student surveys. These include student assessments conducted by the International Association for the Evaluation of Educational Achievement (IEA), the OECD’s Programme for International Student Assessment (PISA) or UNESCO’s Latin American Laboratory for Assessment of the Quality of Education (LLECE). As explained by Bonnet (2004), “The conception of educational evaluation has changed over the years, moving from an essentially national to a more international perspective. It has also taken a new dimension with the fundamental role it now plays in Europe. In parallel with national developments countries started to show interest in comparative evaluation at the international level.” Some education systems have been considerably shaken after publication of international comparative scores.

h) Greater technological sophistication

The expansion of assessment, particularly the spreading out of standardised student assessment, as well as the management of the data it generates has greatly benefited from greater capacity of information and communication technologies. Improvements include more individualised assessment approaches, better assessment of cognitive skills such as problem

solving, capacity for rapidly marking large-scale assessments, reliability in marking and reduced cost to administer student assessment.

4. Conclusion

Assessment is an important part of the educational process. Although there are many different concepts and classifications of assessment, in general assessment must be based on educational goals and authentic evidence, ensuring reliability.

A balanced system of assessment provides feedback to students on how well they are mastering a defined set of skills and knowledge, and points them to ways in which they can improve. A good system can let teachers know how well they and their students are doing, and help identify ways to better deliver and tailor instruction. It can tell parents and other caretakers how well students are performing, and enable them to better support children at home and in other settings outside of school. It can help administrators and education officials to understand the strengths and weaknesses of their schools and school systems, as well as in the performance of individual teachers – and to take actions that help build student success. It can inform policy makers about challenges in their education system, allowing them to develop policies that reinforce performance, and to situate these interventions in a broader policy context. And finally, a sound system of student assessment can ensure accountability to members of the general public, providing assurance that investments are being well spent and providing a sense of where, as concerned citizens, they may need to intervene.

To improve the value of assessment activities in education, it is necessary to carry out many synchronous solutions such as: changing policies, coordinating many different forms of assessment, applying technology in assessment, etc.

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Investigation of needs for developing professional learning communities in schools under Nakhon Phanom Education Area District Office 1

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Abstract

This research aimed to: (1) examine the current state and desired conditions for developing professional learning communities (PLCs) in schools under the jurisdiction of the Nakhon Phanom Primary Educational Service Area Office 1, and (2) explore the need for developing PLCs in primary schools, categorized by gender, educational qualifications, and school sizes. The population consisted of 1,885 teachers from 248 schools under the Nakhon Phanom Primary Educational Service Area Office 1 during the 2024 academic year. The sample size was determined using Krejcie and Morgan's table, with stratified random sampling by school size, proportional adjustment, and simple random sampling without replacement, resulting in a sample of 320 participants. The research instrument was a set of questionnaires with an overall reliability of 0.98. Statistical analyses included mean, standard deviation, and the Priority Needs Index (PNI). The findings revealed the following: 1) The overall current condition of PLC development in schools was at a high level across all five dimensions. The desired condition for PLC development was rated at the highest level in all dimensions. 2) The most critical need for developing PLCs was the provision of a supportive environment, followed by (a) experience sharing, (b) creation of shared values and vision, (c) collaborative learning and application, and (d) providing support and collaborative leadership.

Keywords: Needs, Professional learning community

Introduction

The development of Professional Learning Communities (PLCs) is guided by the National Education Act B.E. 2542 (1999) and its amendments (B.E. 2545 (2002). Section 10 of the Act stipulates that the provision of education must ensure equal rights and opportunities for individuals to receive a minimum of twelve years of basic education, which the state is responsible for delivering comprehensively and with quality, free of charge. Section 22 further emphasizes that every learner is capable of learning and developing, and education must foster each learner's natural potential. All teachers must find methods that help every student learn according to the principles outlined in the Act.

One of the innovative practices teachers must embrace is the concept of Professional Learning Communities (PLCs), which refers to the collective, collaborative, and supportive

efforts of teachers, administrators, and educational professionals working together based on a culture of mutual respect and shared vision, values, goals, and missions. Teachers lead collaborative learning, while administrators provide supportive guidance, driving the development of professional skills and improving educational outcomes. The focus is on enhancing student success and achieving a high-quality learning environment.

The Nakhon Phanom Primary Educational Service Area Office 1 operates under the policies of the Ministry of Education and the Office of the Basic Education Commission. This office has established a vision to create a quality organization that produces morally upright, excellent, and happy individuals. The term "quality organization" encompasses the Nakhon Phanom Primary Educational Service Area Office 1 and its affiliated schools, which must be agencies of high quality, with six key components: Q-Coach, Q-Active Learning, Q-Technology and Innovation, Q-Empowerment, Q-PLC, and Q-Network. Currently, the office oversees 248 schools. During the management and educational oversight, including field visits and monitoring of teachers' instructional practices, it was found that many schools, particularly small ones (66.67% of which are small-sized), face challenges in administration and management. Issues include budget constraints and inadequate infrastructure, with allocated budgets often falling short of planned amounts. Additionally, teacher-related problems include shortages, teachers teaching outside their subject expertise, and a lack of necessary knowledge and skills to focus on student-centered learning. Furthermore, national academic performance remains low across all subjects when compared at the national level (Nakhon Phanom Primary Educational Service Area Office 1, 2024).

Given these principles and challenges, the researcher is interested in exploring current and desired conditions and needs for developing PLCs in primary schools within the Nakhon Phanom Primary Educational Service Area Office 1. This study aims to foster cooperation in driving the development of schools into learning communities in line with national policies, ultimately enhancing student achievement, enabling learners to realize their potential, and improving the efficiency, sustainability, and effectiveness of educational management.

1. Research objectives

1. To investigate the current and desired conditions in the development of Professional Learning Communities (PLCs) within schools under the jurisdiction of the Nakhon Phanom Primary Educational Service Area Office 1.
2. To explore the need for developing Professional Learning Communities (PLCs) within schools under the jurisdiction of the Nakhon Phanom Primary Educational Service Area Office 1.

2. Review of Related Literature

2.1 Professional Learning Community (PCL)

The concept of a Professional Learning Community (PLC) is rooted in the business sector, focusing on the organization's capacity for learning. The implementation of PLC leads to improvements in both teaching quality and student outcomes (Puangsomjit, 2015; Hord, 1997, as cited in the Office of the Basic Education Commission, 2017). A Professional Learning Community should exhibit the following essential characteristics: 1) Positive relationships and a harmonious environment, 2) Enthusiasm and commitment to the profession, 3) Altruism and academic collaboration, and 4) The capacity to drive professional transformation

Research highlights that guidelines for PLCs in primary schools emphasize shared leadership, teamwork, structural support, a shared vision, and professional development (Karawong & Roopaen, 2024). Similarly, Saengsahwang and Ruangmontri (2020) developed

PLC guidelines for primary school teachers in Yasothon, outlining six key aspects with 29 strategies, including shared vision and values, collaborative teamwork, and shared leadership. Likewise, Warunya Najaitrukong and Wichian Rooyueny (2024) found that there were six developmental guidelines with 28 approaches for guidelines for developing PLCs in the new normal era of primary schools in Khon Khen. The guidelines comprised: 1) professional learning and development in the new normal era, 2) co-promoting a caring community, 3) positive shared leadership, 4) supportive structure, 5) collaborative teamwork, and 6) shared vision. In the international context, Aikaterini Balasi and Georgios Lordanidis (2024) investigated the level of PLCs, teachers' professional development, and their relationship in 428 Greek primary schools. The study found that primary schools function as PLCs but remain at an initial stage, lacking maturity. Teachers' PD focuses more on content than research, assessment, or learning communities. The weak, non-significant correlation between PLCs and PD indicates limited job-embedded PD, leading teachers to rely on individual efforts rather than school-wide needs or development.

Extensive research on PLCs also indicates that collaborative group work benefits both educators and students. The establishment of a learning community helps mitigate teachers' feelings of isolation, fosters professional development, and leads to improvements in teaching practices and student achievement (Hord, 1997, as cited in the Office of the Basic Education Commission, 2017). The formation of various groups or teams, such as Critical Friends Groups, Peer Coaching Teams, and Committees, is a critical approach to the development of PLCs (Nantaphong, 2018). Thus, the concept of a Professional Learning Community integrates the idea of a learning organization within schools, facilitating transformative changes in professional practices and student achievement (Phechnawa, 2020).

Researchers have defined the key characteristics of effective PLCs as follows: mutual trust and respect, support challenge and constructive critique, shared vision and focus on learning for all learners, collaborative and reflective inquiry, inclusive membership, leadership, collective responsibility for student learning, coherent, responsive change in practice, regularity, and systematic, rigorous inquiry into practice (Basic Education Department, Republic of South Africa 2015).

2.2 Challenges to PLCs in School Settings

In the literature, several factors are mentioned that influence the development of PLCs. Challenges to PLCs in schools have been documented. For example, the study by Hairon, Goh, & Abbas (2014) revealed that teachers often struggle to find time within the school day to implement new practices, and to engage in in-depth discussions on teaching and learning. Many schools are not accustomed to participative and collaborative processes because of the hierarchical structure and culture of schools. However, teachers are encouraged to choose their groups in terms of interest. The lack of leadership supporting learning communities has also been identified as a challenge. The participants expressed the need for more optimal use of senior teachers and experienced mentors to contribute to PLC activities.

Haujboom et al. (2021) identified 13 factors influencing PLC development in Dutch schools, including school leader support, facilitator contribution, time and space for meetings, and alignment with school development. Their study found positive development in all seven PLCs, though Reflection, Feedback, and Experimenting showed more limited progress compared to Collaboration. Although interest in PLCs is increasing in Dutch education, they remain uncommon, likely due to the challenge of balancing individual and collective autonomy. While teachers prioritize their independence, collaboration is also strongly encouraged, creating tension that may hinder PLC support in schools.

Similarly, teacher collaboration is not a new concept in South African education, yet in many schools, PLCs are either absent or do not effectively support teacher learning.

Furthermore, Tayag (2020) revealed that The study identifies four key challenges teachers face in participating in PLCs: workload and time constraints, low trust among colleagues, conflicts with ranking and promotion systems, and a lack of appreciation for PLC benefits. These issues stem from school operations and culture. However, PLCs also present opportunities, including enhanced learning strategies and materials, support for new teachers, improved communication between school leaders and teachers, and more relevant discussions on school and student issues. School leaders can leverage these opportunities to strengthen professional development initiatives. Addressing these challenges and opportunities can enhance the effectiveness of PLCs in supporting teacher growth.

Likewise, the study by Balasi and Lordanidis (2024) found that Greek primary schools operate as PLCs but remain at an early implementation stage, lacking cultural refinement and maturity. Teachers' professional development (PD) primarily focuses on content knowledge, while research, assessment, and learning communities receive less attention. Schools provide limited job-embedded PD, leading to a weak and negative correlation between PLCs and PD. As a result, teachers rely on personal initiatives for PD rather than school-driven learning and development. This disconnect hinders the effectiveness of PLCs in fostering continuous professional growth.

In the Thai context, the study on PLCs within educational institutions under the Office of Khon Kaen Primary Educational Service Area 2 found that professional learning and development opportunities are limited. Encouraging PLC activities can enhance teaching practices, improve student outcomes, and guide future improvements, requiring active participation from administrators and teachers in sharing knowledge and exchanging ideas (Najaitrunk & Rooyuenyong, 2024).

In conclusion, effective Professional Learning Communities (PLCs) in primary schools are built on shared leadership, collaborative teamwork, a shared vision, supportive structures, and a focus on professional development. Research highlights the importance of fostering positive relationships, promoting collaborative practices, and embedding professional growth within school-wide needs. While PLCs have the potential to enhance teaching practices and student outcomes, challenges such as limited maturity and reliance on individual initiatives persist. Collaborative groups, such as Critical Friends Groups and Peer Coaching Teams, are essential for sustaining PLCs and driving professional transformation. By integrating the principles of learning organizations, PLCs enable schools to achieve meaningful improvements in both teaching quality and student achievement.

Research Methodology

1. The research procedure includes:

The key findings reported in this paper were drawn from quantitative data.

2. Research instruments

The data collection instrument used in this study was a questionnaire regarding the current and desired conditions of PLCs in primary schools under the Nakhon Phanom Primary Educational Service Area Office 1. The questionnaire consists of 20 items across 5 content areas. The instrument was developed by the researcher and subjected to content validity (CV) checks by three experts. The revised version of the questionnaire was then tested (Try-Out) with a sample of 30 teachers working in primary schools. The reliability of the instrument was analyzed using Cronbach's alpha coefficient, which resulted in a reliability score of .98 for the entire questionnaire.

The analysis of the data from the respondents involved examining general information and questionnaire responses regarding the need for the development of PLCs. The data was analyzed using the mean and standard deviation for the overall results, by domain, and by individual item. The findings will be interpreted by comparing them against absolute criteria, with score ranges categorized accordingly (Srisaard, 2017). Furthermore, the analysis of the need for a Professional Learning Community in schools will be conducted using the Modified Priority Needs Index (PNI_{modified}) to rank the importance of the identified needs.

3. Population and sample

3.1 The population consists of teachers in primary schools under the jurisdiction of the Nakhon Phanom Primary Educational Service Area Office 1 for the academic year 2024, totaling 1,885 individuals across 248 schools.

3.2 The sample group in this study is teachers in primary schools under the jurisdiction of the Nakhon Phanom Primary Educational Service Area Office 1 for the academic year 2024. The sample size is determined using the Kreicic and Morgan table for sample size calculation. A stratified random sampling method is employed, followed by proportionate comparison and simple random sampling using a lottery method without replacement, resulting in a sample size of 320 teachers from 248 schools.

Results

1. General information about the sample, Among the 320 respondents, 51.00% were male and 49.00% were female. Regarding educational qualifications, 81.00% of the respondents held a bachelor's degree, while 19.00% had qualifications higher than a bachelor's degree. In terms of school size, 67.90% of the respondents were from medium-sized schools, followed by 23.20% from small-sized schools, and 8.90% from large-sized schools.

2. Comparison of all variables comprising the current and the desired conditions of the development of PLCs in schools under the Nakhon Phanom Primary Educational Service Area Office 1, both overall and by domain, were analyzed by calculating the mean and standard deviation.

Table 1. The average score and standard deviation of the current and desirable conditions of needs in the development of PLCs in schools. (N = 320)

The need for PLCs	Current condition			Desirable condition		
	\bar{x}	S.D.	Level	\bar{x}	S.D.	Level
1. Support and collaborative leadership	3.98	.81	High	4.72	.75	Highest
2. Creation of shared values and vision	3.88	.67	High	4.66	.84	Highest
3. Provision of supportive learning environment	3.94	.78	High	4.82	.77	Highest
4. Collaborative learning and application	4.06	.79	High	4.77	.82	Highest
5. Experience Sharing	3.91	.62	High	4.71	.81	Highest
Total Result	3.97	.74	High	4.73	.80	Highest

From Table 1, the current and desirable conditions of PLCs in schools under the Office of Nakhon Phanom Primary Educational Service Area 1, found that:

2.1 The current condition in the development of PLCs in schools, overall, was rated at a high level (\bar{x} = 3.97, S.D. = .74). When considering each domain individually, all five domains were rated at a high level, with the mean values ranked from highest to lowest as follows: 1) Collaborative Learning and Application: (\bar{x} = 4.06, S.D. = 0.79) 2) Support and Collaborative Leadership: (\bar{x} = 3.98, S.D. = 0.81) 3) Provision of Supportive Learning Environment: (\bar{x} = 3.94, S.D. = 0.78) 4) Experience Sharing: (\bar{x} = 3.91, S.D. = 0.62) 5) Creation of Shared Values and Vision: (\bar{x} = 3.88, S.D. = 0.67)

2.2 The desired condition in the development of PLCs in schools, overall, was rated at the highest level (\bar{x} = 4.73, S.D. = 0.80). When considering each domain individually, all five domains were rated at the highest level, with the mean values ranked from highest to lowest as follows: 1) Provision of supportive learning environment: (\bar{x} = 4.82, S.D. = 0.77) 2) Collaborative learning and application: (\bar{x} = 4.77, S.D. = 0.82) 3) . Support and collaborative leadership: (\bar{x} = 4.72, S.D. = 0.75) 4) Experience Sharing: (\bar{x} = 4.71, S.D. = 0.81) 5) Creation of shared values and vision: (\bar{x} = 4.66, S.D. = 0.84)

3. Analyze the Modified Priority Needs Index (PNI modified) to rank the priority of needs for developing PLCs in schools under the Nakhon Phanom Primary Educational Service Area Office 1, both overall and by domain.

Table 2. The needs of PLCs in primary schools under the Office of Nakhon Phanom Primary Educational Service Area 1

The need for PLCs	Desirable average (I)	Current average (D)	Difference $I - D$	$\frac{I - D}{D}$	Number
1. Support and collaborative leadership	4.72	3.98	.74	.18	4
2. Creation of shared values and vision	4.66	3.88	.78	.20	3
3. Provision of a supportive learning environment	4.82	3.94	.88	.22	1
4. Collaborative learning and application	4.77	4.06	.64	.15	5
5. Experience sharing	4.71	3.91	.80	.21	2
Total Result	4.73	3.97	.76	.19	

From Table 2, the analysis of the priority needs for the development of Professional Learning Communities in schools under the Nakhon Phanom Primary Educational Service Area Office 1 revealed the following rankings of needs: 1) The need for providing a supportive learning environment ranked the highest (PNI_{modified} = 0.22) 2) The need for experience sharing ranked second (PNI_{modified} = 0.21) 3) The need for creating shared values and vision ranked third (PNI_{modified} = 0.20) 4) The need for collaborative learning and application ranked fourth (PNI_{modified} = 0.18) 5) The need for support and collaborative leadership ranked last (PNI_{modified} = 0.15).

Discussion

The current and desired conditions in the development of PLCs within schools under the jurisdiction of the Nakhon Phanom Primary Educational Service Area Office 1.

1. The current situation of the development of PLCs in these schools, overall, was at a high level. In this regard, the Nakhon Phanom Primary Educational Service Area Office 1 has set missions, organizational values, objectives, and strategies that are consistent with promoting the development of PLCs in all schools under its jurisdiction, with schools implementing the development of such communities according to their contexts (Nakhon Phanom Primary Educational Service Area Office 1, 2024). School administrators and teachers also recognized the importance of developing PLCs in schools to enhance the potential of schools, administrators, teachers, and staff, which leads to improved student outcomes and achievements. This is consistent with the research of Saengsawang (2020), which examined the development of guidelines to promote PLCs for teachers in schools under the Yasothon Primary Educational Service Area Office 2. The study found that the desired state of promoting PLCs in schools was at the highest level across all aspects. It is also aligned with the research of Amata (2020), which investigated the PLCs a guideline for the development of professional learning community operation in schools under the secondary educational service Area Office 3, and found that the overall situation was at a high level across all aspects.

2. The desired condition of the development of PLCs in schools under the Nakhon Phanom Primary Educational Service Area Office 1, overall, was at the highest level. This is because the current situation reflects the level of implementation of the development of PLCs in schools, as directed by the Nakhon Phanom Primary Educational Service Area Office 1. Schools, administrators, teachers, and staff have expressed a desire to enhance the effectiveness of the development of PLCs in all five areas, leading to the expected state of the development of these communities being at the highest level. This is consistent with the research of Saengsawang (2020), which examined the development of guidelines to promote PLCs for teachers in schools under the Yasothon Primary Educational Service Area Office 2. The study found that the desired state of promoting PLCs in schools was at the highest level across all aspects.

3. The analysis of the Modified Priority Needs Index (PNI modified) to rank the priority needs regarding the development of PLCs in schools under the Nakhon Phanom Primary Educational Service Area Office 1 revealed that the highest priority need is related to the provision of a supportive learning environment. The second priority is experience sharing, followed by the creation of shared values and vision, collaborative learning and application, and finally, support and collaborative leadership. The study's findings align with previous research by Orawan Suksi and Sutham Thamatasenahant (2022), which shows that the overall management processes of Professional Learning Communities (PLCs) in schools were rated at the highest level. The areas of vision and shared values, professional learning and development, local supportive structures, local hospitality, joined-up leadership, and team harmony were ranked in descending order of importance. This is also consistent with the research of Warunya Najaitrunk and Wichian Rooyuenyong (2020), which investigated the PLCs in the new normal era of schools under Khon Khen Primary Educational Service Area Office 2, and found that the needs of PLCs development were arranged in the following order: professional learning and development, caring community, shared leadership, supportive structure, collaborative teamwork, and shared vision.

Conclusion

The study on the development of PLCs in schools under the Nakhon Phanom Primary Educational Service Area Office 1 highlights key aspects of both the current and desired states of professional learning community development. The findings indicate that while the current state was at a high level overall, there is a strong desire to further improve and achieve the

highest level of effectiveness in five key areas: provision of a supportive learning environment, experience sharing, creation of shared values and vision, collaborative learning and application, and provision of support and collaborative leadership. These results reflect a significant commitment among school administrators, teachers, and staff to enhance the professional learning communities, which in turn will contribute to better student outcomes. Additionally, the Modified Priority Needs Index (PNI modified) analysis reveals that creating the provision of a supportive learning environment is the top priority, followed by the exchange of experiences and other areas that facilitate the development of these communities. Based on these findings, several recommendations are made, including further support for shared leadership, fostering collaborative environments, and continuous professional development for teachers. Future research should explore the factors influencing the management of these professional learning communities and examine the relationship between participatory management and effectiveness in community development. This study contributes valuable insights for improving the professional learning community development in schools, aiming for a more effective and sustainable educational environment.

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Amplifying Voices: Boosting Speaking Skills in Grade 8 Students Through Voice-Overs

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Abstract

This study investigates the use of TikTok voice-over as a tool to enhance the English-speaking skills of Grade 8 students at a secondary school in Kalasin province, Thailand. The study aimed to assess whether students' speaking skills improved after using TikTok voice-over and to explore their attitudes toward this teaching technique. A one-group pretest-posttest design was employed over 18 weeks. The sample consisted of 20 students selected through purposive sampling from those studied in additional English courses in the 2024 academic year. The findings indicated significant improvements in students' pronunciation, fluency, and overall speaking skills. Additionally, students expressed positive attitudes toward TikTok voice-over, highlighting its potential as an engaging and effective educational tool. These results suggest that integrating modern technology, such as TikTok, into language teaching can enhance students' learning experiences and outcomes.

Keywords: Speaking skills, TikTok, voice-over, attitudes

Introduction

In today's world, English is crucial as a global lingua franca and the primary language in many countries. Recognizing its significance, the Thai government has implemented policies to enhance English proficiency, emphasizing its role as a key communication tool. According to the Department of Academic Affairs (2002), Thai citizens must be able to effectively communicate with foreigners. Kaewthammanukul (2022) highlights that English education in Thailand follows a curriculum designed to develop four essential language skills: listening, speaking, reading, and writing. Among these, speaking is particularly important, as it reflects a learner's ability to use the language effectively. Speaking involves conveying thoughts, understanding, and emotions through verbal communication, making it a critical indicator of successful language acquisition (Nunan, 1991).

However, despite its importance, many Thai students struggle with speaking due to limited exposure to English in daily life. Shumin (2002) argues that a lack of an English-speaking environment significantly hinders students' fluency and overall language proficiency. Without adequate practice, students find it difficult to gain the confidence needed for natural communication. Similarly, Nety et al. (2020) identified key factors that contribute to students' lack of confidence in speaking English, including anxiety, shyness, fear of making mistakes, and a limited vocabulary. These challenges pose significant obstacles to achieving language proficiency.

In response to these challenges, integrating technology into language education has become an essential strategy in the Thailand 4.0 era. Technology enhances teaching effectiveness and fosters the development of 21st-century skills (Epistemo, 2021). Through digital tools, students gain access to modern information and communication technologies, allowing for more efficient learning (Aslamiah, 2023). Moreover, technology has been shown to increase student engagement and motivation in language learning by creating interactive and dynamic learning environments (Nguyen, 2021).

Among the many digital platforms available, TikTok has emerged as a promising educational tool. Launched in 2017, TikTok rapidly gained global popularity, particularly among younger generations (Chongsamanukul, 2020). The platform enables users to create, share, and engage with short-form videos, offering opportunities for creative expression through activities such as singing, dancing, and lip-syncing. One of its key features, the voice-over function, allows users to record spoken content over video footage, a technique widely used in media and education (Brown, 1993; Craig, 2023).

Research has demonstrated that TikTok can be effectively integrated into educational settings. According to Hayes et al. (2020), its short-video format reduces stress and helps sustain students' attention, making learning more enjoyable. Likewise, Cagas (2022) found that TikTok's interactive features can enhance students' speaking skills by providing an engaging and low-pressure environment for language practice.

The voice-over technique, in particular, has been applied in various educational contexts to support language learning. Fitria (2024) highlighted that voice-over activities help students develop pronunciation, intonation, and practical communication skills, preparing them for real-life interactions. Educators have used this technique to narrate dialogues, introduce vocabulary, and improve pronunciation through structured speaking exercises.

Several studies have explored the impact of TikTok voice-over on speaking skills, particularly in Malaysia and Indonesia. Juliana (2020) conducted an experiment with 60 first-year university students in Malaysia, requiring them to participate in twelve voice-over challenges over two months. The challenges involved performing "duets" with other English speakers, ensuring authentic language use. The results indicated that the activities significantly improved students' pronunciation, intonation, and confidence in speaking English. Similarly, Suprayogi and Pranoto (2020) examined voice-over activities among 40 Indonesian university students enrolled in a pronunciation course. Their findings showed that voice-over exercises helped students refine pronunciation, gain awareness of phonetic patterns, and develop independent learning strategies. Chuah and Ch'ng (2023) further validated these findings by demonstrating that TikTok voice-over challenges improved both pronunciation and motivation among Malaysian university students.

Despite the success of TikTok voice-over in Malaysia, this technique has not yet been widely applied in Thailand for language learning. One possible reason for this is the traditional approach to English education in Thailand, which often prioritizes grammar and reading over spoken communication (Darasawang, 2007, Mala & Jikkham, 2016). Additionally, while TikTok is popular among Thai students, its educational potential remains largely unexplored. Unlike Malaysia, where digital tools have been actively integrated into higher education curricula, Thailand has been slower in adopting such innovations for language learning.

Given the importance of speaking skills and the demonstrated effectiveness of TikTok voice-over in neighboring countries, this study aims to introduce and evaluate the use of TikTok voice-over as a tool to improve English-speaking skills among Grade 8 students in Kalasin province, Thailand. By integrating this technique into the teaching process, the study seeks to bridge the gap between traditional language instruction and modern, technology-driven learning approaches.

1. Research Objectives

1.1 To evaluate the improvement in Grade 8 students' English-speaking skills following the implementation of TikTok voice-over activities.

1.2 To investigate students' attitudes toward the use of TikTok voice-over as a tool for teaching and learning to develop speaking skills.

2. Research Questions

2.1 What is the impact of TikTok voice-over activities on the development of speaking skills among Grade 8 students, as measured by their performance before and after implementation?

2.2 What are the students' attitudes toward using TikTok voice-over as a tool to improve speaking skills?

Research Methodology

1. Research Design

This study employed a quantitative approach with a one-group pre-/post-test design. The primary objectives were twofold: first, to evaluate the improvement in Grade 8 students' English-speaking skills following the implementation of TikTok voice-over activities, and second, to investigate students' attitudes toward the use of TikTok voice-over as a tool for teaching and learning to develop speaking skills.

2. Participant

The population used in the study was 20 Grade 8 students from a school in Kalasin province, participating in this study. Participants were selected through purposive sampling from all students studying additional English subjects in the 2024 academic year. The study data collection period is 18 weeks.

3. Instruments

The research instruments included a lesson plan, pre and post-tests, and a questionnaire. The instruments employed in this study were as follows:

3.1 Lesson plans

The lesson plans used in this study consisted of 16 lesson plans, each lesson plan was 50 minutes long and the total experimental period was 8 weeks, 2 hours per week. The content used was based on the learning objectives and the Spark 2 textbook, which was in line with the 2008 Core Curriculum for English. It consisted of the following content: Unit 1: routine, 2 hours; Unit 2: myths & legends, 5 hours; Unit 3: party, 5 hours; and the final chapter: Unit 4: sport, 4 hours.

3.2 Pre and post-tests

To assess students' speaking proficiency before and after the instructional intervention, this study employs a pre-test and post-test design. The pre-test evaluates students' baseline speaking skills by requiring them to create TikTok voice-over clips on self-selected topics. These recordings are assessed using the scoring rubric proposed by Hongsa et al. (2023), which measures key speaking components, including grammar, vocabulary, fluency, pronunciation, and content.

Following the pre-test, students participate in a structured learning phase focused on TikTok voice-over techniques. Upon completion of this phase, a post-test is administered, in which students create another TikTok voice-over clip. The post-test aims to measure improvements in speaking skills, with evaluations conducted using the same rubric as the pre-

test to ensure consistency. Additionally, to enhance the reliability of the assessment, inter-rater reliability is established by having multiple independent evaluators score the students' recordings.

3.3 Questionnaire

To assess students' attitudes toward the use of TikTok voice-over as an instructional tool, a closed-ended questionnaire was administered. This instrument was designed to collect quantitative data on students' perceptions of the TikTok voice-over activity in terms of effectiveness, engagement, and ease of use. The questionnaire comprised a series of structured response options to ensure consistency in data collection and facilitate statistical analysis.

The questionnaire was developed based on key constructs aligned with the study's objectives, including motivation, enjoyment, perceived usefulness, and confidence in using technology for language learning. Respondents rated their agreement with statements on a Likert scale, ranging from “strongly agree” to “strongly disagree”, allowing for the measurement of varying levels of attitude intensity. Additionally, the questionnaire included items assessing students' perceived improvement in speaking skills, enjoyment of the TikTok voice-over task, and willingness to continue using TikTok for language learning in the future.

To ensure content validity, three experts evaluated the questionnaire using the Item-Objective Congruence (IOC) index, yielding an average score of 0.93, indicating a high level of agreement on item relevance. Following a pilot test, Cronbach's alpha was calculated to assess internal consistency reliability, resulting in a score of 0.872, demonstrating strong reliability.

4. Data Collection

The study was conducted during the first semester of the 2024 academic year, with the pre-test administered in the first week of classes to assess students' speaking skills. The research employed a communicative language teaching method integrated with TikTok voice-overs. At the end of the semester, a post-test was administered, using the same content as the pre-test, requiring oral responses. The purpose of this post-test was to evaluate the effectiveness of using TikTok voice-overs in teaching speaking skills to students. Additionally, a post-test questionnaire was distributed to assess students' attitudes toward the use of TikTok voice-overs in enhancing their speaking abilities. The questionnaire utilized a 5-point Likert scale (Likert, 1979) to measure students' responses.

5. Data Analysis

In this study, statistical data were analyzed using mean, standard deviation, and a dependent t-test. A quantitative approach was employed to evaluate the data obtained from both pre- and post-tests. Additionally, the researchers designed a questionnaire to assess college students' attitudes toward using TikTok voice-overs for developing speaking skills.

The questionnaire consisted of 10 closed-ended questions using a Likert scale, where a score of 5 indicated "strongly agree," and a score of 1 indicated "strongly disagree." Its purpose was to gather students' perspectives on the benefits of incorporating TikTok voice-overs in teaching spoken English.

The pre- and post-test speaking performances were evaluated using a rubric based on key speaking features proposed by Hongsa et al. (2023), including grammar, vocabulary, fluency, pronunciation, and content. The table below presents the numerical scoring scale, ranging from 1 to 5.

Table 1. Speaking Assessment Rubric.

Criteria	5	4	3	2	1
Grammar	Consistent use of correct grammar.	It uses a variety of grammatical structures with few errors	Some syntax errors limit structural resources	Grammatical errors have been encountered in the infrastructure	Many grammatical errors obscure the meaning.
Vocabulary	Effective use of vocabulary that matches the context	Most of the time, effective use of the term has some impropriety.	Effective use of vocabulary There are some that are inappropriate.	Limited use of vocabulary with frequent inappropriateness	Frequently uses incorrect vocabulary; word choice does not correspond to the meaning expressed.
Fluency	Smooth in speaking Speak without interruption, and speak clearly in communication.	A little minor in speaking, but still able to communicate	Some stammer and hesitate to speak, but are still able to communicate	Speak in words, pausing at intervals. Makes communication unclear.	Hesitant to speak can speak some words, but is unable to convey meaning.
Pronunciation	Correct pronunciation of words little mistakes and sounds like a native speaker	Most of them demonstrate authenticity. pronunciation and attempts to make the text understandable.	The speaker wants the listener to interpret what the speaker is saying, where some pronunciation is erroneous.	A large number of pronunciation errors often affect the listener	A large number of pronunciations cause mistakes Affect the audience
Content	Describe complete knowledge and understanding	Mostly shown understand the topic and provide	Show sufficient knowledge and understanding about the topic	The speaker doesn't have enough information	The overall content is difficult to understand

Results

The responses to Question 1, which assessed the improvement in students' speaking skills after using TikTok voice-over in comparison to the pre-test, are presented in Table 2.

Table 2. Pre- and post-test comparison after using TikTok voice-over

Test	N	\bar{X}	S.D.	t	df	sig
Pre-test	20	8.40	2.87	13.50	18.00	0.00
Post-test	20	15.05	2.78			

Table 2 presents a comparison of English-speaking scores before and after the use of TikTok voice-over in learning. The average pre-test and post-test scores were 8.40 and 15.05, respectively. In the experimental group, the standard deviations for the pre-test and post-test scores were 2.87 and 2.78, respectively. Statistical analysis revealed a significant difference between the pre-test and post-test scores ($t = 13.50$, $p < 0.00$). These results indicate a substantial improvement in post-test scores compared to pre-test scores. Thus, the findings

demonstrate that students' English-speaking skills improved significantly after incorporating TikTok voice-over into their learning process.

Table 3. Students’ attitudes towards using TikTok voice-over to teach speaking

Details	\bar{X}	S.D.	Level
1. TikTok Voice-over can improve speaking skills.	3.60	0.58	Strongly Agree
2. Using TikTok Voice-over enhances learners' ability to express themselves.	3.35	0.48	Neutral
3. TikTok Voice-over allows you to use English outside of classroom.	4.55	0.50	Strongly Agree
4. TikTok Voice-over helps boost confidence in speaking English.	4.45	0.59	Strongly Agree
5. Using TikTok Voice-over supports the development of English fluency.	2.60	0.49	Neutral
6. TikTok Voice-over helps increase interest in learning English.	2.20	0.81	Disagree
7. Using TikTok Voice-over helps learners develop positive attitudes towards learning English.	4.10	0.83	Agree
8. TikTok voice-over is suitable for developing speaking skills.	4.80	0.40	Strongly Agree
9. Using TikTok Voice-over makes learning English more enjoyable.	3.35	0.85	Neutral
10. Using TikTok Voice-over encourages learners to be creative.	4.90	0.30	Strongly Agree
Total	3.79	0.19	Strongly Agree

The majority of students agreed with the use of TikTok voice-over to develop English speaking skills (mean score of 3.79 or 0.19). Item 10 (Using TikTok voiceover encourages learners to be creative) received the highest score (mean score of 4.90), item 8 (TikTok voiceover is suitable for developing speaking skills) had an average score of 4.80, followed by item 3 (TikTok voice-over allows you to use English outside of the classroom) had an average score of 4.55, while item 4 (TikTok voice-over helps boost confidence in speaking English) had an average score of 4.45, item 7 (Using TikTok voice-over helps learners learn in real life) had an average score of 4.10. In addition, item 1 (Using TikTok voice-over improves speaking skills) had an average score of 3.60. Meanwhile, statements 2 (TikTok voice-over can improve English speaking) and 9 (Using TikTok voice-over gives learners the opportunity to use English in real situations) had an average score of 3.35, item 5 (Using TikTok voice-over helps learners learn in real life) had an average score of 2.60, and finally item 6 (TikTok voice-over helps increase interest in learning English) received the lowest average score of 2.20 (Table 3).

Discussion

Based on the response to Question 1, the results indicated a significant improvement when comparing pre-test and post-test scores across different criteria, particularly in pronunciation. These findings align with the research of Chuah and Ch'ng (2023), which highlighted that student held positive views about voice-over challenges, particularly in how they encouraged improvements in speaking abilities, specifically pronunciation, intonation, and fluency. Furthermore, the research of Henrichsen (2015) supports this conclusion, noting that students found preparing and delivering video voice-overs to be both enjoyable and effective in improving speaking accuracy and fluency. Through practice, students worked on speaking rate, rhythm, pauses, and intonation. Similarly, the findings of Fitria (2024) reinforce that using voice-over (VO) techniques in teaching English-speaking skills provides relevant contexts that enhance student proficiency. These materials offer realistic conversation models,

improve understanding of language structures, boost confidence, and prepare students for real-life interactions.

The data obtained from the questionnaires revealed that students held positive attitudes toward the use of TikTok voice-over in teaching and learning to enhance speaking skills. This finding aligns with Chuah and Ch'ng (2023), where participants reported increased motivation and a greater willingness to complete speaking tasks. Similarly, the study by Ferstephanie & Pratiwi (2022) found that students demonstrated a moderate level of motivation when using TikTok, based on their questionnaire responses. Unexpectedly, the impact of TikTok on improving students' motivation received overwhelmingly positive feedback. The students' performance improved progressively with each test, suggesting that their motivation to speak increased as they gained new experiences with the platform. This highlights the potential of TikTok in enhancing motivation and engagement in language learning.

However, the researcher identified a notable disadvantage of using TikTok voice-over: many students continued to struggle with pronunciation, primarily due to a lack of self-confidence. This lack of confidence led to hesitation in speaking and a lack of fluency, as students were afraid of making mistakes. Additionally, since this technique was applied to Grade 8 students, who may not yet possess sufficient responsibility for managing their own work, the improvement in speaking skills was not as significant as anticipated.

Conclusion

TikTok voice-over is a feature within the TikTok platform that allows users to add their own recorded narration or voice track to a video. This feature is often used to overlay commentary, storytelling, or other spoken content onto pre-recorded videos. In an educational context, TikTok voice-over can be utilized as a tool to enhance language learning, particularly speaking skills, by encouraging users to practice pronunciation, intonation, and fluency.

A study on the use of TikTok voice-overs to develop speaking skills in Grade 8 students found that this approach led to noticeable improvements in students' speaking abilities. The use of TikTok voice-overs as a tool for enhancing speaking skills proved particularly effective in the areas of pronunciation and fluency. Although pronunciation was identified as the most challenging aspect for students, it showed the highest average improvement, suggesting that students' confidence and accuracy in speaking increased over time.

Despite the promising results in pronunciation and fluency, further refinement in the use of TikTok voice-overs is needed. Additional support in areas such as grammar, content comprehension, and vocabulary development, along with strategies to boost students' confidence, would enhance the overall effectiveness of this technique in language teaching. The researchers recommend that TikTok voice-overs be implemented with high school students and above, as older students typically demonstrate greater self-responsibility compared to middle school students.

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Leveling Up Language: Enhancing Grade 5 Students Vocabulary Mastery Through Gamification

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Abstract

This pre-experimental study investigates the impact of integrating gamification on the vocabulary mastery, motivation, and participation of primary students in Kalasin Province, Thailand. Despite the importance of vocabulary acquisition in language learning, traditional teaching methods often fail to engage learners effectively. This research examines both quantitative and qualitative outcomes to assess the effectiveness of the intervention. Participants included 19 Grade 5 students, purposively selected based on their similar levels of English vocabulary mastery. They underwent pre-tests and post-tests to evaluate vocabulary mastery, followed by questionnaires and semi-structured interviews to assess their motivation, participation, and attitudes toward gamified learning. The pre-test and post-test data were analyzed quantitatively using the Statistical Package for the Social Sciences (SPSS), while the questionnaire responses were subjected to thematic analysis to explore students' attitudes toward gamification in the classroom. The findings revealed significant improvements in students' vocabulary mastery, along with increased motivation and participation during the gamified sessions. Additionally, students expressed positive attitudes, emphasizing gamification's potential to create an enjoyable and engaging learning experience.

Keywords: gamification, vocabulary mastery, motivation, elementary education.

Introduction

Vocabulary is a fundamental component of language learning, particularly for young learners. Mastery of vocabulary forms the foundation of overall language proficiency, enabling students to comprehend texts, express themselves effectively, and develop essential cognitive skills. Research has consistently demonstrated that vocabulary acquisition directly influences academic success, particularly in reading comprehension and writing proficiency (Snow, 2010; Beck et al., 2002). For students learning English as a second language (ESL), expanding their vocabulary is not only crucial for effective communication but also for enhancing higher-order thinking skills such as analysis, synthesis, and evaluation (Laufer, 1997). A well-developed vocabulary allows learners to access diverse educational materials, engage in deeper levels of learning, and transfer knowledge across different contexts (Nation, 2001). Beyond academic achievement, vocabulary mastery also plays a significant role in building students' confidence in using English in real-life scenarios, whether in academic settings, social interactions, or future professional opportunities (Snow, 2010).

Despite its importance, vocabulary instruction often relies on traditional methods that may feel monotonous and uninspiring for young learners, leading to disengagement and limited retention. Research suggests that vocabulary learning is most effective when it is enjoyable, interactive, and engaging (Beck et al., 2002; Snow, 2010). One approach that has gained increasing attention is gamification, which incorporates game-like elements into educational contexts to create a more dynamic and immersive learning experience (Deterding et al., 2011). By integrating components such as competition, progression, and rewards, gamification transforms conventional learning activities into interactive experiences that foster active participation (Deterding et al., 2011; Domínguez et al., 2013). This approach not only improves vocabulary retention and application but also encourages students to engage more deeply with the learning process (Su & Cheng, 2015). Furthermore, gamification supports the development of essential life skills, such as collaboration, problem-solving, and resilience, making it a holistic and multifaceted educational strategy (Gee, 2003; Anderson & Reder, 1999).

The theoretical foundation of gamification is closely tied to motivation theories, particularly Self-Determination Theory (SDT), which highlights three key components of intrinsic motivation: competence, autonomy, and relatedness (Ryan & Deci, 2000). According to SDT, learners are more motivated to engage in activities that provide a sense of achievement, opportunities for self-direction, and meaningful connections with peers and educators. In a gamified classroom, these components are integrated through mechanisms such as experience points (EXP), level progression, badges, and leaderboards. These elements not only enhance engagement but also offer continuous feedback and a clear sense of progression, empowering students to take ownership of their learning journey (Deterding et al., 2011; Hamari et al., 2014).

Existing research highlights the positive impact of gamification in various educational settings, particularly in improving English vocabulary acquisition. For instance, Su and Cheng (2015) found that gamified activities, such as point accumulation and rank progression, significantly increased post-test scores from 6.74 to 9.53 on average, demonstrating notable improvements in vocabulary mastery. Additionally, gamification aligns with SDT by fostering intrinsic motivation, as elements like rewards and badges enhance learners' sense of competence, autonomy, and relatedness (Ryan & Deci, 2000; Hamari et al., 2014). Beyond vocabulary retention, gamification has also been shown to foster positive attitudes toward learning. Nicholson (2015) emphasized that gamified classroom environments promote engagement and teamwork, enhancing students' overall participation. Surveys further indicate high student satisfaction with gamified learning, with an average satisfaction score of 4.40 out of 5, highlighting its effectiveness in creating a supportive and enjoyable learning atmosphere (Domínguez et al., 2013).

Furthermore, gamification fosters essential life skills, including critical thinking, problem-solving, and time management. For example, collaborative quests and group tasks encourage students to develop teamwork skills while overcoming challenges. Research also suggests that gamified learning environments improve students' ability to manage time effectively, as they work toward completing objectives within structured timeframes (Su & Cheng, 2015). These life skills, cultivated in a supportive learning environment, contribute to students' holistic development and better prepare them for real-world applications.

The growing body of research on gamification, including studies by Su and Cheng (2015) and Domínguez et al. (2013), has consistently demonstrated its potential to improve language retention, participation, and motivation. However, despite these promising findings, challenges such as competition-related stress and the need for diverse activities to ensure inclusivity remain important considerations (Hamari et al., 2014; Domínguez et al., 2013). While many studies incorporate aspects of gamification, few have implemented a

comprehensive gamification system, particularly in Thai primary school settings, where teaching strategies must align with students' developmental needs.

In the context of English language learning, there remains a significant gap in understanding how gamification influences vocabulary acquisition among young learners, particularly in Thailand, where English proficiency is a crucial skill for academic and career advancement. While gamification has been widely studied in higher education and digital learning environments, limited research explores its direct impact on primary school students' vocabulary mastery.

This study aims to address this gap by investigating the impact of gamification on English vocabulary acquisition among Grade 5 students in Thailand. By incorporating game-like elements such as point accumulation, badges, and level progression, this research seeks to enhance students' motivation, engagement, and vocabulary retention. The findings will contribute to the development of more effective and engaging teaching strategies for elementary-level English learners, ultimately supporting their academic and personal growth.

1. Research Objectives

To examine the effects of gamification on fifth-grade students' vocabulary learning.

To investigate fifth-grade students' attitudes toward using gamification as a tool for improving English vocabulary mastery.

2. The Research Questions

2.1 How does gamification affect fifth-grade students' vocabulary learning?

2.2 What are fifth-grade students' attitudes toward using gamification to improve English vocabulary mastery?

Research Methodology

1. Method

This study adopted a mixed-method approach to comprehensively investigate the impact of gamification on students' vocabulary skills and their attitudes toward its use in learning. The quantitative component utilized a one-group pretest-posttest design to assess the effectiveness of gamification in improving vocabulary acquisition. In this phase, students' vocabulary skills were measured before and after the intervention to identify any significant changes attributable to the gamified learning activities.

In addition, a qualitative approach was incorporated to explore students' perspectives and attitudes toward gamification as a medium of instruction. Data for the qualitative analysis were collected through semi-structured interviews, allowing researchers to gain deeper insights into the students' experiences, perceived benefits, and challenges associated with the gamified learning environment. By integrating both quantitative and qualitative methods, the study aimed to provide a well-rounded understanding of the pedagogical implications of gamification in vocabulary instruction.

2. Populations

The participants of this research consisted of 19 grade 5 students in the first semester of the academic year 2024 from a school in Kalasin Province. All participants were selected purposively from school that offer English language courses to upper-primary students. Most

of the participants had similar levels of English vocabulary mastery and were cooperative in conducting this research.

3. Instruments

The instruments used in this study were lesson plans, pre-tests, and feedback questionnaires, which were presented to experts to assess the content validity and accuracy of the content.

3.1 pre-test and post-test

The pre-test and post-test English for Grade 5 students is a test created by the researchers with 30 original questions and selected 20 questions that were approved by the experts to be used as pre-test and post-test. Pre- and post-tests with multiple-choice and fill-in-the-blank questions are used to measure vocabulary mastery before and after the intervention. Validity and reliability were ensured through experts review and pilot testing (Brown, 2001). The validity of the test was confirmed by three teaching experts, with an average item consistency index (IOC) score of 0.94.

3.2 Questionnaire

The study employed a Likert-type questionnaire based on Keller's (1987) ARCS model to assess students' motivation and perceptions of gamification. Additionally, an open-ended question was included to explore learners' attitudes toward integrating gamification for enhancing vocabulary mastery and motivation. To minimize misunderstandings, the questionnaire was translated into Thai.

To ensure content validity, three experts evaluated the questionnaire using the Item-Objective Congruence (IOC) index, yielding an average score of 0.95, which indicates a high level of agreement on item relevance. A pilot test was conducted to assess the reliability of the instrument, and Cronbach's alpha was calculated, resulting in a score of 0.846, demonstrating strong internal consistency.

3.3 Semi-Structured Interviews

Semi-structured interviews were conducted to gain qualitative insights into students' experiences with gamified learning. These interviews allowed for open-ended responses, encouraging participants to share honest and reflective thoughts (Adams, 2015). To ensure accessibility, the interviews were conducted in Thai and later translated into English by the researchers, with careful attention to accuracy and consistency. The collected data were transcribed verbatim and analyzed using thematic analysis (Braun & Clarke, 2006). The analysis followed a structured process, beginning with familiarization, where researchers read and re-read the transcripts to understand the data comprehensively. Next, initial coding was performed by identifying recurring patterns and significant statements (Patton, 2024). These codes were then grouped into broader themes such as motivation, engagement, learning outcomes, and challenges. Finally, the themes were reviewed and refined to ensure their relevance to the research questions and maintain analytical consistency.

4. Data Collection

This study sought to enhance the English vocabulary mastery of Grade 5 students at a school in Kalasin Province, Thailand, through a gamification-based approach. Conducted during the first semester of the 2024 academic year, the intervention involved bi-weekly learning activities implemented throughout the semester. A pre-test was administered at the beginning of the study to assess students' baseline English vocabulary skills, serving as a benchmark for evaluating progress following the gamified learning intervention.

The teaching process was organized into three stages—pre-task, while-task, and post-task—specifically adapted for gamified vocabulary learning (Brown, 2018; Karimi et al., 2019; Movva et al., 2022). The lesson plans incorporated gamification elements such as rank progression (Silver, Gold, Platinum, Diamond, Overlord, and Conqueror) and point accumulation, drawing inspiration from Richards and Rodgers (2014). Learning activities were framed as "Quests," including tasks such as completing assignments, quizzes, and group activities.

In the pre-task stage, students were introduced to the lesson objectives and engaged in discussions to activate their prior knowledge through related keywords. During the while-task stage, students participated in various "Quests," including matching words with definitions, solving puzzles, and engaging in collaborative role-playing activities. These activities were designed to be both educational and engaging, with students earning Experience Points (EXP) for task completion. The accumulation of EXP allowed students to progress through ranks, from Gold to Conqueror, fostering both motivation and engagement.

At the end of the semester, a post-test was conducted to measure students' improvement in English vocabulary mastery. Additionally, feedback on the gamified learning experience was collected through questionnaires, focusing on students' motivation, engagement, and overall satisfaction. To gain further insights, semi-structured interviews were conducted with eight students, exploring themes such as motivation, engagement, and learning outcomes (Adams, 2015). Each interview, lasting approximately 5–10 minutes, was recorded, transcribed, and analyzed for qualitative insights (Creswell & Plano Clark, 2017).

5. Data Analysis

The pre-test and post-test data were analyzed using quantitative methods with the Statistical Package for the Social Sciences (SPSS). The analysis included calculating the mean (\bar{x}), standard deviation (S.D.), and p-value to evaluate the significance of the results. Additionally, a satisfaction questionnaire, based on a 5-point Likert scale ranging from strongly agree to strongly disagree (APA PsycNet, 2025), was assessed using descriptive statistics, including mean and standard deviation. Semi-structured interview responses from students were categorized thematically to gain insights into their attitudes toward mastering English vocabulary through gamification.

Results

To answer the first question the scores of 20 Questions pre and post-test were compared. The results are as follows:

Table 1. Pre- and post-test comparison after utilizing gamification.

Test	N	Full score	Mean	S.D	t.	Df.	Sig.
Pre-test	19	20	6.74	2.80	2.89	18	<0.01
Post-test	19	20	9.53	3.25			

Table 1 presents the findings of pre and post-test comparison scores after utilizing gamification. Improving English Vocabulary Mastery of Grade 5 Students Using Gamification pre-test and post-test scores. The mean scores for the pre-test and post-test were 6.74 and 9.53, respectively, with standard deviations of 2.80 and 3.25, respectively. Statistical analysis revealed that both pre-test and post-test scores were significantly different ($t = 2.89$, $p < 0.01$),

indicating a notable increase in post-test scores compared to pre-test scores. Consequently, the data suggests a significant improvement in students’ Improving English vocabulary following gamification.

Table 2. Mean and Standard deviation values from Student Satisfaction questionnaires.

Statement	x	S.D.	Interpretation
1. Content and Learning Activities			
1.1 Content suitable for students' abilities.	4.11	0.96	Agree
1.2 Activities to help students learn English words better	4.37	0.92	Strongly agree
1.3. Interesting activities to encourage students to learn	4.16	0.82	Agree
2. Learning environment			
2.1. Teachers encourage students to express themselves in English.	4.11	0.88	Agree
2.2. The classroom is equipped with sufficient equipment to support learning.	4.37	0.68	Strongly agree
2.3. The classroom atmosphere makes students feel relaxed and enjoy themselves.	4.21	0.71	Strongly agree
2.4 opportunities for collaboration among students are encouraged.	4.26	0.73	Strongly agree
3. Benefits of Learning			
3.1. Students have more confidence in using English.	4.42	0.61	Strongly agree
3.2. Activities help students have a positive attitude towards learning English.	4.05	0.85	Agree
3.3. Students can use the English vocabulary they have learned in their daily lives.	4.32	0.67	Strongly agree
Total score	4.24	0.73	

Table 2 shows that students continue to express a highly positive attitude towards using gamification to improve English vocabulary mastery (mean = 4.19, SD = 0.71). The study of satisfaction with the learning activities organized using gamification reveals insights into content, learning environment, and learning benefits as follows:

In terms of content and learning activities, Overall, students expressed satisfaction at the Agree level (mean = 4.11, SD = 0.79). The item with the highest mean score was item 1.4, "Activities provide clear learning objectives" (mean = 4.32, SD = 0.75), followed by item 1.2, "Activities to help students learn English words better" (mean = 4.26, SD = 0.81), at the Strongly agree level. The lowest mean score was for item 1.3, "Interesting activities to encourage students to learn" (mean = 4.00, SD = 0.82), at the Agree level.

Regarding the learning environment, overall, students expressed satisfaction at the Agree level (mean = 4.07, SD = 0.72). The item with the highest mean score was item 2.4, "Opportunities for collaboration among students are encouraged" (mean = 4.42, SD = 0.61), at the Strongly agree level. This was followed by items 2.1 and 2.2, "Teachers encourage students to express themselves in English" and "The classroom is equipped with sufficient equipment to support learning" (both with mean = 4.21, SD = 0.71 and 0.85, respectively). The item with the lowest mean score was item 2.3, "The classroom atmosphere makes students feel relaxed and enjoy themselves" (mean = 3.79, SD = 0.71), which also falls under the Strongly agree level.

According to the benefits of learning, overall, students expressed satisfaction at the Strongly agree level (mean = 4.39, SD = 0.62). The highest mean score was for item 3.3, "Students can use the English vocabulary they have learned in their daily lives" (mean = 4.58,

SD = 0.51), followed by item 3.4, "Students can apply vocabulary knowledge to other subjects" (mean = 4.47, SD = 0.61), and item 3.1, "Students have more confidence in using English" (mean = 4.53, SD = 0.51), all at the Strongly agree level. The lowest mean score was for item 3.2, "Activities help students have a positive attitude towards learning English" (mean = 4.05, SD = 0.85), which falls at the Agree level.

Table 4 Students' Motivation in Relation to the Use of Gamification as a Learning Tool

Respondents	Example of students' Respondents
Student 1	"I liked collecting badges because it was exciting."
Student 2	"I want to get a lot of points to be the leader of the group."
Student 3	"I wanted to win points to level up faster."

The inclusion of gamification elements, such as badges, points, and level progression, significantly motivated students to engage in learning. For instance, one student mentioned, "I liked collecting badges because it was exciting," reflecting the intrinsic motivation fostered by reward systems. Another student emphasized the drive for competition, stating, "I want to get a lot of points to be the leader of the group," which aligns with the concept of extrinsic motivation discussed in Ryan and Deci's (2000) Self-Determination Theory. Moreover, a student shared, "I wanted to win points to level up faster," highlighting how gamification provides a clear sense of progression, which has been shown to enhance students' sense of competence (Hamari et al., 2014). These features collectively fostered excitement and achievement, driving students to participate actively in the learning process. The findings echo those of Su and Cheng (2015), who observed that gamification promotes engagement by integrating game mechanics that cater to students' intrinsic and extrinsic motivational needs.

Table 5. Students' Engagement in Relation to the Use of Gamification as a Learning Tool

Respondents	Example of students' Respondents
Student 1	"I enjoyed working on group quests with friends."
Student 2	"Playing games made me focus on learning words."

Gamification activities were perceived as enjoyable and engaging by students. For instance, one student noted, "I enjoyed working on group quests with friends," highlighting the value of interactive and collaborative tasks in fostering teamwork. Another student remarked, "Playing games made me focus on learning words," demonstrating how these activities helped students concentrate better on vocabulary acquisition. This aligns with Nicholson's (2015) perspective, which suggests that gamification promotes meaningful engagement by incorporating collaborative and interactive elements. Additionally, the playful nature of the activities is consistent with the findings of Su and Cheng (2015), who reported that gamified learning environments improve focus and reduce stress, creating a positive and productive atmosphere for learners.

Table 6. Students' Perceived Challenges in Relation to the Use of Gamification as a Learning Tool

Respondents	Example of students' Respondents
Student 1	"Sometimes I felt stressed when I couldn't win."
Student 2	"I wish there were more types of games."
Student 3	"Sometimes competition makes me feel insecure."

Despite the benefits of gamification, some challenges emerged. One student shared, "Sometimes I felt stressed when I couldn't win," pointing to the pressure created by the competitive elements. Another student expressed a desire for greater diversity, saying, "I wish there were more types of games." Additionally, the competitive nature of gamification left some students feeling vulnerable, as one admitted, "Sometimes competition makes me feel insecure." These challenges are consistent with findings from Hamari et al. (2014), which indicate that gamification can sometimes lead to stress and disengagement if activities are overly competitive or lack variety. Addressing these issues by incorporating a broader range of game types and balancing competition with cooperative elements could enhance the inclusivity and effectiveness of gamified learning environments (Domínguez et al., 2013).

Discussion

Regarding the first question, the findings demonstrate that gamification significantly enhances students' intrinsic motivation. (Sailer, M., Hense, J., Mandl, H., & Klevers, M. 2017) This is evidenced by students' positive feedback in the post-intervention questionnaire, where most agreed that gamified activities were engaging and fostered motivation to learn English vocabulary. The use of game elements like Experience Points (EXP) and Rank Progression aligns with Self-Determination Theory (Ryan & Deci, 2000), providing students with a sense of achievement and autonomy. These results echo previous studies that highlight gamification as a powerful motivator in educational contexts (Deterding et al., 2011; Hamari et al., 2014) For the second question, the gamified approach successfully increased student participation, as evidenced by their consistent engagement with tasks, such as completing "quests" and solving puzzles. Students expressed enjoyment and felt encouraged to collaborate and compete healthily, as highlighted in the qualitative data from interviews. For example, one student mentioned, "I liked competing with my friends because it made me more focused on learning" "This indicates that gamification fosters active participation by making learning activities more interactive and enjoyable. These findings are consistent with Domínguez et al. (2013), who noted that gamified systems promote teamwork and resilience, critical factors for sustained classroom engagement.

Overall, the study underscores the effectiveness of gamification in fostering intrinsic motivation, increasing participation, and improving academic performance in language learning. It highlights the importance of integrating game elements thoughtfully to maximize their educational benefits. However, some challenges, such as occasional stress from competition and the need for diverse activities, should be addressed to ensure all students benefit optimally from this approach. Future studies could explore long-term effects and adapt gamification for different age groups and subjects.

Conclusion

The implementation of gamification in English vocabulary learning for Grade 5 students has proven to be a highly effective strategy. The study demonstrated a significant improvement in students' vocabulary mastery, with post-test scores showing a notable increase compared to pre-test results. This improvement underscores the efficacy of gamified learning approaches in fostering academic progress.

Gamification not only enhances students' academic performance but also creates an engaging and enjoyable learning environment. Through elements like Experience Points (EXP), Rank Progression, and interactive tasks, students experienced increased intrinsic motivation and active participation. These game-based strategies also nurtured essential life

skills such as collaboration, resilience, and adaptability, further supporting students’ personal and academic development. (Nicholson, S. 2015)

The findings from this research provide valuable insights for educators seeking innovative methods to motivate learners and improve language proficiency. By incorporating gamification, teachers can create dynamic, student-centered classrooms that promote both enjoyment and educational achievement.

Despite its strengths, the study highlights some challenges, including occasional stress from competition and the need for varied activities to maintain engagement. Future research could address these limitations and explore the long-term effects of gamification in different educational contexts. Expanding gamification to other subjects and age groups may further enhance its potential as a transformative tool for teaching and learning.

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Literature Review: Assessment in education

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Abstract

Assessment in education is an important part of the teaching process. This article presents an overview of assessment in education and its development trends in the world. This emphasizes the importance of having more in-depth research on assessment in education to improve the quality of the teaching process. This study focuses on analyzing, synthesizing and comparing research on assessment in education to draw valuable conclusions. The results of this study are useful for new researchers, helping them understand the overall picture of educational assessment and define the research approach more clearly.

Key words: assessment, education, educational assessment, trend of assessment, Concepts of assessment, Classification of assessment.

1. Introduction

Assessment is a critical and integral part of education and continuous improvement. Effective educational systems must use reliable, valid, fair and relevant assessments that can convey accurate information about student learning to educators and other stakeholders (Maphalala, 2016).

Assessment is commonly discussed as a matter of teaching and learning. However, assessment carries a more profound social function. Through assessment, students become known. Assessment helps students understand themselves (Barrow, 2006).

Assessment is a powerful learning tool that can enhance learning and education. The process of student assessment should align with curricular goals and educational objectives. Identifying the assessment strategies necessary for the proper evaluation of students' progress is as important as establishing curricular content and delivery methods (Fuentealba, 2011).

This short review article aims to provide readers with an overview of the role of assessment in education. The article will also emphasize the trend of assessment innovation in education in countries around the world.

2. Study Methods

- Literature synthesis: The study uses this method to collect data and information on assessment in education and trends in innovation in assessment activities in education from countries around the world, which are synthesized from research published in prestigious scientific journals around the world.

- Feces Analyze: This study analyzes previously published documents on assessment in education. This allows us to assess the current state of research, focusing on complex problems, unresolved issues in this topic.

3. Findings and discussion

3.1. Concepts of assessment

Currently, there are many concepts about assessment in education. Some of the following concepts can be mentioned:

(i) Assessment involves the use of empirical data on student learning to refine programs and improve student learning (Allen, 2004).

(ii) Assessment is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning (Huba and Freed, 2000).

(iii) Assessment is the systematic basis for making inferences about the learning and development of students. It is the process of defining, selecting, designing, collecting, analyzing, interpreting, and using information to increase students' learning and development (Erwin, 1991).

(iv) Assessment is the systematic collection, review, and use of information about educational programs undertaken for the purpose of improving student learning and development (Palomba and Banta, 1999).

Although assessments used in various contexts and for differing purposes often look quite different, they share certain common principles. One such principle is that assessment is always a process of reasoning from evidence. By its very nature, moreover, assessment is imprecise to some degree. Assessment results are only estimates of what a person knows and can do (National Research Council, 2001).

3.2. Classification of assessment in education

Currently, in documents and research there are many ways to classify values in education.

According to McAlpine (2002), based on the purpose of assessment, we will design assessments accordingly. Some of the main types of assessments include the following:

(i) Formative or Summative

Formative assessment is designed to assist the learning process by providing feedback to the learner, which can be used to highlight areas for further study and hence improve future performance. Self and diagnostic assessment are types of formative assessment with specific purposes. Summative assessment is for progression and/or external purposes, given at the end of a course and designed to judge the students' overall performance

Examples:

Summative assessment: IQ tests, traditional examinations, driving test

Formative assessment: computer-based test which provides feedback on areas of weakness, an essay which annotated with the lecturer's comments, but no overall mark.

(ii) Formal or Informal assessment

Formal assessments are where the students are aware that the task that they are doing is for assessment purposes. With informal assessment the judgements are integrated with other tasks.

Examples:

Formal assessments: examinations, course work essays, thesis.

Informal assessments: lecturer notes taken during a practical, tape-recording of class French conversation, audit trails of the use of computer-based learning and self-assessment tests.

(iii) Final or Continuous assessment

Final (terminal) assessment is that which takes place only at the end of a course while continuous assessment is scattered throughout the course.

Examples:

Final assessment: the traditional ‘finals’ assessment, where the result of 3 years’ study is assessed over a period of a few days.

Continuous assessment: the more modern form of modular assessment, where judgements are made at the end of each field of study.

(iv) Process or Product Assessment

With the rapidly changing nature of modern society, increased emphasis is being placed on skills and abilities rather than knowledge. It is therefore important to consider whether you wish to assess the product of student learning, or the process undertaken.

Examples:

Product driven: (e.g. in French) computerised objective test of recently taught vocabulary, an essay question on an area of study.

Process driven: (e.g. in French) computerised objective test of unfamiliar vocabulary aided by an online French dictionary, research of an unfamiliar area.

(v) Convergent or Divergent assessment

Convergent assessments are those which have one correct answer that the student is trying to reach. Divergent assessments appreciate a range of answers based on informed opinion and analysis.

Examples:

Convergent assessment: computerised objective test; there is only one correct answer.

Divergent assessment: essay type question; no one correct answer, but rather an overall measure quality.

According to Tinh (2020), there are six types of assessment in education including:

- Classification based on assessment purpose: (i) Placement assessment; (ii) Diagnostic assessment; (iii) Change assessment.

- Classification based on the time of assessment: (i) Formative assessment; (ii) Summative assessment.

- Classification based on control objects: (i) norm - referenced assessment; (ii) criteria-referenced assessment.

- Classification based on assessment scale: (i) Large scale assessment; (ii) Classroom assessment;

- Classification based on assessment participants: (i) self assessment; (ii) peer assessment; (iii) group assessment.

- Classification based on assessment type: (i) Paper Testing; (ii) Authentic assessment.

Although there are many different types of assessment in education. However, the choice of assessment form will depend greatly on the assessment objective. As we know, no type of assessment has absolute advantages. Therefore, to increase the reliability and value of assessment results, it is necessary to coordinate many different forms of assessment.

3.3. Trends in assessment

a) Expansion of educational assessment in school systems

(i) Increased prominence of assessment in education policy

It is apparent that education policy is increasingly conferring a central strategic role to assessment as indispensable tools for improvement, accountability, educational planning and policy development. In the last two decades, most countries have introduced a wide range of measures intended to improve assessment at all levels from the student to the school system itself. These have done much to stimulate public awareness of assessment and to develop an evaluation culture within school systems.

(ii) Creation of dedicated agencies as part of new approaches to govern assessment

In many, the greater importance of assessment in education policy has involved the creation of specifically dedicated agencies which assume a central role in the governance of the assessment framework

b) Greater variety of assessment activities

The expansion of educational evaluation was accompanied by considerable diversification of assessment activities. Although educational evaluation within school systems is not a recent concern, it has traditionally focussed mostly on the assessment of students. In recent years, countries are increasingly developing more comprehensive assessment frameworks with more resources devoted to assessment components other than student assessment.

c) The rise of educational measurement and indicators development

(i) Student outcomes as the focal point for analysis

A major benefit of the stronger emphasis on evaluation and assessment has been the greater focus on improving student outcomes and achieving student learning objectives. This is reflected in the growing importance of student outcomes for system evaluation (increasingly relying on results of standardised student assessment and the international assessment of students), school evaluation (with school accountability increasingly tied to student outcomes) and teacher appraisal (with the exploration of direct links to student progress); the requirements for reporting publicly on student results; and the establishment of education national targets for student achievement including for particular groups of students. Performance in schools is increasingly judged on the basis of effective student learning outcomes. This is part of the general shift to outcome measures in the public sector. There is a greater emphasis on the use of student achievement data both to understand the balance between school, student and contextual data and to look at the school processes that appear to support improved achievements (Campbell and Levin, 2008).

(ii) The growing emphasis on measuring student outcomes

The introduction of national standardised assessments for students in a large number of countries reflects the stronger focus on measuring student outcomes. These make data on student learning outcomes available, providing a picture of the extent to which student learning objectives are being achieved, and they grant the opportunity to compare student learning

outcomes across individual schools, regions of the country and over time. As put by Kellaghan and Greaney (2001), “The most remarkable development in assessment towards the end of the 20th century has probably been the growth in its use to measure the achievement outcomes of national systems of education, either considered uniquely (in national assessments) or in the context of the performance of other education systems (in international comparative studies of achievement).”

(iii) The proliferation of education indicators

For the purpose of monitoring education systems and evaluating school performance, data are increasingly complemented by a wide range of education indicators based on demographic, administrative and contextual data collected from individual schools. Datasets typically include information on students (type of enrolment, completion, absenteeism, age, gender, marks, socio-economic background), teachers (functions, qualifications, career status, age, gender, areas taught, teaching hours, absenteeism, remuneration), non-teaching staff (qualifications, age, gender, category), and schools (financial management, use of technology, organisation of learning). The emphasis is increasingly on output measures.

d) Larger and more varied uses of assessment results

Countries are giving a more varied use to evaluation and assessment results, including as a tool for understanding better how well students are learning, for providing information to parents and society at large about educational performance and for improving school and teaching practices. As will be analysed below, an increasingly marked focus is the use of evaluation and assessment results to hold policy makers, school leaders and teachers accountable. There is also a growing use of evaluation as a system steering tool. As put by Broadfoot and Black (2004), “In recent years the importance of assessment as a policy tool has grown enormously as governments have increasingly come to realise its powerful potential as a mechanism of state control.” Evaluation procedures are now increasingly being considered as potential levers of change that can assist with decision making, resource allocation or school improvement.

e) The growing prominence of accountability as a purpose of assessment

Countries are increasingly using evaluation and assessment for accountability purposes. A central assumption in accountability is that substantial improvement necessitates that the school agents are held accountable for the outcomes they generate. By measuring student outcomes and holding teachers, schools and policy makers responsible for results, accountability systems intend to create incentives for improved performance and identify underperformance within school systems. Hargreaves and Shirley (2009), in their analysis of educational reforms, maintain that countries have gradually shifted from local and sampled assessments to high-stakes census testing for accountability purposes. Klenowski and Wyatt-Smith (2012) point to the political appeal of school-based accountability policies, in the sense of the clear need for politicians to be seen to deliver improved outcomes in education. Broadfoot and Black (2004) note, for example, that “decisions about assessment procedures – particularly those concerning high-stakes testing of various kinds – are as often based on perceived political appeal as they are on a systematic knowledge on the scientific evidence concerning fitness for purpose”.

f) Greater reliance on educational standards

The focus on student learning outcomes has, in many countries, driven the establishment or underlined the importance of educational standards for the quality of the work of schools and school agents, and encouraged means for monitoring progress towards those

standards. Educational standards refer to descriptions of what students should know (content standards) and be able to do (performance standards) at different stages of the learning process. In many countries, there is growing emphasis on the development and use of ambitious educational standards as the basis of assessment and accountability. By creating a set of standards against which student performance can be measured, countries aim to assess students against a desired measurable outcome. Examples of countries which implemented national educational standards are Australia, Austria, Belgium, Denmark, France, Luxembourg, Norway, the United Kingdom and the United States. By setting national or common standards, student outcomes can be more easily controlled for quality and they are more comparable (Wang et al., 2006). The movement towards comparing student outcomes to standards also has had a role in motivating countries to administer national standardised assessments.

g) Internationalisation of assessment

National education debates are increasingly shaped by international comparisons, particularly of student performance in international student surveys. These include student assessments conducted by the International Association for the Evaluation of Educational Achievement (IEA), the OECD's Programme for International Student Assessment (PISA) or UNESCO's Latin American Laboratory for Assessment of the Quality of Education (LLECE). As explained by Bonnet (2004), “The conception of educational evaluation has changed over the years, moving from an essentially national to a more international perspective. It has also taken a new dimension with the fundamental role it now plays in Europe. In parallel with national developments countries started to show interest in comparative evaluation at the international level.” Some education systems have been considerably shaken after publication of international comparative scores.

h) Greater technological sophistication

The expansion of assessment, particularly the spreading out of standardised student assessment, as well as the management of the data it generates has greatly benefited from greater capacity of information and communication technologies. Improvements include more individualised assessment approaches, better assessment of cognitive skills such as problem solving, capacity for rapidly marking large-scale assessments, reliability in marking and reduced cost to administer student assessment.

4. Conclusion

(i) Concepts of assessment

Assessment is an important part of the educational process. Assessment is the process of collecting information about learners in order to make the most accurate comments about the development of learners' abilities. Although there are many different concepts and classifications of assessment, in general assessment must be based on educational goals and authentic evidence, ensuring reliability.

(ii) Classification of assessment in education

Although there are many different assessment methods in education. However, the choice of assessment form will depend greatly on the assessment objective. To increase the reliability and value of assessment results, it is necessary to coordinate many different forms of assessment. In addition, stakeholders need to clearly understand the characteristics and nature of each type of assessment during the process of implementing assessment in education.

(iii) Trends in assessment

All changes in assessment in education aim to accurately assess learners' abilities and progress. To improve the value of assessment activities in education, it is necessary to carry out many synchronous solutions such as: changing policies, coordinating many different forms of assessment, applying technology in assessment, etc.

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Teaching methods of economic law for students of economics

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Abstract

Economic law is an important subject for students who can become entrepreneurs, accountants, and business executives. In the future career orientation of students with dynamic, creative, and perceptive qualities, many situations related to economic law can arise in this field. Understanding the nature of the legal framework as well as the role and impact of legal norms on businesses will have a different approach than students majoring in law. By observing and collecting information from the practice of teaching this subject, the article reflects the current situation and proposes solutions such as: raising students' awareness of economic law due to its impact on business transactions; students need to complete many case studies at home actively, lecturers guide students to use problem-based learning methods to ensure that it is suitable for students' qualities for the major.

Keywords: economic law; problem-based teaching method; economics students

Introduction

Economic law is one of the compulsory subjects for students majoring in economics at universities that do not specialize in law. This subject has a capacity of 45 periods equivalent to 3 credits, which is the foundation for specialized subjects. The objective of the economic law subject is to help students acquire basic knowledge related to different business entities, focusing on the issue of limited and unlimited liability, procedures for establishing enterprises and concluding contracts, dissolution, and bankruptcy of enterprises. In addition, based on the nature of dynamic and creative students through the self-awareness of presenting ideas on topics related to the content of the subject, the investment in preparing lectures by lecturers as well as the teaching process when teaching under the characteristics of students in this field to ensure feasibility is an urgent issue.

Objectives

I have used the method of observation and collection, analysis and processing of information, discussion, and practice on how to teach economic law to students majoring in economics at universities of various countries. Thereby, drawing experience to propose improvements in teaching methods for this subject in Vietnam to be better in the future.

Boundary

1. Theoretical basis

Economic law is a difficult subject for non-law students. The teaching method of this subject needs to be implemented in a way that students accept to attract their attention. Therefore, lecturers need to have a suitable teaching plan to ensure that students study and love the subject of Law. However, this is not easy. Students face many challenges because the subject requires students to read and memorize many provisions of legal documents. While memorizing legal provisions and reading legal terminology is not simple for non-law students. Usually, the basic contents of the economic law subject in the training program of colleges and universities are built into chapters such as General issues of economic law; Law on types of enterprises, Law on contracts; Law on bankruptcy, and Dispute resolution in business.

In addition to the group work method, the situational method, or the application of information technology in the digital age, the problem-posing method is also applied by lecturers when guiding students to grasp knowledge content through solving problematic situations to promote students' creative activities. At the same time, overcoming the one-way transmission situation, contributes to changing the learning state; stimulating thinking, creativity, interest, and positivity; and training students' ability to analyze, synthesize; present, and debate.

2. Current status of economic students studying economic law

2.1. Achievements

2.1.1. *Students are aware of the importance of the subject of economic law*

The achievements of economics students in the subject of economic law are not simply scores or knowledge acquired through lectures for each student. Instead, students satisfy their passion and ability through the content of discussions and presentations in class. The content that students have done at home is compared with the conclusions of the lecturer in each content section. Students are free to present ideas revolving around the content of the lesson with confidence, sensitivity and teamwork

2.1.2. *Lecturers apply appropriate methods to exploit students' potential*

In fact, lecturers play an important role in interpreting and conveying concepts, ideas, and regulations of law and how to implement economic law for each business entity. The main motivation for students to learn is the importance of the volume, output standards of the course, and the skills and qualities of students in the economic sector to promote students' active participation in learning activities. Because students are not majoring in law, lecturers are required to be creative and innovative to ensure that students have the conditions to participate in activities to achieve the course objectives with appropriate teaching methods. Lecturers can learn about students' experiences in learning law through the teaching methods and assessments of lecturers. From there, it will change the perception of both teachers and students. Appropriate and beneficial activities for students will effectively raise learners' awareness not only for the subject of economic law.

2.1.3. *Students are interested in the subject through the problem-based approach*

Students identify real-life business-related problems when studying Business Law as situations that they may encounter in their future careers. This is an intrinsic motivation that leads students to a deep learning approach, recognizing their own participation in the lesson in the commercial field. This experience provides students with knowledge, building confidence in their ability to understand the law. Combining existing knowledge with the skills students are learning will enhance the student's learning experience. Employers have higher expectations of students' work readiness and address issues such as how to achieve this through

the choice of a business entity or various forms of contractual relationships. For example, the sale of goods/provision of services, transportation arrangements, employer-employee relationships; legal consequences of business transactions; discussing the legal services market; and the products that consumers and businesses require. These services include providing advice; carrying out legal work to ensure legality and conflict management through lectures and module exercises, and introducing students to the idea of many legal service providers, including lawyers.

Regarding contracts, the lecturer will ask students to choose a specific business entity to operate a bus service as a typical example. The first tutorial in each module is dedicated to examining a real-life situation that is the topic of each student group's implementation. In this case, students will make a list of agencies or people who can be contacted to collect information. In addition, students must present a list of people they have interviewed. A letter or fax sent to the state agency or any legal service provider requesting advice on one or more of those points; confirm the decision to establish a specific business entity from the choice: sole proprietorship, partnership or limited liability company, joint stock company. The initial choice includes non-legal approaches to the information-gathering issues. But at the appropriate stage of the learning process, students will be directed to the legal aspects of the issue and asked to make choices about the type of business entity that best suits the circumstances. The information-gathering exercise allows students to make a convincing choice to operate their business as a sole trader, a partnership or a limited liability company. From there, students will decide on the financial or monetary economic concerns; the management constraints, and, importantly, the requirements of local authorities for each type of business.

For the contract module, students are asked to identify the subjects entering into contracts and the contents that need to be considered in each contract. For example, a contract with an employee would involve other considerations because the contract is with the landlord. Students are also asked to write a simple contract to a partner or client, noting the obligations and risks that may be involved in the agreement. For example, the cost of transporting goods to the location. However in this case, the student may not have to draft a contract. However, this is valuable content, helping students consider the legal terminology that should be included in the contract. Therefore, the lecturer is interested in the student mentioning the terms associated with the agreement rather than encouraging contracts to follow a specific form as prescribed by law.

Thus, the teaching of economic law can be applied based on different applied methods. In which, the issue is to shift the responsibility for understanding and learning from the teacher to the learner. The lecturer mainly acts as a facilitator with a deep understanding to ensure the correct implementation of the steps of the teaching process.

2.2. Challenges

2.2.1. The number of legal documents is too large and what is expected of students

Not only the Enterprise Law, Bankruptcy Law, Commercial Law, Civil Code, and Commercial Arbitration Law, but also the sub-law documents will have to be updated by students to apply to each specific situation, condition, and circumstance. Meanwhile, students are not yet proficient in how to research specific applications to handle situations for each case. Legal terms are strict and refer to other regulations, making it difficult for students to apply them to case studies during the preparation process. At the same time, once the lecturer conveys inappropriate information, such as applying the traditional way to explain each content, it will not stimulate students' initiative and self-awareness in the learning process for the Economic Law subject. Instead, students expect teachers to encourage them by giving them bonus points

for preparing well before class, forming study groups, participating in class, and not using cell phones during class.

2.2.2. Traditional teaching methods do not allow students to be creative

The characteristic of the traditional method is that students have to absorb information provided by the lecturer. In the age of information technology, the teaching method must be suitable to be able to use e-learning. Moreover, the attitude of students when learning economic law is identified as a challenge in teaching law to learners. Therefore, lecturers must share with students about the structure of the subject, the meaning of the subject, the perfection of the law and the thinking process is important in teaching economic law. Therefore, the pedagogical method of teaching law to students of economic majors is completely different from the method of teaching pure law students, requiring a series of integrated process assessment methods.

2.2.3. The extent to which students apply their knowledge of Business Law

Most undergraduate business degrees require students to complete a business law module. This requires students to identify legal issues in a given real-world situation, apply legal principles to practice, and then advise clients. Therefore, during the course, students taking this module may be required to assume the role of a hypothetical lawyer. In this way, students will feel that they themselves are seeking legal advice. If lecturers are serious about improving their teaching, they must continually examine the relevance and impact of their teaching on students in order to facilitate their experience. In other words, the lecturer must translate what has been learned into a clearer presentation of structure and content in a scientific way so that students can easily recognize the relevance of economic law to their future working life. From there, students participate in document research to improve their knowledge and abilities.

2.2.4. Economic Law Impacts on Students' Future Careers

In the future, economic students will hold positions in the business world. Therefore, students need to be familiar with the legal regulations that impact the transactions of their future profession. For example, a businessman needs to realize that certain legal regulations require businessmen to regulate their transactions with employees or to take specific actions when marketing or trading products or services. Students must understand that a purchase or sale transaction or service will give rise to obligations and rights between parties that may result in disputes due to breach of contract or other violations of law. The content of economic law creates an environment that allows students to perceive the legal consequences that may arise after their decisions in the daily operations of the business entity. From there, it helps learners build risk management policies. In practical terms, these business students will then become entrepreneurs who are able to structure their affairs to avoid legal challenges.

2.2.5. Lectures to support students in collecting information

Lectures only play a supporting role for students in collecting information for case study exercises in each enterprise. The lecture clearly states the necessary requirements in forming business entities, the topics of each module are taught weekly. The lecturer provides information to students and the expected exercises. Students are confirmed in their knowledge by this method. The test questions will reflect the exercises of the module so that students feel that they are constantly prepared with content to consolidate their knowledge.

Common questions for students studying economic law often require students to advise a client on a specific situation or are required to write a page (assuming an average of about 250 words per page) on the following content: imagine that you are a manufacturer of canned food. Describe the different types of legal liability for which you may be responsible. Which partnership is popular. Why was this form of business entity chosen among the various types of business entities?

This type of question allows students to draw on and apply the knowledge they have gained while completing the exercise. For example, answering the question, “Why do you want a partnership?” Most students answer this question by listing the advantages. However, they do not realize that a complete answer will also include an answer about the disadvantages. Students should be alerted to the need to justify their choice. It is part of the normal decision-making process to consider the impact of these disadvantages and whether they can be mitigated. Since a partnership is chosen, it can be assumed that one of the disadvantages is that each partner is responsible for the actions of the other partner under the agency principle. However, the impact of this could be lessened if it were acknowledged that when individuals form partnerships, they often think of people they are close to or choose partners they trust.

In general, the use of problem-based modules in tutorials focuses on relevant situations to give a realistic perspective on what students will experience in their commercial transactions. And then, testing students in the same way to effectively present the law in relation to the business environment. In doing so, consider the concerns and cognitive needs of students and try to incorporate these considerations into the content and presentation. Here,” the objective of the module is not to equip students with the ability to advise anyone as a lawyer. But business law will help students identify how the law affects them as business people and prepare them to act more proactively in legal terms” (Lillian Corbin BBus, LLB (Hons), Grad Cert H Ed Lecturer, 2002)

3. Solutions for effective teaching methods of Economic Law for economics students

3.1. Raising awareness of economic law affecting business transactions

Working knowledge of economic law is very important for economics students. After graduation, this group will participate in the business labor market and apply their legal knowledge to the daily real-life environment. Although economic law is very important and useful for students, it is also a very difficult topic for students to grasp. Economic law can easily confuse even intelligent law students who are familiar with complex legal concepts. However, teaching interdisciplinary subjects is still a challenge even for lecturers, so it requires lecturers to closely analyze the principles of applying teaching and learning methods to each lesson.

Nowadays, the subjects are not rigid to teach conveniently for students, especially the dynamic, flexible and creative nature of students in the field of economics. Topics can and often overlap with each other according to the principles of business and law. Economic law affects all business transactions and the law itself can be considered a business activity. Therefore, most training programs in the field of economics include law modules. This means that businesses will be affected by many different aspects such as labor law, contract law and economic law. Therefore, raising awareness of economic law affecting business transactions is the first solution that teaching and learning activities need to aim for.

3.2. Students need to actively complete a lot of case studies

For the economic law course, students must master the terms related to contract law. For example: offer, acceptance to enter into a contract. This problem can be overcome by requiring a basic introduction to the legal system or contract law as a prerequisite for choosing courses for the economic major. Participation in the study of economic law courses can be considered undesirable or even detrimental to the progress and academic performance of marketing students in terms of practice.

Because, the most important problem that students encounter when studying economic law is the complexity of this field of law and its sources. Economic law is necessarily a complex field of law. The number of legal documents applicable to companies is very large. The main sources are corporate law and other statutory provisions related to contracts and bankruptcy law.

However, it is difficult to fully understand bankruptcy law without a thorough understanding of investment capital, owner's charter capital, bankruptcy law, and contract law. The difficulty for business students when studying corporate law is trying to understand the abstract nature of the company. In theory, each enterprise is a separate legal entity. However, "a business is not a physical entity, so it cannot act physically on its own but must rely on legal regulations. People represent the activities on behalf of the company. Students are confused when approaching such abstract concepts to understand exactly who is acting on behalf of whom; the legal consequences of those actions. Therefore, to master the skills in the implementation process, students need to actively complete situational exercises or suggest problems that need to be solved from the lecturer". (Nicolette Butler and Omar Madhlom, 2015)

3.3. Instructors guide students to use problem-based learning

Problem-based is a pedagogical strategy that poses real-life situations with important contexts and provides resources and guidance for learners to develop knowledge content and problem-solving skills. Accordingly, instructors change teaching methods such as integrating problem questions into lectures in the order: of problem, law, application, and conclusion. When teaching economic law to non-law students, instructors need to provide strategies. There are many different methods to solve legal problems. However, instructors can familiarize students with a single method applied to each lesson or topic. Students need to be encouraged by instructors to learn to negotiate between their field of study and legal practice.

The problem-solving approach to teaching students will expose them to the realities and ways of presenting a case when a dispute arises in the business world. The result of this approach is that students become very good problem solvers. However, many learning methods can be completely transformed when information technology provides students with problem-based learning. Students can be provided with a space to be independent and use more technology in their learning. The integration of technology will affect the way of teaching and learning

Conclusion

Applying the right method in teaching economic law to non-law students is very important. Lecturers must be able to approach students accurately based on their abilities. Teaching and assessment methods need to be appropriate to attract attention and develop interest in the subject, especially when students have preconceived ideas about the subject, lectures must collect students' opinions on each content right from the beginning of the course. Therefore, lecturers can plan appropriate activities to support students in learning economic law chapter by chapter. In addition, “friendly teaching assessment methods can help students feel comfortable and reduce their fear of the subject” (Hanna Ambaras Khan, 2021).

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Generative AI in Educational Assessment: Opportunities, Challenges, and Demonstrative Prototype for Multiple-Choice Test Grading

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Abstract

The rapid growth in student enrollment at universities worldwide is placing immense pressure on educators, particularly in the domain of assessment. While traditional grading, especially for multiple-choice tests, can be time-consuming and lack personalization, Generative Artificial Intelligence (GenAI), particularly Large Language Models (LLMs), offers transformative potential. This paper provides an overview of the key opportunities and challenges associated with leveraging GenAI in educational assessment. To illustrate the practical application of these concepts, we present a web-based prototype that utilizes LLMs for flexible Optical Mark Recognition (OMR) and personalized feedback generation for multiple-choice tests. Initial testing of the prototype demonstrates the feasibility of applying LLMs for these tasks. The paper argues that while GenAI presents significant advantages for enhancing assessment efficiency and personalization, careful consideration of ethical implications and practical challenges is crucial for its successful integration. We conclude by outlining future research directions focused on responsible development and implementation of GenAI in education.

Keywords: Generative AI, Large Language Models, Automated Grading, Personalized Feedback, OMR.

Introduction

Assessing student learning is fundamental to education, serving as a crucial gauge of knowledge acquisition and a guide for pedagogical refinement. While diverse assessment methods exist, they often present challenges related to efficiency, scalability, personalization, and timely feedback (Burrows et al., 2015). The rapid growth in student enrollment, particularly in institutions like Hue University of Economics, further exacerbates these challenges, with thousands of assignments and tests requiring processing each semester. Traditional grading, especially for multiple-choice tests, can be time-consuming and lack personalization, creating a significant burden for educators, especially in developing countries with large class sizes and limited resources (Hafeez et al., 2024). This situation creates an urgent need for technological solutions that can automate aspects of the assessment process, reduce workload for lecturers, improve the quality and depth of evaluations, and provide better support for students.

Early research in automating assessment focused heavily on computer vision technology and Optical Mark Recognition (OMR) for multiple-choice questions (MCQs) (Ascencio et al., 2021; Das et al., 2021). While OMR systems offer advantages like scalability, faster grading, and reduced bias compared to manual grading (Hahn et al., 2021), they are often limited to structured formats and lack the ability to provide rich, personalized feedback.

The advent of Generative Artificial Intelligence (GenAI), especially Large Language Models (LLMs), presents a significant paradigm shift, offering the potential to revolutionize educational assessment far beyond the capabilities of traditional methods. LLMs, with their ability to understand and generate human language (Li, Jiang, et al., 2024; Schneider et al., 2023), can analyze diverse question formats, evaluate open-ended responses, generate personalized feedback, and even create new assessment items. As highlighted by Hafeez et al. (2024), there's a growing need for research focused on leveraging LLMs for automated assessment and personalized feedback, particularly in developing countries, but the potential extends globally across all educational contexts (Hafeez et al., 2024).

This paper explores the transformative potential of GenAI in educational assessment, outlining key opportunities and challenges in areas like efficiency, personalization, and pedagogical effectiveness. To demonstrate this potential, we present a web-based prototype using LLMs for flexible OMR and personalized feedback generation in multiple-choice tests. While this prototype offers a practical example, it represents only a fraction of GenAI's broader possibilities in education.

The remainder of this paper is structured as follows: Section 2 reviews the literature on assessment technologies, leading to GenAI. Section 3 outlines the opportunities and challenges of GenAI in assessment, while Section 4 discusses overarching challenges in education. Section 5 details our prototype, Section 6 concludes the paper and outlines future research.

1. Research Objectives

1.1 Explore GenAI's potential: Investigate how GenAI, especially LLMs, can enhance educational assessment efficiency, personalization, and effectiveness.

1.2 Identify opportunities and challenges: Determine how GenAI can improve assessment (e.g., automated grading, personalized feedback) while also addressing ethical, privacy, technological, and pedagogical challenges.

1.3 Develop, evaluate, and plan: Create a web-based prototype using LLMs for flexible OMR and personalized feedback in multiple-choice tests, evaluate its feasibility and effectiveness, and outline future research for responsible GenAI integration in education.

2. Review of Related Literatures

This section reviews the literature on assessment technologies, focusing on the rise of Generative Artificial Intelligence (GenAI). GenAI refers to AI models that create new content, like text or images, based on learned patterns. A key example is Large Language Models (LLMs), which excel at understanding and generating human-like text. We'll first trace the evolution of assessment technologies, leading to GenAI, and then explore the current landscape of GenAI applications in educational assessment.

2.1. The Evolution of Educational Assessment Technologies: From OMR to GenAI

Figure 1 depicts the evolution of educational assessment, from pre-19th-century informal methods to today's Generative AI. Key milestones include the introduction of standardized testing in the early 20th century and the mid-century emergence of technology-based assessments, including early computer-assisted grading and the first Intelligent Tutoring Systems (ITS) (Carbonell, 1970). The late 20th century saw a shift towards “assessment for learning” (AFL), emphasizing formative assessment to guide instruction and improve student

learning (Black & Wiliam, 1998). The early 21st century brought AI-powered assessments and learning analytics, enabled by increased computing power and the availability of large datasets. While initial automation efforts focused on Multiple-Choice Questions (MCQs) due to their structured format, the field has broadened. Optical Mark Recognition (OMR) technologies offered scalability, speed, and reduced bias for MCQs (Hahn et al., 2021), but were limited by cost, sensitivity to imperfections, and a lack of detailed feedback (Ascencio et al., 2021; Hafeez et al., 2024). These limitations, coupled with a need for richer assessment, spurred explorations into Automated Short Answer Grading (ASAG) and Automated Essay Scoring (AES) (Burrows et al., 2015). However, these early systems faced challenges in accurately interpreting natural language. The recent rise of GenAI and Large Language Models (LLMs) represents a significant leap forward. LLMs are now being used for automated essay scoring (Schneider et al., 2023), intelligent tutoring systems (Foung et al., 2024; Li, Jiang, et al., 2024), personalized learning platforms (Foung et al., 2024), and automated feedback generation (Fleckenstein et al., 2024; Latif & Zhai, 2024). Unlike traditional methods, LLMs can handle diverse question formats beyond MCQs and provide explanations for answers, enhancing understanding and facilitating deeper learning. Despite advancements, a significant gap remains in leveraging LLMs for automated grading of paper-based assessments with personalized feedback, especially in developing countries. This research directly addresses this gap, aiming to improve educational equity and learning outcomes in under-resourced environments by developing and evaluating an LLM-based system for this purpose.

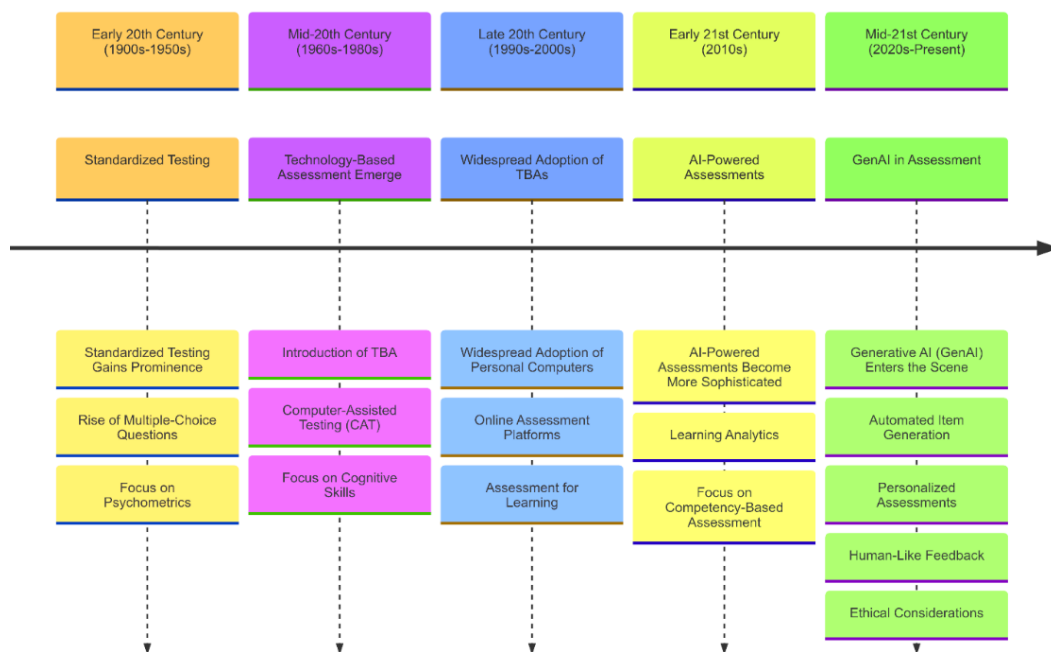


Figure 1. Evolution of Educational Assessment

2.2 The Landscape of GenAI in Educational Assessment: Applications and Tools

Building on LLM capabilities, the field is exploring diverse GenAI applications in assessment, including automated grading (Schneider et al., 2023), test item generation (Das et al., 2021), personalized feedback (Matelsky et al., 2023), and academic dishonesty detection (Fleckenstein et al., 2024). GenAI is rapidly transforming education, with tools implemented across various levels, from primary schools to universities (The Open Innovation Team and Department for Education, 2024). Educators are using non-specialized tools like ChatGPT, Google Bard (now known as Gemini), and Midjourney, alongside education-specific tools like

TeachMateAI (The Open Innovation Team and Department for Education, 2024). These tools streamline curriculum development, administrative tasks, and lesson planning. While concerns about accuracy and data privacy remain, GenAI is also used to personalize learning materials, support students with special needs, and aid in research, writing, and content creation (The Open Innovation Team and Department for Education, 2024). Furthermore, it's used to train staff and students on GenAI itself and enhance educators' professional development. Across subject domains, GenAI aids in creating writing exemplars, generating comprehension questions, facilitating language learning, generating experiment ideas, creating multiple-choice questions, producing programming code, creating self-marking quizzes, producing artwork and creative outputs, and even creating interactive historical figures. GenAI shows significant potential for scaling personalized learning, delivering real-time feedback, automating assessment, enabling independent study, enhancing organizational efficiency, and aligning programs with employer needs (The Open Innovation Team and Department for Education, 2024). In language learning, tools like Quillbot, ChatGPT, Grammarly, and Just The Word are gaining popularity (Foung et al., 2024), supporting writing assistance, proficiency building, and teacher support via automation and personalization (Foung et al., 2024). Notably, 74% of students in a five-country survey report (i.e., India, Japan, the UK, Brazil, and the US) using ChatGPT for assessments (Foung et al., 2024).

Research Methodology

1. The Research Procedure Includes 3 Steps which are:

1.1 We reviewed academic articles and industry reports to understand how GenAI and Large Language Models (LLMs) are impacting educational assessment. Thematic analysis helped us identify and categorize key opportunities and challenges.

1.2 From the literature review, we developed a framework to organize the identified opportunities (e.g., personalized learning, automated assessment) and challenges (e.g., ethical concerns, data privacy).

1.3 We built a web-based prototype using Google's Gemini API to demonstrate automated multiple-choice test grading. This illustrated how GenAI could be applied in a real-world assessment scenario.

1.4 Initial testing of the prototype helped us reflect on the practical implications of the opportunities and challenges identified earlier. These insights informed the paper's discussion and conclusions, highlighting areas for future research.

2. Research Instrument (s)

2.1 Literature Review and Analysis: This involved a comprehensive review and thematic analysis of scholarly articles, industry reports, and online resources to identify opportunities and challenges of GenAI in educational assessment.

2.2 Demonstrative Prototype: A web-based prototype using Google's Gemini API was developed to provide a practical example of GenAI's application in automating multiple-choice test grading.

Results/Research

1. The opportunities and Challenges

Integrating Generative Artificial Intelligence (GenAI) into educational assessments presents numerous potential benefits that could revolutionize learning experiences for both students and educators (Lan et al., 2015; Matelsky et al., 2023). This technology offers opportunities to personalize learning, provide real-time feedback, automate assessments, enhance assessment quality, support diverse learning needs, generate data-driven insights, streamline administrative tasks, and promote critical thinking skills (Hahn et al., 2021; Li, Wang, et al., 2024). However, alongside these opportunities, there are challenges that must be addressed for each area.

1.1 Opportunities

1.1.1 *Personalized and Adaptive Learning*

GenAI has the potential to revolutionize education by creating personalized and adaptive learning experiences tailored to each student's needs. Building on earlier adaptive learning research (Ling & Tan, 2018), GenAI can dynamically adjust learning pathways based on student strengths, weaknesses, and preferences (Hahn et al., 2021). AI-powered systems can analyze student responses, offer immediate feedback (Matelsky et al., 2023), and identify at-risk students. GenAI is also enabling the development of advanced AI tutors that adapt their teaching approach (Matelsky et al., 2023) and curate personalized materials (Kasakowskij et al., 2022), leading to enhanced student engagement and improved outcomes. Examples like Noodle Factory's and Fulford School's AI implementations (The Open Innovation Team and Department for Education, 2024) demonstrate GenAI's potential to create more effective learning experiences.

1.1.2 *Automated Assessment*

GenAI is transforming educational assessment by automating grading, generating diverse questions, and enhancing overall efficiency. This allows educators to save time, provide timely feedback, and focus on more engaging teaching aspects. GenAI can automate grading for various formats, including MCQs, fill-in-the-blank, and short answer questions, building upon OMR technology (Ascencio et al., 2021; Chai, 2017; Kommey et al., 2022) to offer enhanced efficiency, objectivity, and scalability (Hahn et al., 2021; Kommey et al., 2022). It can also generate diverse assessment questions, including MCQs with plausible distractors, true-false questions, and fill-in-the-blank questions (Das et al., 2021; Kasakowskij et al., 2022). This saves time, provides variety, and allows for customization to specific learning objectives. GenAI enhances assessment quality by creating questions aligned with learning objectives and generating high-quality distractors (Schneider et al., 2023). Furthermore, it can analyze large datasets to reveal hidden patterns in student performance (Hahn et al., 2021; Kommey et al., 2022), create personalized learning pathways, and adapt assessment methods to individual student needs (Das et al., 2021; Hahn et al., 2021). It can also provide instant feedback, automate grading, and help make data-driven decisions regarding curriculum and instruction (Hahn et al., 2021; Schneider et al., 2023).

1.1.3 *Data-Driven Insights for Improved Instruction*

The analysis of student performance data by generative AI (GenAI) presents a transformative opportunity to enhance instructional practices. GenAI offers a powerful way to improve instruction through data analysis. It can analyze vast amounts of student data to uncover hidden patterns in learning, pinpoint areas of difficulty, and identify individual student needs (Hahn et al., 2021; Kommey et al., 2022; Lan et al., 2015). This allows for personalized learning pathways, tailored interventions, and adaptive assessments (Das et al., 2021; Hahn et al., 2021). GenAI can also provide real-time feedback to students, helping them improve

immediately (Hahn et al., 2021; Schneider et al., 2023). Additionally, it can automate test creation and grading, and inform data-driven decisions about curriculum and instruction (Hahn et al., 2021; Kommey et al., 2022; Lan et al., 2015). In essence, GenAI enables educators to better understand student learning and tailor their approach for greater effectiveness.

1.1.4 Support for Diverse Learners and Accessibility

GenAI holds immense potential to make education more inclusive and accessible. It can create personalized learning paths tailored to individual needs, benefiting students with and without disabilities (Fleckenstein et al., 2024; Hahn et al., 2021; Matelsky et al., 2023). GenAI can automatically generate accessible learning materials in multiple formats, including text-to-speech, audio descriptions, and translations (Hahn et al., 2021). It can also create accessible assessments with alternative formats and assistive technology support (Fleckenstein et al., 2024; Hahn et al., 2021). Students with SEND (Special educational needs and disabilities) can particularly benefit from individualized instruction and adaptive tools (Matelsky et al., 2023; The Open Innovation Team and Department for Education, 2024). Furthermore, GenAI can expand access to education for learners in remote or underserved areas through online platforms (Hahn et al., 2021; Matelsky et al., 2023). In short, GenAI can revolutionize educational access and support for diverse learners.

1.1.5 Streamlined Operations and Educator Support

GenAI offers tremendous potential for streamlining operations and providing valuable support to educators, allowing them to focus more on teaching and student support. By automating administrative tasks, offering data-driven insights, and assisting with content creation, GenAI can significantly reduce educators' workloads and empower them to deliver more effective and engaging learning experiences.

Automating administrative tasks is a key benefit. GenAI can automate the grading of objective assessments like multiple-choice questions, achieving accuracy comparable to human graders, and can even assist in providing feedback on subjective assessments like essays by identifying common errors and suggesting improvements (Chang & Ginter, 2024; Latif & Zhai, 2024). It can also streamline lesson planning and content creation, generating lesson plans, quizzes, assignments, and interactive learning materials based on learning objectives and curriculum requirements (Ling & Tan, 2018; Matelsky et al., 2023). Furthermore, GenAI can assist with communication tasks, such as drafting emails, creating newsletters, and managing student schedules.

Another significant advantage is GenAI's ability to provide data-driven insights and support. It can analyze student data to pinpoint learning gaps, track performance over time, and suggest personalized interventions (Hahn et al., 2021). It can also provide feedback on the effectiveness of educators' assessment practices, helping them refine their strategies and develop more equitable and valid assessments (Das et al., 2021; Hahn et al., 2021).

By automating tasks and providing insights, GenAI frees up educators' time for more meaningful interactions with students, allowing for more personalized feedback, deeper discussions, and stronger relationships. Finally, GenAI can support educators in their professional development by providing access to personalized learning resources, connecting them with peers, and offering opportunities for self-directed learning (Zhang et al., 2019). This allows educators to stay current with research, enhance their teaching skills, and constantly strive for improvement.

1.1.6 Development of Critical Thinking and Future-Ready Skills

Integrating GenAI in education offers a significant opportunity to enhance critical thinking and prepare students for an AI-driven workplace. By fostering AI literacy, students gain a foundational understanding of AI concepts, applications, and limitations (Matelsky et al., 2023; The Open Innovation Team and Department for Education, 2024), learn to critically

evaluate AI outputs (Fleckenstein et al., 2024; Latif & Zhai, 2024), and understand the ethical considerations surrounding AI use (Latif & Zhai, 2024; Matelsky et al., 2023).

GenAI promotes deeper analysis by automating lower-order tasks, allowing students to focus on higher-order thinking skills like analysis, evaluation, and synthesis (Fleckenstein et al., 2024; Fount et al., 2024; Matelsky et al., 2023). It encourages questioning and skepticism towards AI outputs, fostering a mindset of critical inquiry. Students also learn to make informed decisions about using AI tools, selecting the most suitable tool for a given task (Fount et al., 2024).

These skills directly translate to the demands of the modern workplace. Students gain AI fluency, becoming more competitive in the job market (The Open Innovation Team and Department for Education, 2024). They develop adaptability and a commitment to lifelong learning, essential in the rapidly evolving field of AI (Latif & Zhai, 2024). They also learn human-AI collaboration, preparing them for a future where humans and AI work together (Schneider et al., 2023).

To foster these skills, educators can incorporate AI literacy into the curriculum, design assessments that encourage critical AI use, provide opportunities for experimentation, and foster open discussions about AI’s impact (Fleckenstein et al., 2024; Matelsky et al., 2023). In essence, GenAI empowers students to become informed, adaptable, and responsible citizens prepared for an AI-driven future.

1.2 Challenges

While the integration of GenAI into educational assessment offers a plethora of opportunities, it also presents a complex web of challenges that must be addressed to ensure responsible, equitable, and effective implementation. These challenges span ethical considerations, data privacy and security, technological and implementation hurdles, pedagogical adjustments, and equity concerns. Successfully navigating these challenges requires careful planning, ongoing evaluation, and collaboration among educators, researchers, policymakers, and technology developers. This section provides an overview of the key challenges associated with the adoption of GenAI in educational assessment, categorized for clarity and summarized in a tabular format for easy reference.

Challenge	Description	Opportunities	Reference(s)
Algorithmic Bias	GenAI models can inherit and amplify biases present in training data, leading to unfair or discriminatory outcomes in assessments, particularly for underrepresented groups.	1.1.1, 1.1.2, 1.1.3, 1.1.4, al., 1.1.5, 1.1.6	(Fleckenstein et al., 2024; Matelsky et al., 2023; Schneider et al., 2023)
Lack of Transparency (“Black Box” Nature)	The opaque decision-making process of some GenAI models makes it difficult to understand how they arrive at their outputs, hindering trust, accountability, and error detection.	1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5	(Waleed Abdullatif Khader Salameh, 2024)
Data Privacy and Security	The use of GenAI involves collecting and analyzing sensitive student data, requiring robust security measures, adherence to regulations, and transparent data handling practices.	1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5	(Mittal et al., 2024)

Challenge	Description	Opportu -nities	Reference(s)
Cost and Infrastructure	Implementing and maintaining GenAI systems can be expensive, requiring investment in hardware, software, and technical expertise, potentially creating disparities between institutions.	1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6	(Khlaif, 2024)
Technological Integration	Ensuring interoperability between GenAI tools and existing educational platforms (e.g., LMS) can be complex and require significant technical expertise.	1.1.2, 1.1.3, 1.1.5	(Khlaif et al., 2024)
Rapid Technological Advancements	The fast-paced evolution of GenAI requires ongoing monitoring of advancements and adaptation of strategies to keep pace with new developments.	1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6	(Perkins et al., 2024)
Teacher Training and Professional Development	Educators need adequate training and support to effectively use GenAI tools, interpret their outputs, and integrate them into their teaching practices.	1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6	(The Open Innovation Team Department for Education, 2024)
Balancing Automation with Human Oversight	It's crucial to maintain a balance between AI-driven automation and the vital role of educators in providing guidance, support, and fostering critical thinking.	1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6	(Waleed Abdullatif Khader Salameh, 2024)
Maintaining Academic Integrity	The potential for GenAI to be used for cheating or plagiarism necessitates strategies to ensure academic honesty, such as detection software and proctoring tools.	1.1.2	(Pulivarthy & Whig, 2024)
Equity and Accessibility	Ensuring equitable access to GenAI tools and resources for all students, regardless of background, location, or disability, is crucial to prevent exacerbating existing inequalities.	1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.6	(Hahn et al., 2021; Matelsky et al., 2023)
Defining and Assessing AI Literacy	Establishing a clear definition of AI literacy and developing effective methods for assessing students' understanding and skills related to AI are ongoing challenges.	1.1.6	(Moorhouse et al., 2023)
Balancing Development Ethics	It is important to foster ethical awareness and responsible use of AI in conjunction with developing technical	1.1.6	(Kaldaras et al., 2024)

Challenge	Description	Opportunities	Reference(s)
Avoiding Overemphasis on Technical Skills	skills. Students need to understand the societal impacts of AI. AI literacy should not overshadow the development of other essential skills, such as creativity, communication, and collaboration.	1.1.6	(Moorhouse et al., 2023)
Individualization vs. Standardization	Balancing the personalization capabilities of GenAI with the need for standardized assessments to ensure fairness and comparability across different schools and regions.	1.1.4	(Kaldaras et al., 2024)
Overreliance on Technology	on GenAI should augment, not replace, the vital role of educators in creating inclusive environments and providing personalized support	1.1.1, 1.1.4	(Ostiiian, 2024; Waleed Abdullatif Khader Salameh, 2024)

Addressing these challenges requires ongoing dialogue and collaboration among educators, researchers, policymakers, technology developers, and the broader community. By working together and carefully considering the ethical, technological, pedagogical, and equity implications, we can harness the transformative potential of GenAI to create a more effective, engaging, and equitable education system for all students.

2. The Web-Based Prototype for LLM-Powered Multiple-Choice Test Grading

This section presents a web-based prototype designed to automate the grading of multiple-choice tests using Generative AI. The system leverages Google’s Gemini API for optical mark recognition (OMR) and answer extraction, aiming to improve assessment efficiency and reduce instructor workload. The prototype, with its source code available on GitHub <https://github.com/LeonDragon/AutoMQA>, is built using a technology stack that includes HTML, CSS, and JavaScript for the frontend, Python with the Flask framework for the backend, and OpenCV and Imutils for image processing. The user interface, shown in Figure 3, is designed for simplicity and ease of use, allowing instructors to easily upload answer sheets and view results.

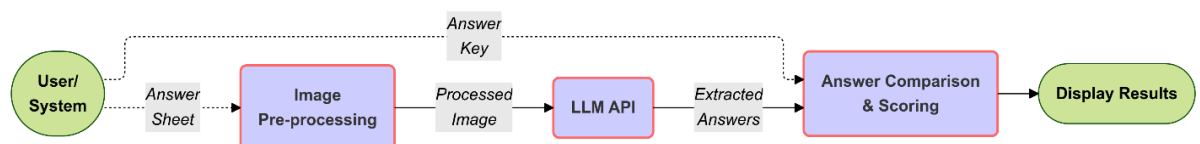
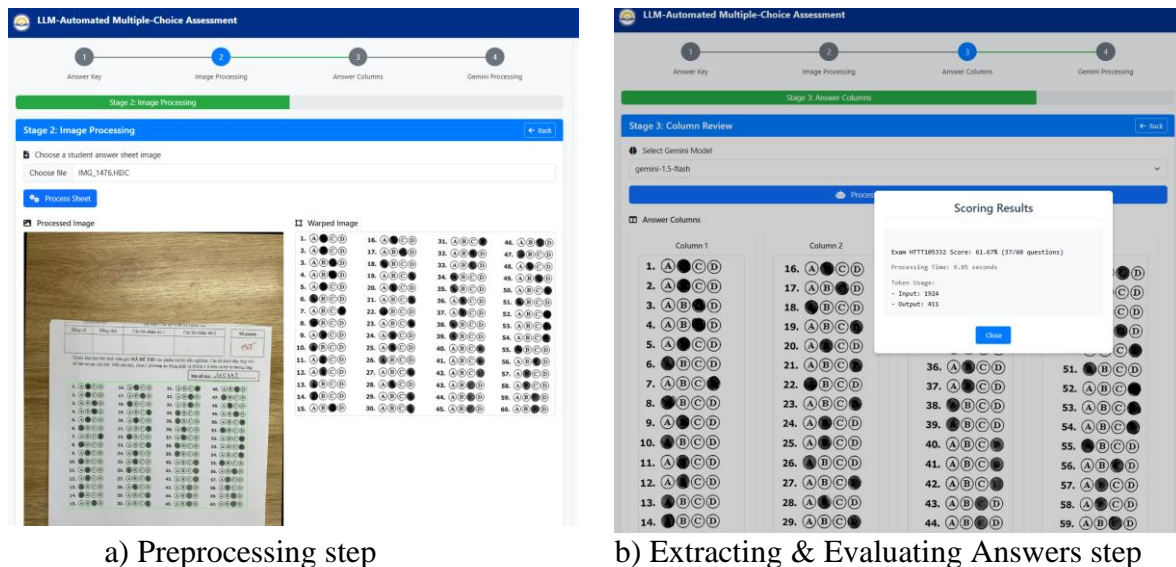


Figure 2. Overall architecture of the prototype

The prototype operates as follows, visually represented in the Figure 2. The process begins with the *User/System* providing an *Answer Sheet* and an *Answer Key*. The answer sheet image then undergoes *Image Pre-processing*, a crucial step involving techniques like perspective correction, noise reduction, contrast enhancement, blurring, thresholding, and morphological operations using the OpenCV and Imutils libraries. This pre-processed image is then sent to the *LLM API*, specifically Google’s Gemini API. A carefully crafted prompt

instructs the LLM to perform OMR, identifying marked bubbles and extracting the answers, along with their corresponding question numbers, in a structured JSON format. The provided *Answer Key* is also processed by the LLM API to obtain a similarly structured format of the correct answers. The system then proceeds to the *Answer Comparison & Scoring* stage, where the extracted student answers are compared with the answer key to calculate the final score. Finally, the *Display Results* component presents the calculated score and other relevant information to the user.



a) Preprocessing step

b) Extracting & Evaluating Answers step

Figure 3. Screenshot of the Prototype's User Interface

Initial testing has demonstrated the feasibility of this approach. The system accurately processes images, extracts answers using the Gemini API, and calculates scores. Future development will focus on optimizing the image processing pipeline, refining the prompts for the Gemini API to enhance accuracy and robustness, handling a wider variety of answer sheet layouts and marking styles, and exploring the generation of personalized feedback. This prototype showcases the potential of GenAI to automate the grading process, paving the way for more efficient and potentially more insightful assessment practices.

Conclusion

This paper explored GenAI's potential in educational assessment, highlighting opportunities and challenges. Our prototype demonstrates the feasibility of using LLMs for automated multiple-choice test grading. While promising, responsible implementation requires addressing ethical considerations and practical challenges. Future work will focus on refining the prototype and exploring GenAI's broader applications in education, with particular attention to equitable access and the needs of developing countries. Collaboration between stakeholders is crucial to harness GenAI's power for a more effective and engaging learning experience for all

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A Model of Curriculum Development Through the Engagement of Employers and Alumni

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Abstract

A curriculum development model that actively involves employers and alumni is crucial for ensuring that educational programs remain relevant, effective, and responsive to the needs of both students and the industries they serve. This research aims to achieve multiple objectives: identifying an appropriate and effective curriculum development model that promotes engagement with employers and alumni, gathering suggestions and recommendations for updating and aligning curriculum development with employer and industry needs, and enhancing the quality and attractiveness of the curriculum and teaching methods to better prepare students for employment, positioning Souphanouvong University as a preferred learning destination. The study, employing a mixed-methods approach with questionnaires and structured interviews among 160 participants (89 males and 71 females, including employers, alumni, and faculty members), revealed various aspects of curriculum development through employer and alumni engagement. Positive impacts were noted in human and ICT skills, though areas needing improvement included problem-solving, adaptability, English language proficiency, and literacy skills, identified as crucial for addressing challenges and progressing effectively. To overcome these challenges, the study recommends a heightened focus on improving English proficiency and emphasizes the pivotal role of academic faculty in institutions, highlighting their contribution in designing courses that meet societal demands by closely collaborating with employers.

Keywords: Model, curriculum development, Engagement, Employer, Alumni

1. Introduction

Souphanouvong University (SU), established in 2003 in Luang Prabang, Laos, is dedicated to preparing specialists, researchers, and scholars while preserving Laos' cultural heritage. SU offers diverse academic and experiential learning opportunities, including industry attachments and international exchanges, preparing students for dynamic careers with a global perspective. The university's six faculties regularly update their curricula every 4 to 5 years to align with national standards and industry needs, emphasizing both technical knowledge and essential 'soft' skills like problem-solving and interpersonal abilities crucial for employability.

Aligned with its 2021-2025 strategic plan, SU focuses on creating modern, industry-aligned curricula, promoting inclusivity in higher education, and enhancing partnerships with public and private sectors. This approach aims to improve the teaching-learning process, engage alumni, and collaborate closely with industry stakeholders to ensure graduates meet current and future labor market demands. This research contributes insights into graduate skills and informs future educational policies, highlighting the importance of collaborative curriculum design to bridge academia-industry gaps effectively at SU and beyond.

2. Literature Review

2.1 The Importance of Alumni Engagement in Curriculum Development

Alumni engagement in curriculum development is critical for ensuring graduates acquire skills that meet current workforce demands. Research by Nanda et al. (2021) underscores the value of alumni as credible sources to assess how well graduates apply their learning in real-world settings. Rafik and Priyono (2018) emphasize that alumni satisfaction hinges on institutions equipping graduates with career-ready skills. Effective educational outcomes are pivotal for alumni success in the workplace.

2.2 Engagement of Alumni

Establishing meaningful alumni relationships is vital for universities to develop, enhance, and sustain educational programs (Maholtra et al., 2023; Broom et al., 2023). Alumni not only enhance a university's brand visibility and credibility but also provide significant financial support (Conner, 2019). However, there remains a gap in the literature regarding alumni involvement in curriculum development in Lao PDR. This study aims to explore integrating alumni contributions into curriculum design at SU.

2.3 Engagement of Employers in Curriculum Development

Engaging employers in university curriculum development is crucial for aligning educational programs with industry needs (Bolden et al., 2010). Collaborative efforts between universities and employers are essential for ensuring graduates possess skills demanded by the labor market Ma, Y. (2011). Sun, Q. (2011). highlights successful approaches to integrating employer perspectives into curriculum design, enhancing student readiness for employment.

2.4 Employers' Perception on University Curriculum Development

Employers' insights are pivotal for universities to tailor education effectively. Understanding employer expectations helps universities prepare students with skills relevant to the workplace (Hill et al., 2019). Bridging the gap between education and employment requires universities to incorporate employer feedback into curriculum development.

2.5 Employability Skills Framework

Defining employability skills is crucial for preparing graduates for the job market (Weligamage, 2014). Employers prioritize skills such as communication, problem-solving, and emotional intelligence, alongside technical expertise (Suarta et al., 2017). The evolving job market underscores the importance of soft skills in enhancing graduates' employability and career success.

2.6 Higher Education Quality Indicators

Quality indicators in higher education, as identified by Bahat Isa (2023), guide universities in aligning strategic plans with labor market demands. These indicators encompass dimensions such as education, internationalization, and technological competence, ensuring students are well-prepared for employment.

This research contributes to enhancing curriculum development by integrating alumni and employer perspectives, thereby ensuring educational programs align with industry needs and enhance graduates' employability.

3. Methods

3.1 Participants and context

The study employed a mixed-methods approach, integrating qualitative and quantitative methodologies to comprehensively address the research questions (Creswell, 2009). Data was collected from a total of 160 participants, comprising 89 males and 71 females. The quantitative aspect utilized survey research, while qualitative data was gathered through structured interviews. These methods aimed to explore the perspectives of employers and alumni on employability skills across four provinces—Luang Prabang, Oudomxai, Luangnumtha, and Borkeo—and to understand faculty members' views on curriculum development in universities. Three distinct sets of questionnaires and semi-structured interviews were utilized. The questionnaires employed a Likert scale, and mean scores were interpreted based on defined ranges to assess perceptions and viewpoints on quality. Interview data underwent analysis through six sequential steps: reading and annotating transcripts, conceptualizing data, segmenting data, analyzing segments, and summarizing findings.

Procedures

The study utilized both translated Lao-language questionnaire forms and interviews to collect data. Researchers initially developed Google Forms for the questionnaires and distributed them via online platforms. Additionally, they personally distributed questionnaires and conducted one-to-one interviews with participants in Lao language. These interviews covered participants' professional backgrounds and hiring experiences, ensuring a comprehensive data collection approach.

Data analysis

The data collected from 160 respondents were analyzed using statistical software to calculate percentages, means, and standard deviations. Initially, descriptive statistics were applied to the demographic data from the first part of the questionnaire to outline participant characteristics in terms of percentages. Subsequently, statements regarding employees' and employers' perceptions, as well as faculty members' views on education quality, were analyzed for mean and standard deviation scores. These scores were interpreted based on the Likert scale categories adapted for each questionnaire type:

Score Range:

4.21-5.00: Highest

3.41-4.20: High

2.61-3.40: Moderate

1.81-2.60: Low

1.00-1.80: Lowest

Finally, the interview data underwent analysis through six steps: reading the transcripts, annotating the transcripts, conceptualizing the data, segmenting the data, analyzing the segments, and writing the results.

4. Results

Alumni' perception

The study outlines a curriculum development model involving employers and alumni. Overall, the model showed a mean score of $M = 3.38$ ($SD = 0.962$). Problem-solving and Adaptability skills were rated with a mean of $M = 2.47$ ($SD = 0.98$), while Human skills demonstrated a higher mean of $M = 4.054$ ($SD = 0.97$). English Language Proficiency and Literacy skills scored $M = 2.795$ ($SD = 0.91$), and ICT skills had a mean of $M = 3.91$ ($SD = 2.05$). Personal organization and Time management skills received a mean of $M = 3.73$ ($SD = 0.80$), Leadership skills $M = 3.334$ ($SD = 0.8651$), and Communication skills $M = 3.28$ ($SD = 0.962$). The findings indicate strengths in human skills but also underscore areas for enhancement, particularly in problem-solving, adaptability, and English language proficiency. Continued collaboration with employers and alumni is essential for refining the curriculum to better align with the dynamic demands of the workforce and society.

Employer' perspective

The Overall Model received a high mean score ($M = 3.77$) with a moderate standard deviation ($SD = 0.808$), indicating a generally positive perception of the curriculum development model. Strong Skill Areas include ICT Skills ($M = 4.115$, $SD = 0.54$), which garnered the highest mean score, suggesting effective preparation in Information and Communication Technology. Human Skills ($M = 4.01$, $SD = 0.72$), likely encompassing interpersonal and social skills, were also highly rated. Problem Solving and Adaptability Skills ($M = 3.967$, $SD = 0.809$) were deemed valuable for graduates. Areas for Potential Improvement were identified in English Language Proficiency and Literacy ($M = 3.19$, $SD = 0.908$), which received the lowest mean score and may benefit from increased emphasis in the curriculum. Communication Skills ($M = 3.405$, $SD = 0.8125$) were viewed positively but scored lower compared to other areas, suggesting a need for further investigation into specific communication skill development.

Faculty academic's perspective

The overall level of implementation achieved in our institution's services was found to be moderate ($M = 2.893$, $SD = 0.692$). Specifically, Education and Instruction received a mean score of ($M = 3.084$, $SD = 0.1966$), indicating a relatively higher level of implementation in this area. Technology/Academic Competence followed with a mean score of ($M = 2.98$, $SD = 0.818$), reflecting a moderate level of implementation. Similarly, University Structure and Student Needs both obtained a mean score of ($M = 3.06$), suggesting consistent implementation across these dimensions. However, the findings highlighted areas needing improvement. Socio-Cultural Facilities, Internationalization, Economic Facilities, and Preferability all received a lower mean score ($M = 2.7$). This indicates that efforts should be focused on enhancing these dimensions in the future to better meet the needs of our educators and stakeholders

Results from the Interview and group Discussion

Based on interviews conducted, the majority of respondents expressed a need for curriculum improvement at Souphanouvong University (SU) to better align with current workforce demands. Many suggested that involving employers and alumni in curriculum development would enhance relevance. Additionally, there was consensus among employers that finding staff with both hard and soft skills, including multitasking, proactivity, and innovation, is challenging. While most interviewees felt adequately prepared by SU programs, they emphasized the need for greater emphasis on soft skills such as problem-solving, leadership, communication, and English proficiency. Some noted outdated content in certain subjects and recommended a shift towards more practical teaching methods that integrate real-

world applications. Alumni highlighted the value of internship experiences and part-time jobs during their studies in building confidence and readiness for professional roles.

5. Conclusion And Discussion

The research explored a curriculum development model involving alumni and employers, which highlighted significant insights compared to existing literature. Alumni emphasized the urgent need for enhanced problem-solving and adaptability skills in the workplace, underscoring the critical role of soft skills alongside academic knowledge. They pointed out deficiencies in teamwork, independent problem-solving, and adapting to competitive environments. While ICT skills for communication were generally adequate, there was a notable gap in proficiency for creating presentations. Moreover, alumni exhibited low proficiency in English language literacy for professional documents, indicating a need for targeted language training. Employers echoed challenges in finding staff with multitasking abilities, adaptability, and English proficiency, particularly in document creation. Institutional challenges included reliance on traditional teaching methods and insufficient innovation in course materials and research support. Overall, the study underscores the importance of aligning curriculum with industry demands, enhancing employability skills, and integrating global perspectives to effectively prepare graduates for the evolving job market in ASEAN and Lao PDR.

In conclusion, it highlighted positive impacts in human and ICT skills, while identifying areas such as problem-solving, adaptability, English language proficiency, and literacy skills as needing improvement. Addressing these challenges calls for increased emphasis on English proficiency through additional training or curriculum adjustments. The employer perspective emphasized the importance of adaptability and open-mindedness in response to evolving work environments. Moving forward, enhancing connections between institutions and alumni is crucial for improving outcomes, alongside the pivotal role of academic faculty in adapting courses to societal needs and collaborating closely with employers. Ultimately, aligning educational curricula with employability demands necessitates collaboration across stakeholders and responsiveness to changing labor market dynamics and societal requirements.

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Teachers and Administrators’ Perspectives toward the Preparation of being Model Schools: The Case of Laboratory and Network Schools of the Two TTCs

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Abstract

Laboratory and school networks are important for Teacher Training College (TTC) to train student teachers and teacher educators for their continuous professional development. Preparing those schools to become model schools in the future is needed. The objectives of this study are to explore school teachers’ and administrators’ views toward the preparation of laboratory and network schools in becoming model schools specifically looking into eight components including teacher professional development, teaching-learning innovation, school environment, community engagement, sharing opportunity, student learning achievement, school management and research engagement. Utilizing a convenient sampling technique, the study collected data from 246 school teachers using questionnaires and semi-structured interviews with 28 administrators. For this paper, however, the study reported only the results from the 51 questionnaires and the interview data from 8 administrators that belong to the two TTCs in the northern part of the country. The study revealed that the demonstration schools affiliated with TTCs could be model schools regarding teacher professionalism, some aspects of the school environment, community engagement, student achievement and school management. However, in terms of innovative teaching methods, scientific research, the opportunity to share academic work with outside schools, and some aspects of school environments are not yet perceived to be a model.

Keywords: Model school, teacher professional development, teaching-learning innovation, community engagement, research engagement.

Introduction

A model school is perceived as a school with good performance. To be a model school, several components need to be considered including school teachers’ professional knowledge and development, school administration, and school infrastructure. Teacher professional development “allows for a balance between the needs of the school, the needs of the individual, and the national needs and it aims for the promotion of knowledge, skills and value” (Fraser, Kennedy, Reid & McKinney, 2007). The school model is needed and necessary in the current

situation, especially among TTCs that serve pre-service and in-service teachers in society. The Ministry of Education and Sports (MoES) emphasizes the present school models to be a school of quality that consists of teaching-learning, infrastructure, administration, and community. The school model or qualified school is needed to be made from kindergarten to upper secondary school (Lao Star TV, 2022). There is also a need to prescribe the standard of the school model, the decree of the school model, and spread those requirements to society as well as create a handbook of school model assessment (Lachanthaboun, 2021). In Vientiane municipality, in the academic year 2019-2020, there were several schools were announced as being schools of quality and school models based on these three conditions, such as teaching and learning, activity (sport and arts activity), and assisting organization and social. This honour announcement includes Xinxay Primary and Secondary School, Xanaphon Primary and Secondary School, Laboratory Secondary School, Pathana and Virathavone Primary School (Somsavanh, 2022).

Regarding the TTCs, it is necessary to have laboratory schools and network schools to train student teachers and teacher educators for their continuous professional development. At present 8 TTCs in Laos have already had laboratory schools for pre-service teachers to familiarize themselves with the general education system, acquiring subject matter knowledge and pedagogical content knowledge. Therefore, transforming laboratory schools to be school models is necessary to serve society and correspond to the new curriculum that emphasizes a learner-centred teaching approach. However, laboratory schools have just been attached to TTCs and it is now in a period of academic and administration improvement. The direction of development is also not yet clarified. Therefore, there is a need to explore how laboratory schools are prepared to become model schools in the future. Specifically to explore the teachers' and administrators' perspectives toward the preparation of becoming model schools.

1. Research Objectives

1.1 To explore school teachers' views toward the preparation of laboratory and network schools in becoming model schools.

1.2 To investigate school administrators toward the preparation of laboratory and network schools in becoming model schools.

2. Review of Related Literatures

Model schools in Laos would be considered to meet five educational pillars: moral education, intellectual education, labor education, physical education and artistic education. It would also meet three characteristics such as national characteristics, scientific and modern characteristics, and public characteristics. It would also meet the following three points: good teaching, good learning, preventing the phenomenon of decline, and creating a good learning environment in schools, centers, and educational institutions.

Research and Educational Assessment Center (2021) studied about situation and issues of creating quality school models of both public and private schools and found pros and cons of six points including the decree of school model, school administration, teaching and learning, school environment, community engagement and following up of creating school model. School administrators don't understand the decree of school model in the same line for so many decrees and high standards. Although schools have school development plans, upgrading their qualifications and receiving academic positions of experienced and expert teachers, still there were only a few teachers who got such positions, some teachers left their jobs and some students sneaked out during the classes. Regarding teaching and learning activities, although most of the teachers have lesson plans, and teaching materials and get along the planned lessons well, still there were some of them couldn't do so.

The handbook of school organization mentioned 9 points for creating school clusters including academic activity (opportunity to share lesson plans and teaching), students (opportunity to learn together), teachers (exchanging teaching and training weak and good students), making teaching-learning materials (using local materials creating teaching-learning materials), creativity (find new ways of teaching and learning materials), school administration (exchanging and being model of others), school environment (big trees, large sports yard, clean classrooms, bathroom and sufficient and clean facilities), community participation and assessment and evaluation (Department of general education, 2019).

Toronto district school board (2024) concluded that Model Schools are committed to “innovative teaching and learning practices, providing support services to meet social, emotional and physical well-being of students; establish schools as the heart of the community; researching, reviewing and evaluating students and programs and ongoing commitment to share successful practices.” “The goals of Model Schools are to achieve and sustain: equity, community, inclusiveness and expectations.” Achieving fairness and equity to ensure the lives and realities of our students are reflected and affirmed. The focus is on closing the opportunity gaps and removing barriers to support equitable outcomes for all students.” “ Equitable educational opportunities and adequate school resources to allow schools to become the heart of their communities.” “An inclusive culture that respects, reflects, welcomes, and encourages all students and families.” “High expectation to enable all students to reach their full potential as variable and contributing members of society”

Based on previous studies, we developed a conceptual framework for the model schools that consists of eight components, such as teacher professional development, teaching-learning innovation, school environment, community engagement, sharing opportunity, student learning achievement, school management, and research engagement. See Figure 1.

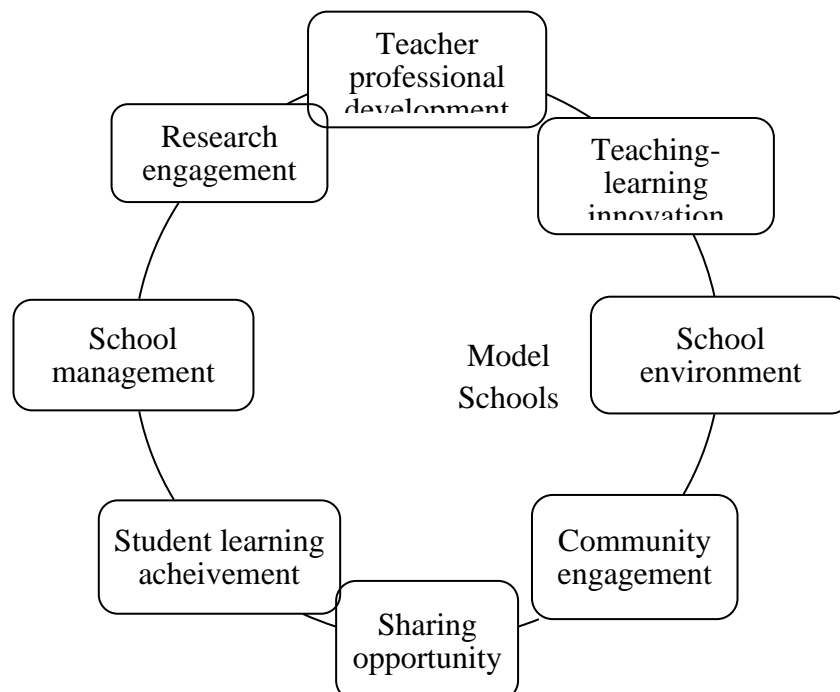


Figure 1 The Conceptual framework of model schools

Teacher professional development, for this study, is defined as “systematic efforts to bring about change in the classroom practices of teachers, in their attitudes and beliefs and in the learning outcomes of students” (Thomas Guskey, 2003, as cited in Freeman, 2023). These

are “essential mechanisms for enhancing teachers’ content knowledge and developing their teaching practices in order to teach to high standard” (Freeman, 2023). The activities of the teacher’s professional development include participation in a conference or meeting about teaching and learning, training about teaching and learning, content knowledge, and self-study regarding teaching and learning.

Teaching-learning innovation or innovative teaching and learning is sometimes related to digital educational technologies (Weigand, Trgalova & Tabach, 2024). It is also directly related to game-based learning (GBL) and peer teaching (Kaba, Misailovski, Brähler, Garcia, Artelt, Raupach & Scheithauer, 2024). Innovative teaching and learning are associated with student-centred and active learning, such as experiential learning, problem-based learning, project based-learning, short lectures, simulation, role-playing, and individual portfolios (Nicolaidis, 2012). In relation to the teaching method in Laos, 15 teaching strategies were organized and attempted to apply in the Lao educational teacher guidebook. In this study, the study focuses on applying existing several teaching approaches and adapting or creating a new teaching approach. Specifically on applying new teaching methods in teachers’ classrooms, adapting new teaching methods, creating new teaching method that differs from the existing ones, and making new teaching materials that are different from the textbook.

School and classroom environment is important for students’ learning healthiness. It plays “a pivotal role in students’ learning and is intimately linked to their health” for the fact that “the students spent the majority of their time in schools and classrooms, optimizing the classroom visual environment is paramount to safeguarding their visual health (Qin, Shi, Gao, Niu & Zheng, 2024). This component includes cleanness of a classroom, sufficient classrooms with students, sufficiently clean toilets, sufficient teachers’ working room and clean. The schoolyard should be large, and clean. There should be a rubbish bin in a designated place and the rubbish should be separated into groups.

Community engagement is also an important component of educational development in their school. In Japan, school is an important part of the community. Community involves not only educational management and social welfare, but also disaster prevention (Wen, Gao, Kawane & Shaw, 2024). The involvement of “parent, family, and community in education correlated with higher academic performance and school improvement. When schools, parents, families, and communities work together to support learning, students tend to earn higher grades, attend school more regularly, stay in school longer and enrol in higher level programs” (Van Roekel, 2008). “Collaborative partnerships among parents, communities, and educational institutions are essential for enhancing educational outcomes and fostering social improvement” (Alam and Mohanty, 2023). In this study, we pay attention to community involvement in school repair/building, school management, teaching and learning, teaching-learning materials, and parent association.

Sharing opportunities is another important component. The opportunity to share knowledge and experience about teaching and learning or research work will increase teacher professional development. This sharing opportunity includes learner-centred methods, reflecting and thinking differently, close collaboration with colleagues, and dimensions of normal working practice (Van Velzen, Volman, Brekelmans & White, 2012). To make it clear, the study focuses on opportunities to exchange or share regarding teaching and learning with surrounded or network schools, collaboration in lesson study practice, and sharing or presenting research findings in a conference or meeting.

Student learning achievement is called “achievement index” which “is a number that shows a person’ achievement in studying or working for a certain period. As well as performance index is the average value of all courses taken by students” (Lastri, Kartikowati & Sumarno, 2020). In this study, we refer to the performance index, such as students’ scores

at the end of the academic year that reaches 50% or more, the transition from grade to grade score, excellent student contest, and the performance of not leaving school during the term.

School management is associated with the teacher’s support activities, running the organization, and students’ support activities (Peltola, Lindfors & Luukka, 2024). Typically, it focuses on the work of school policy management, “setting discipline policy, determining the content of the in-service program, hiring new full-time teacher, school budget management, teacher evaluation and establishing curriculum” (Stockard & Lehman, 2004). In this study we emphasize on short and long-term school development plan, the attention of the school administrators toward teaching and learning work, school budget approval, and staff organization based on their competency accordingly.

Research engagement is the opportunity for teachers to understand and develop their teaching (Ekiz, 2006). A previous study found that Chinese primary school teachers had “a variety of research experiences. Their research engagement was undermined by numerous contextual constraints and their perceived inadequacy as teacher researchers” (Gao & Chow, 2012). Doing research is very important to support their decisions as well as to be more informative. By engaging in research, “teachers will be more critical, reflective and analytical about their practice in classrooms” (Mehrani, 2015). This study focuses on if the teacher has an opportunity to engage with research. For example, teachers have a willingness to do research, if the research is being conducted, publishing the research in a journal hosted by a Teacher Training College level, national level, and/or international level.

Research Methodology

1. This research includes 6 steps as below

1.1 First, researchers search and review previous studies as well as relevant documents to make a conceptual framework. Due to the limitation of accessing previous studies, researchers use not only related literature but also government reports to create the framework.

1.2 Second, based on the conceptual framework, researchers develop research tools for data collection. The tools include questionnaires and semi-structured interviews with school administrators. Consistently, the questions listed in research tools are based on some previous studies and local context.

1.3 Third, the research tools were submitted to 3 experts to find Item Objective Congruence (IOC) value to make sure that the content of the questionnaires is appropriate and suitable for teachers in the Lao context.

1.4 Fourth, data were collected from August to October 2023 with 7 primary and secondary laboratory schools throughout the country. These laboratory schools are dependent on 7 Teacher Training Colleges in Laos.

1.5 Fifth, after data collection is finished, research key in the raw data from the questionnaires into Microsoft office Excel 2016 getting ready for data analysis.

1.6 Sixth, manipulating, sorting, and analysing the data using the software and writing a research report.

2. Research Instruments

2.1 The questionnaire for teachers in laboratory and network schools includes 3 parts. The first part is the general information about the teachers including gender, qualification, and number of years of working experience. The second part is about teachers’ perspectives regarding model schools. This part corresponds to the 8 components in the conceptual framework including teacher professional development (five questions), teaching-learning innovation (five questions), school environment (nine questions), community engagement (five

questions), sharing opportunity (three questions), students’ learning achievement (four questions), school management (four questions) and research engagement (five questions). Each question of component has a rating scale from 5 (means very much) to 1 (means not available). The third part is an open question asking teachers’ comments or suggestions regarding on how to transform current laboratory schools into model schools.

2.2 Semi-structured interview has four parts. The first part is collecting administrators’ general information. The second part asks for information on laboratory schools and school networks. The third part asks for school administrators’ perspectives on transforming their school into a model school. The fourth part is about other concerns, suggestions, and recommendations other than those discussed above.

3. Population and samples

3.1 In Lao PDR, other than four faculties of education from the four universities, there are eight TTCs that are responsible for training pre-service and in-service teachers to serve society in each part of the country. Each TTC has a primary and secondary school as a laboratory school and five school networks. Therefore, in this research, the populations were primary and secondary school teachers from 16 laboratory schools and 40 network schools.

3.2 The targeted samples of the study were the teachers who are currently working in the laboratory and network schools under the TTCs. Through the availability of the participants, however, we used nonprobability sampling which was a convenient sampling technique for data collection (Creswell and Guetterman, 2019). Significantly, we were able to collect the data from 246 teachers from both the laboratory and network schools. For this article, however, we reported only the results from 51 teachers of the laboratory and network schools and 8 administrators that are associated with the two TTCs in the northern part of the country.

4. Statistics for Data Analysis: The statistics used for analysing data were mean and percentage (Chattamvelli & Shanmugam, 2023). The middle value of the percentage is 50%. If the percentage of agreement is higher than 50 % it means that the respondents tend to agree on the items being asked. The higher percentage is the more agreement of being a school model on such particular items is made.

Research results

1. Profile of respondents

Respondents are from two primary laboratory schools, two secondary laboratory schools, and 4 network schools that depend on the two TTCs located in the northern part of Lao PDR (see Table 1).

Table 1: profile of respondents

No	Gender	N	Percentage (%)
1	Female	40	78.43
2	Male	11	21.57
Total		51	100.00

Table 1 shows that the number of females is higher than male which is 78.43% female and 21.57% male.

2. School teachers’ and administrators’ views on the components of model schools

The results of the data analysis showed school teachers’ views on the eight components of model schools including professional development, teaching-learning innovation, school environment, community engagement, sharing opportunity, students’ learning achievement, school management, and research engagement. The data analysis also showed the results from the semi-structured interviews. In addition, the interviewed data were added in some components complementarily to support the quantitative data as revealed below.

2.1 School teachers’ views on teacher professional development

From Table 2, below, the results of the data analysis showed that 60.8% of teachers in the demonstration schools agreed that they attended meetings on teaching and learning management. Of these, more than half, or 56.9% of teachers also attended training courses on teaching and learning management and 66.7% paid attention to their online research (on the Internet) on teaching and learning management. In addition, one important thing is that 92.1% of teachers in the demonstration schools believed that they had a solid knowledge of the subjects they taught and during actual teaching, 82.4% of teachers were confident that they had motivated students to learn or create their knowledge. This shows that teachers in the demonstration schools under the northern TTCs have the potential to become model schools in terms of teacher professional development (see Table 2).

Table 2: Teacher Professional Development

No	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a1	Attending teaching-learning conference	7 (13.7)	24 (47.1)	15 (29.4)	5 (9.8)	0
a2	Participating in training about teaching-learning	6 (11.8)	23 (45.1)	14 (27.5)	8 (15.7)	0
a3	Self-study through online about teaching-learning conference	8 (15.7)	26 (51.0)	11 (21.6)	4 (7.8)	2 (3.9)
a4	Deeper knowledge on subject matter content knowledge	22 (43.1)	25 (49.0)	4 (7.8)	0	0
a5	Motivating students’ constructivism	11 (21.6)	31 (60.8)	9 (17.6)	0	0

The data from the Table 2 also is illustrated in the Figure 2 below

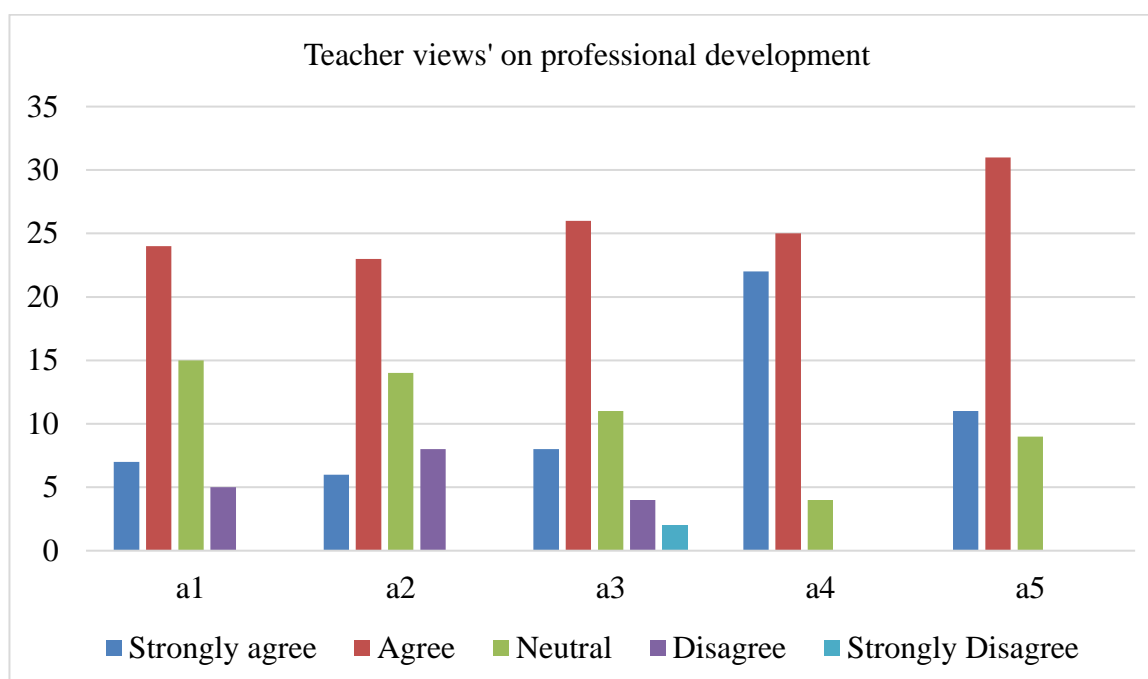


Figure 2 Teachers' views on the professional development

From this data, it can be concluded that the demonstration schools affiliated with the northern TTCs are, from the teachers' perspectives, highly exemplary in terms of teacher professionalism, especially in terms of solid knowledge of the subjects taught and the teaching-learning process that encourages students to learn or create their own knowledge. However, from the interviews, it was found that the teachers in the demonstration schools are still not technically strong in terms of knowledge about children because the teachers in the laboratory primary and secondary schools are teachers who have taught adults in the TTCs for many years. For example, SVL gave the view that “...[if] we go by the subject matter, it is still lacking because most of the teachers have taught adults but the teaching methods of children may not be [deep]” However, in terms of subject matter knowledge, it is seen that it can be a model school because “most of them [are] teachers who have a lot of experience and are at a good level and can produce excellent students at the national level [in some years]”-DPLNT. Some demonstration schools affiliated with the Northern TTCs were able to produce excellent students at the district level, both primary and secondary, in the past school year.

2.2. School teachers' views on teaching-learning innovation

90.2% of teachers in demonstration schools affiliated with the Northern TTCs agreed to a high degree that when teaching, teachers modelled for students to watch and then had students follow, which was the teacher's imitation. Of these, 74.5% of teachers in demonstration schools agreed to a high degree that teachers used 15 teaching methods in teaching. In order to make teaching and learning more relevant to students' reality, 58.8% of teachers had adapted some of the 15 teaching methods to their own teaching. However, only 45.1% of teachers agreed to a high degree that they had designed new teaching methods that were different from the 15 teaching methods. 54.9% of teachers agreed to a low to moderate degree. In addition, 70.6% of teachers agreed to a high degree that they had invented new teaching media that were different from textbooks (see Table 3).

Table 3: teaching-learning innovation

No	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
b1	First, teacher solves activity as an example, then let students follow the example	23 (45.1)	23 (45.1)	3 (5.9)	2 (3.9)	0
b2	Utilizing 15 teaching strategies	4 (7.8)	34 (66.7)	12 (23.5)	0	1 (2.0)
b3	Adapting 15 teaching strategies in your own teaching	4 (7.8)	26 (51.0)	17 (33.3)	2 (3.9)	2 (3.9)
b4	Creating a new teaching approach that differs from 15 teaching strategies	6 (11.8)	17 (33.3)	21 (41.2)	5 (9.8)	2 (3.9)
b5	Making teaching materials that differs from textbook	17 (33.3)	19 (37.3)	12 (23.5)	2 (3.9)	1 (2.0)

The data from the Table 3 also is illustrated in the Figure 3 below

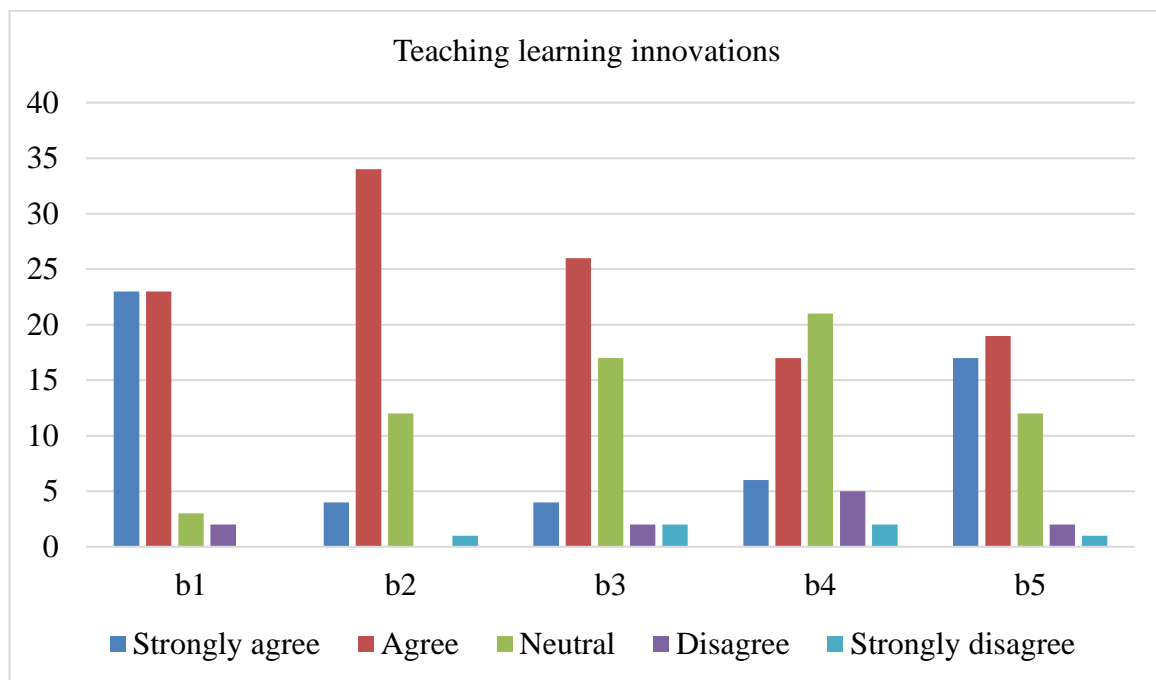


Figure 3 Teachers' views on the teaching-learning innovation

From the results of the data analysis, based on the level of teachers' agreement, it can be concluded that, in terms of innovations in teacher learning, teachers in the demonstration schools in the northern region may not yet be a model because the new teaching designs that differ from the old methods are still few and at a moderate level. The interview data also indicated that “Most [teachers] teach in this curriculum, considering the curriculum as the core, but the difference is in the teaching media. They use the same old teaching media, some do it in a new way.” - CHT

2.3. School teachers’ views on school and classroom environment

Table 4 below shows that 90.2% of teachers in the demonstration school affiliated with the Northern Lao Teachers College agreed that the classrooms were clean and tidy. A large number of teachers (64.8%) agreed that the classrooms were adequate and appropriate for the number of students. In addition, 62.7% agreed that the toilets were clean and adequate for the students. In addition, a majority of teachers (82.3%) agreed that the offices were clean, tidy and adequate for the teachers. However, 54.9% agreed to a lesser extent that the schoolyard was clean and spacious; 82.4% of teachers agreed to a greater extent that the school had electricity and running water. However, as for the school’s walking paths, only 35.5% of teachers agreed to a greater extent that the school’s concrete/asphalt roads were convenient. Based on the reality, 76.5% of teachers believed that there were trash cans at various points in the school. However, only 31.3% believe that there is solid waste segregation.

In conclusion, in terms of the school environment, many sub-aspects can be exemplary, whether it is the cleanliness of the classrooms, offices and classroom orderliness, electricity facilities, and water supply. However, things that may not be exemplary are the cleanliness and spaciousness of the schoolyard and the segregation of various waste types is still at a moderate to low level.

Table 4: Classroom environment

No	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
c1	Classrooms are clean and organized	19 (37.3)	27 (52.9)	4 (7.8)	1 (2.0)	0
c2	Classrooms are sufficient and adequate for numbers of students	14 (27.5)	19 (37.3)	12 (23.5)	6 (11.8)	0
c3	Toilets are clean and suitable to numbers of students	10 (19.6)	22 (43.1)	17 (33.3)	2 (3.9)	0
c4	Offices are clean, organized and sufficient for teachers	17 (33.3)	25 (49.0)	8 (15.7)	1 (2.0)	0
c5	School yard is clean and wide	7 (13.7)	16 (31.4)	16 (21.4)	10 (19.6)	2 (3.9)
c6	Electricity and water supply are facilitated	26 (51.0)	16 (31.4)	16 (31.4)	2 (3.9)	1 (2.0)
c7	School pathways are covered by concrete/ asphalts	4 (7.8)	14 (27.5)	11 (21.6)	13 (25.5)	9 (17.6)
c8	There are rubbish bin in suitable and several places	13 (25.5)	26 (51.0)	10 (19.6)	2 (3.9)	0
c9	Rubbishes are separated	9 (17.6)	7 (13.7)	22 (43.1)	2 (3.9)	11 (21.6)

The data from the Table 4 also is illustrated in the Figure 4 below

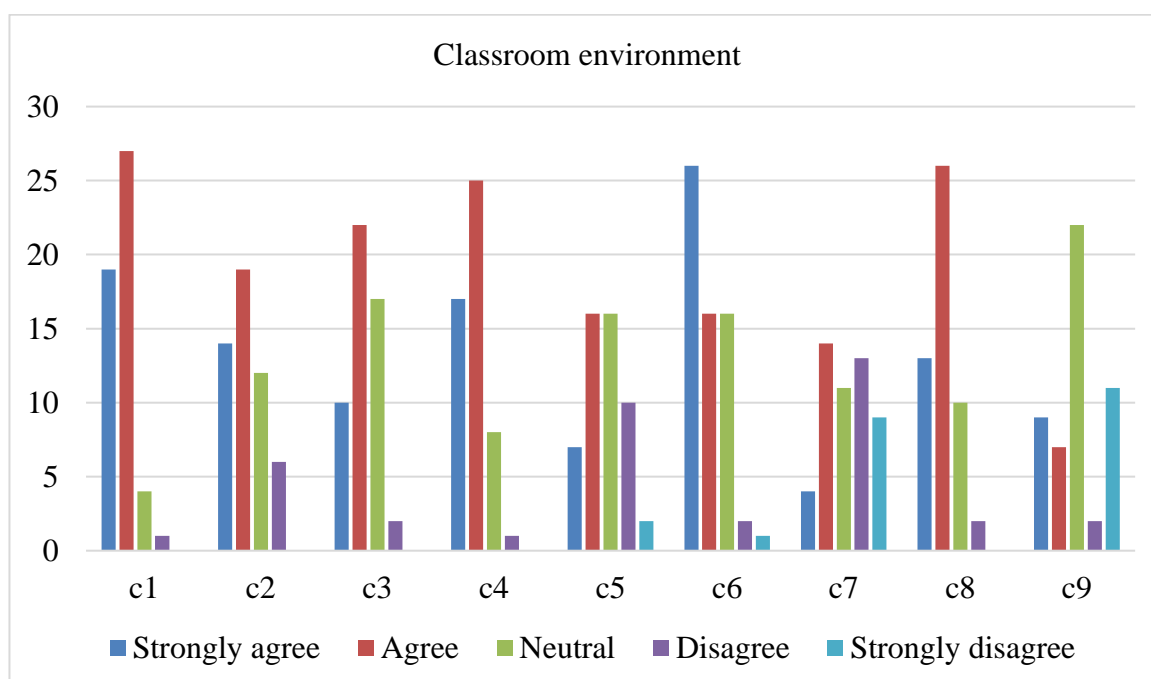


Figure 4 Teachers' views on the classroom environment

However, from interviews with administrators of one demonstration primary school, it was found that the space for students to do activities or play sports was still cramped. For example, the administrator commented, “Before there was no middle school, we could have done a few things, but we really couldn’t. The space, the playground, the sports field, the activity yard, was still cramped. There was no place to salute the flag” -ONJ

2.4. School teachers' views on community engagement

For the demonstration school affiliated with the Northern Teachers College, the community still plays a role in building or renovating the school, but not as much as it should, with only 45.10% agreeing to a greater extent, while 54.90% agreeing to a moderate extent. Similarly, 47.06% of teachers agree to a greater extent that the community is involved in school management, but 52.94% still agree to a moderate extent. Furthermore, for community participation in teaching and learning and the community’s contribution to providing teaching and learning materials, even less so, with 70.59% of teachers agreeing to a moderate extent, and only 29.41% agreeing to a greater extent. However, it is good that the school has also established a parent-teacher association, with most teachers, 84.31%, agreeing to a greater extent. Of these, only 15.69% expressed a moderate or moderate agreement (see Table 13). In terms of community involvement in schools, the establishment of a parent-student association can be a model. Other aspects still need to be improved.

Table 5: Community engagement

No	Items	Level of agreement				
		Strongly agree	agree	Neutral	Disagree	Strongly disagree
d1	Community helps buildings or schools maintenance	5 (9.80)	18 (35.29)	13 (25.49)	7 (13.73)	8 (15.69)
d2	Community involves in school management	4 (7.84)	20 (39.22)	12 (23.53)	6 (11.76)	9 (17.65)

d3	Community involves in teaching-learning	2 (3.92)	13 (25.49)	17 (33.33)	10 (19.61)	9 (17.65)
d4	Community supports teaching-learning materials	5 (9.80)	10 (19.61)	9 (17.65)	11 (21.57)	16 (31.37)
d5	Establishing parents association	19 (37.25)	24 (47.06)	4 (7.84)	3 (5.88)	1 (1.96)

The data from the Table 5 also is illustrated in the Figure 5 below

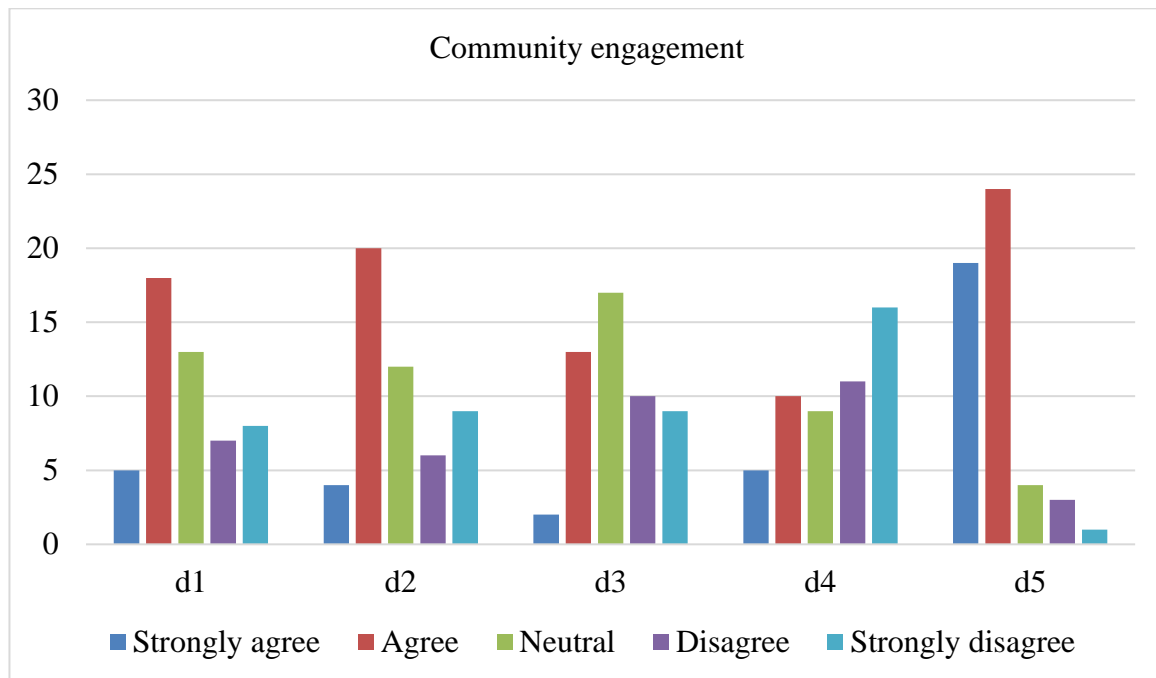


Figure 5 Teachers’ views on the community engagement

The results of the interview analysis also indicate that the villagers have not paid enough attention to the demonstration school. There is also a tendency to ignore the needs of the school. For example, CHT commented, “The surrounding community is not as involved as it should be... I don’t understand the head of the village... We ask for cooperation, invite them to come and discuss with us, but they don’t want to come, they don’t want cooperation. But we take the students to collect garbage for the community. We have organized them to collect garbage along the roadside and in the village... Once a week, they go.”

2.5. School teachers’ views on sharing opportunity

For demonstration schools affiliated with the Northern TTCs, it is seen that the school also has technical exchange activities with the outside world to increase the knowledge and experience of teachers. However, only a few teachers have participated in this process. Of the teachers who went on a tour to exchange lessons on teaching with surrounding schools, only 43.1% agreed to a high degree, while 56.9% agreed to a moderate degree. In particular, joint teaching studies with other schools and presenting technical or research work at conferences are still few, accounting for only 35.3% who agreed to a high degree with such activities. A large number of teachers, or 64.7%, still agreed to a moderate degree to none (see Table 6).

In terms of technical exchange trips with the outside world, it is seen that it may not be a model school, especially presenting technical or research work at conferences with the outside world.

Table 6: Sharing opportunity

Code	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
e1	Exchanging tour about teaching-learning with surrounding schools	5 (9.8)	17 (33.3)	15 (29.4)	6 (11.8)	8 (15.7)
e2	Doing lesson study with other schools	1 (2.0)	17 (33.3)	14 (27.5)	5 (9.8)	14 (27.5)
e3	Presenting academic or research work in a conference	2 (3.9)	16 (31.4)	10 (19.6)	12 (23.5)	11 (21.6)

The data from the Table 6 also is illustrated in the Figure 6 below

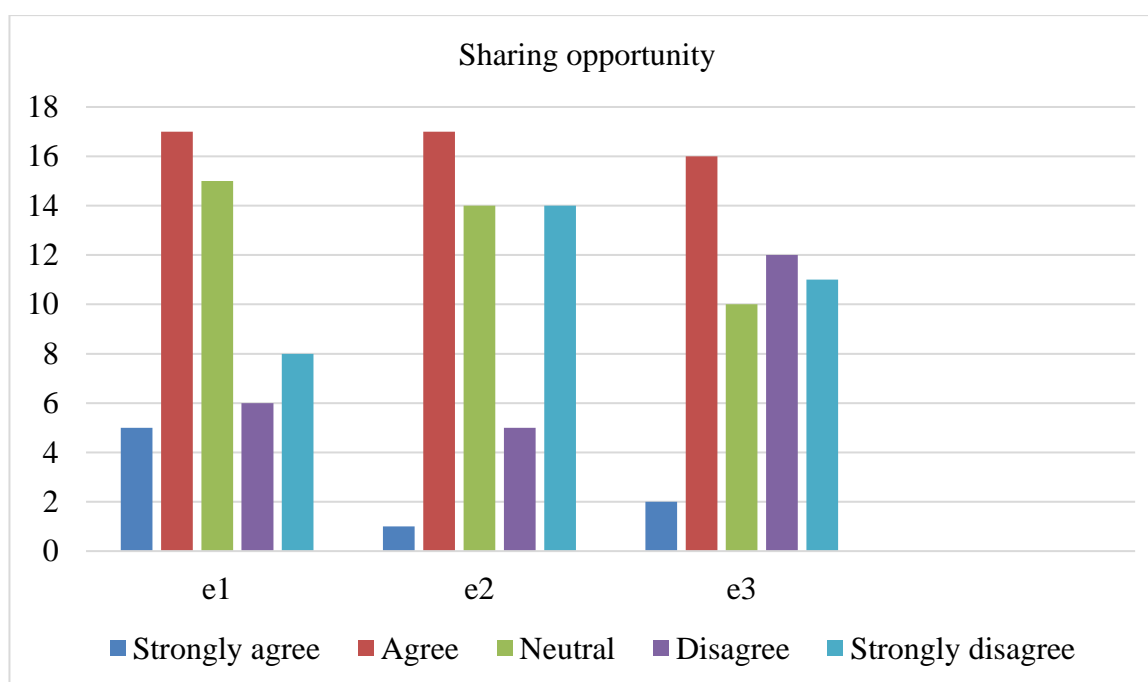


Figure 6 Teachers' views on the sharing opportunity

The interview data further clearly shows that there is no such thing as a joint study with other schools, but there is a lot of work on academic and administrative matters. For example, CHT said, “This lesson study has not been done with other schools yet. It is just about exchanging lessons learned in terms of academic activities, administrative activities, etc. ... some academic staff, some administrative staff”. Most of the people who have participated in the lesson study are at the leadership level to bring the results of the lessons learned to the members to implement. For example, the director of the demonstration primary school said, “Since I have been here, I have not been to any school for exchange. It is just that our teachers

take the technical staff to the district, the group schools, the level, only the head of the department goes... only one person goes to any school” ONCH.

2.6. School teachers’ views on student learning achievement

In terms of student achievement, 90.2% of teachers in the demonstration school agreed to a high degree that students’ scores met expectations by 50% or more; 84.3% agreed to a high degree that students’ test scores were good; 52.9% agreed to a high degree that students ranked in the top 3 of the district or provincial top students; and 62.7% agreed to a high degree that students did not drop out of school mid-year or at the end of the year (see Table 7).

Table 7: Student learning achievement

Code	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
f1	Students’ scores reached expected level	17 (33.3)	29 (56.9)	4 (7.8)	1 (2.0)	0
f2	Students’ transitioning scores are in good level	12 (23.5)	31 (60.8)	8 (15.7)	0	0
f3	Students get first to third ranging in district or provincial level	6 (11.8)	21 (41.2)	11 (21.6)	3 (5.9)	10 (19.6)
f4	Students are not leaving school during the middle or by the end of semester	14 (27.5)	18 (35.3)	10 (19.6)	6 (11.8)	3 (5.9)

The data from the Table 7 also is illustrated in the Figure 7 below

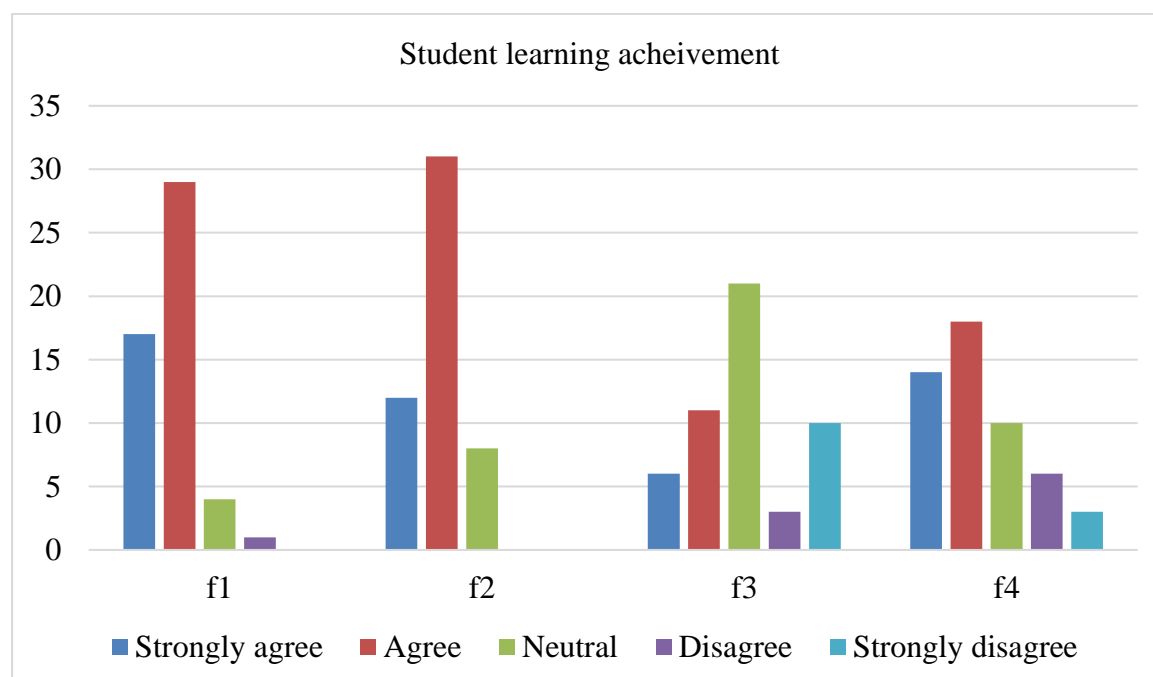


Figure 7 Teachers’ views on student learning achievement

The interview data showed that the demonstration primary school had previously ranked 1st, 2nd and 3rd at the district and provincial levels. ONCH- commented, “In the past, when students came here, we passed the group exams first, and then went up to the provincial level... But our school couldn’t do it at the provincial level... We went to the group exams, the district level, and then the provincial level, and we rarely went. At the district level, we only got one place [3rd place] in the first year, and then we went up from there... In 2021-22, we got 3rd place... Last year, this year, the Covid situation was a bit complicated.” However, another demonstration school affiliated with the Northern Teachers College was still able to win the first place at the provincial level. SVL commented, “This school has previously submitted its district and provincial exams and came in 2nd and 1st. Last year, it even took the ministerial exam. This year, one of them went to China and passed the national primary school exam. The secondary school has not yet reached the district level; the province has only reached the commendable level”.

In terms of student achievement based on academic performance, it can be concluded that the demonstration schools in the northern region can be a model, whether in terms of student scores meeting the target of 50% or more, students' passing test scores are at a good level, students rank 1st out of 3 among the district or provincial top students, and students do not drop out of school mid-year or at the end of the year.

2.7. School teachers’ views on school management

The demonstration school is a school with systematic organization and management. Of these, 90.2% of teachers agreed to a greater extent that the school administrator has an annual summary, a short-term and long-term school development plan, especially in academics. The administrator is also very attentive. 80.4% of teachers agreed to a greater extent that the administrator pays attention to promoting academic work such as teaching and learning, curriculum development, and monitoring and evaluation. One important issue is the budget. 60.8% of teachers agreed to a greater extent that the administrator provides an appropriate budget according to the reality of the school. However, about 40% of teachers still agreed to a moderate degree with the administrator’s budget provision. Another important issue is the allocation of personnel to administrative positions. 70.6% of teachers agreed to a greater extent that the administrator appoints and distributes personnel responsibilities according to their knowledge and abilities (see Table 8).

In conclusion, the demonstration school affiliated with the Teachers College in the North can be a model in terms of school management, especially in terms of administrators having short-term and long-term school development plans, attention to academic work, and the appointment and distribution of personnel responsibilities according to their level of knowledge and ability.

Table 8: School management

Code	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
g1	There are yearly report, short-long school development plan	25 (49.8)	21 (41.2)	5 (9.8)	0	0
g2	School administrators pay attention to academic work, such as, teaching-learning,	14 (27.5)	27 (52.9)	5 (9.8)	2 (3.9)	3 (5.9)

Code	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	curriculum development, assessment and evaluation follow-up.					
g3	Providing sufficient budget depending on current situation	5 (9.8)	26 (51.0)	13 (25.5)	4 (7.8)	3 (5.9)
g4	Appoint and giving responsible work based on teachers’ competency	12 (23.5)	24 (47.1)	7 (13.7)	3 (5.9)	5 (9.8)

The data from the Table 8 also is illustrated in the Figure 8 below

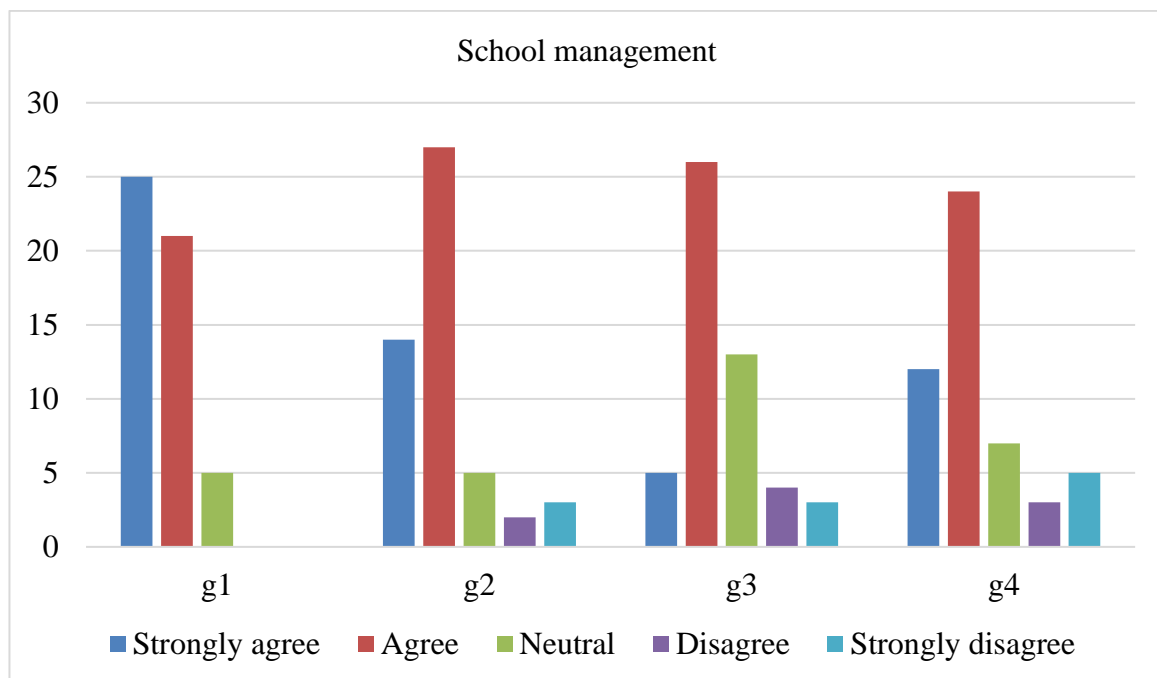


Figure 8 Teachers’ views on school management

2.8. School teachers’ views on research engagement

To improve teaching and learning, teachers also support research. Among them, 31.4% of teachers in demonstration schools agreed to a greater extent that they were thinking about doing research but had not yet started. In addition, 29.4% of teachers agreed to a moderate degree, 13.7% agreed to a lesser degree, and 25.5% did not think about doing research. For teachers who are doing research but have not yet completed it, almost 20% of teachers agreed to a greater degree, 25.5% agreed to a moderate degree, 19.6% agreed to a lesser degree, and 35.3% did not agree at all. For those who have completed it, they have published in various journals. Regarding publishing research results in journals at the TTC level, 15.7% of teachers agreed to a greater degree and at a moderate level, 11.8% of teachers agreed to a lesser degree, and about 60% did not publish at all. In addition, publishing research results in national journals level also occurs in demonstration schools, with 11.8% of teachers agreeing to a greater extent and at a moderate level, 13.7% of teachers agreeing to a lesser extent, and 62.7% of teachers

not publishing at the national level. Publishing research results in international journals also occurs, with 9.8% of teachers agreeing to a greater extent, but 90.2% agreeing to a lesser extent. In summary, publishing in journals of various levels by teachers in demonstration schools appears at each level, but is low at all levels.

Table 9: Research engagement

Code	Items	Level of agreement				
		Strongly agree	Agree	Neutral	Disagree	Strongly agree
h1	Thinking of doing a research but not starting yet	3 (5.9)	13 (25.5)	15 (29.4)	7 (13.7)	13 (25.5)
h2	In the process of doing a research but not completed yet	0	10 (19.6)	13 (25.5)	10 (19.6)	18 (35.3)
h3	Publishing a research article in a TTC level	1 (2.0)	7 (13.7)	8 (15.7)	6 (11.8)	29 (59.6)
h4	Publishing a research article in a national level	1 (2.0)	5 (9.8)	6 (11.8)	7 (13.7)	32 (62.7)
h5	Publishing a research article in an international journal	0	5 (9.8)	6 (11.8)	8 (15.7)	32 (62.7)

The data from the Table 9 also is illustrated in the Figure 9 below

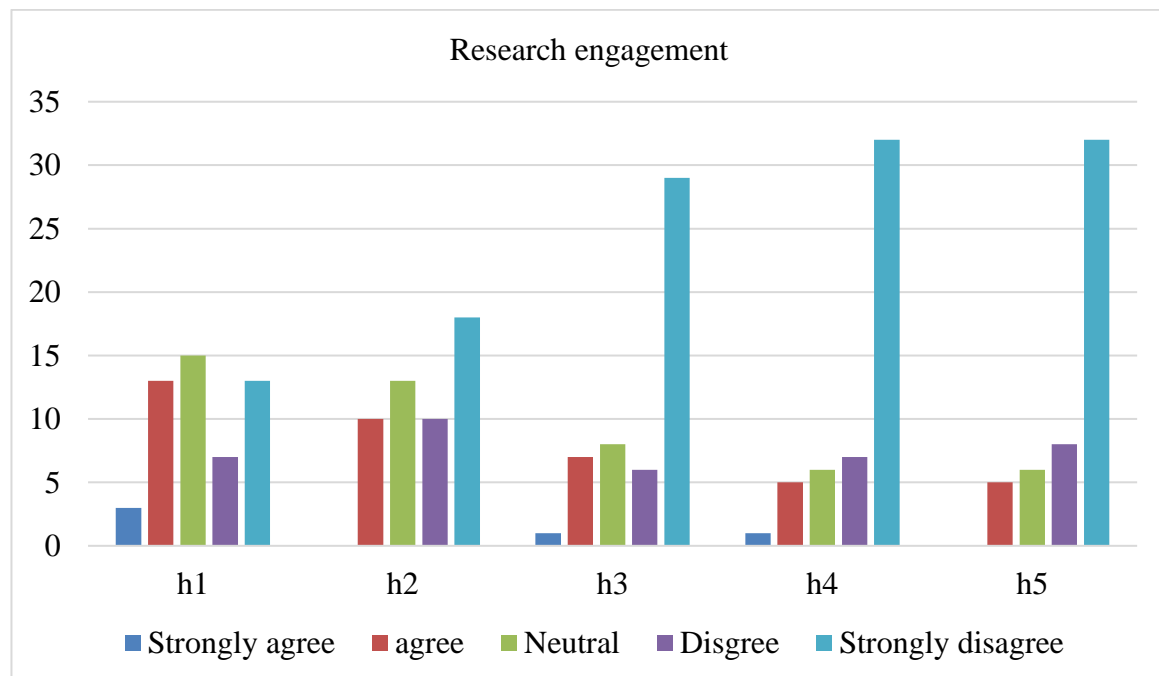


Figure 9 Teachers' views on the research engagement

Discussion

The results of the data analysis show that teachers in the demonstration school affiliated with the Northern TTCs can be role models in terms of professionalism. They can be role

models in terms of solid knowledge of the subjects they teach, the teaching-learning process that motivates students to learn or create their knowledge, and their participation in conferences on teaching-learning management and training on teaching-learning. To be a professional teacher, there must be 3 characteristics: teaching well, having discipline and morality, developing oneself, and learning continuously. To teach well, the teaching-learning process must be organized by considering students as the most important and organizing activities according to the interests, abilities, needs, and conditions of the learners. Allowing learners to think, act and experience directly. Organizing learning so that it can happen at any time and place and conducting research as part of learning. Organizing learning so that learners can develop themselves from technology continuously and consistently. Complying with the standards of the teacher profession and teacher ethics, and complying with the regulations of the teacher civil service. Develop yourself and study for knowledge, improve your skills and have a good attitude towards work, develop teaching and learning and develop learners (Mayuri Duangsri, 2015). For a teacher to be professional, he must have knowledge of the subject and knowledge of teaching methods. Knowledge of the subject means the amount of knowledge available and the organization of knowledge; for knowledge of teaching methods, it means the knowledge of how the teacher will present the knowledge of the subject to the students so that the students can learn, which should be in many forms. Teachers also need to understand what makes learning in a given subject easy or difficult for students with different levels of knowledge (Shulman, 1986). If we look deeper into the knowledge for teacher professionalism, there are still 6 important components: general knowledge of the subject, specific knowledge of the subject, content and student knowledge, content and teaching knowledge, knowledge of the curriculum and knowledge of the continuity of lessons for each chapter and each grade (Thames, Sleep, Bass & Ball, 2008). In addition to knowledge, there must be development beyond that knowledge, whether it is professional development in one's own identity (knowledge, beliefs, values, and actions), research and application (using research results and transferring from theory to practice), and development of integrity and practice (caring for others, fairness, tolerance, respect, etc.) (Lui & Lui, 2015).

In terms of new innovations, teaching and learning in demonstration schools affiliated with northern TTCs may not yet be a model because new teaching designs that are different from the original methods have not yet been seen, but what can be seen is the use and application of 15 teaching methods in their own teaching according to the ideas of the respondents and interviewers. In which, actual teaching observations have not yet been seen. New teaching and learning innovations are the creative ideas of teachers who change their own teaching methods so that students are more involved in learning, enthusiastic and involved in teaching and learning activities. New teaching innovations may be the integration of technology, images, text, and video into teaching time so that students are as involved as possible. If students are more involved, they will learn more and retain that knowledge for a long time. Students who participate in activities tend to make an effort and have fun completing the activities. Innovative teaching methods include the use of video, images and audio, brainstorming, classrooms outside the classroom, role-playing, competitive games and presenting lessons as a continuous story (Kalyani & Rajasekaran, 2018). Creative teaching and learning must be flexible according to the surrounding environment, changing the culture from teacher-centered to student-centered, helping students understand the ideas of the lesson, teachers must observe students, active learning, think-pair-share, jigsaw or game-based (Sivarajah et al., 2019). In addition, there are new teaching and learning activities such as the flipped classroom, which allows students to learn in a holistic way, which includes 4 important elements: determining the teaching method, allowing students to search for information with the teacher as a guide, students building a body of knowledge from the media received,

demonstration and application by students as project implementers. There are also virtual classrooms and smart classrooms (Phanuwat Sivaskunlat, 2010).

Based on the results of a survey of teachers' opinions on the environment of demonstration schools affiliated with the northern TTC, it is found that they can be models, whether in terms of cleanliness of classrooms, offices and classroom order, facilities, electricity, and water supply. However, the cleanliness of toilets in demonstration schools affiliated with some teacher training colleges is still a problem. This may be because some demonstration schools are under construction, which necessitates the use of new temporary locations. Another issue that cannot be a model is the proper disposal and storage of garbage, especially garbage separation, which is still a major obstacle that prevents schools from being models. This may be because the responsible government agencies, capitals, provinces, or districts have not yet seen the importance or taken measures to require communities, shops, schools, hospitals, and other places to separate garbage, which has caused educational institutions to not emphasize the importance and necessity of this issue. Also, this problem has not been seriously addressed in large cities such as Vientiane. “Currently, the municipality does not have any mechanism to encourage waste separation at source, so all types of waste are mixed and destroyed together” (Atsaphangthong Siphandone, 2021). This problem has caused “economic losses along the waste value chain, which is equivalent to resources not being collected and causing waste collection sites to fill up quickly”. It is estimated that, in Vientiane, 816 grams of waste are generated/ per person/day. Organic waste (food waste and leafy waste) accounts for the most, 67%, followed by plastic 12.1%, paper and cardboard 8.8%, glass 3.3%, cans 0.7%, cloth waste 0.3%, metal and scrap 0.1%, and others 7.8% (Atsaphangthong Siphandone, 2021).

Conclusion

In conclusion, the demonstration school affiliated with the Northern TTC is a high model in terms of teacher professionalism, but in terms of innovative teaching methods, it may not yet be a model. In terms of the school environment, it can be a model in some aspects, but it is not yet a model, such as the cleanliness of the schoolyard, its spaciousness, and the separation of various types of waste. In terms of community participation, it is seen that a parent-teacher association has been established, but other aspects still need to be improved. In terms of field trips and technical exchanges with the outside schools, it may not yet be a model school. In terms of student achievement and school management, it is seen that it can be a model. However, it is not a model school in terms of scientific research. To be a model school, it is suggested that teachers and school administrators should pay particular attention on these eight components. If it happens to be difficult to implement all components together at the same time, they may annually make an effort to improve one or two components.

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From Classroom to Camp: English Camps' Impact on Lifelong Learning in Public Administration

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Abstract

Anchored on the concepts of Willingness to Communicate (WTC) and motivation in learning English as a Foreign Language (EFL), this qualitative descriptive study investigates the impact of English camps on the lifelong learning of Public Administration students in a public university in Thailand. Utilizing the total population sampling technique, a total of 23 graduate and undergraduate non-native English speakers from Thailand and neighboring Southeast Asian countries participated in an English camp facilitated by two Filipino English teachers. Participants voluntarily completed a post-event evaluation to provide insights into their experiences. Thematic analysis was employed to analyze the qualitative data. The findings revealed that the various activities conducted during the English camp significantly improved participants' communication skills and enhanced their cross-cultural understanding and awareness. Engaging in interactive exercises, group discussions, and cultural activities fostered a supportive learning environment that encouraged students to practice their English in real-life contexts. Notably, despite the English camp facilitators being non-native English speakers, participants expressed high satisfaction with the English camp's organization and execution. To effectively foster students' communication competence, cultivate positive character traits, and promote intercultural understanding within the ASEAN community in Thailand, it is essential to incorporate interactive outdoor activities into English language instruction. Overall, the study recommends a comprehensive transformation of the school ecosystem to sustain these initiatives, ensuring that all students receive ongoing opportunities for language practice and cultural exchange. This approach not only targets language proficiency but also equips students with the skills necessary for effective communication in lifelong intercultural settings.

Keywords: English as a Foreign Language, English camps, intercultural communication, lifelong learning, Willingness to Communicate (WTC)

Introduction

In the contemporary globalized world, English proficiency has become a practical and indispensable skill which enables individuals to participate effectively in international discourse, access global knowledge, and enhance worldwide career opportunities. As the modern workplace continues to evolve into a more global and interconnected landscape, proficiency in foreign languages, especially English, plays a crucial role in international business relations.

English camps, designed as immersive, interactive learning environments, have emerged as a promising intervention to address these challenges and foster greater willingness to communicate (WTC) in English.

1. Research Objectives

This study aims to explore the experiences and perceptions of Public Administration university students in Thailand and other Southeast Asian countries with regard to the effectiveness of English camps, focusing on how these activities influence their communication competence, Willingness to Communicate (WTC), and cross-cultural understanding within the ASEAN context.

2. Review of Related Literature

The ability to navigate culturally diverse environments – understanding how international stakeholders think, work, and express themselves through their attitudes and behaviors – has become equally important (Simões, 2021). Thus, for Public Administration students in Thailand and other neighboring countries in Southeast Asia, acquiring a Willingness to Communicate (WTC) in English remains a significant educational goal. Despite formal education efforts such as the integration of several English courses in the university curriculum in some universities in Thailand, many students still exhibit reluctance to engage in English communication, often due to low confidence, high anxiety (Jing & Junying, 2016), and insufficient practical exposure.

A fun learning environment enhances a student's lifelong learning journey. This is in consonance with the United Nations Sustainable Development Goal (SDG) 4 on the assurance of inclusive and equitable quality education and the promotion of lifelong learning opportunities for all. In May 2018, the Council of the European Union (CEU) also adopted a Recommendation on Key Competences for Lifelong Learning. This framework seeks to create a shared understanding of the competences essential for today and the future, highlighting the connections between knowledge, skills, attitudes, and values. It serves as a vital reference for education and training stakeholders and outlines the various key competences. Particularly relevant to English camps, English as a Foreign Language (EFL) and lifelong learning are the competences of a) multilingual skills; b) cultural awareness and expression; c) digital skills, and d) personal, social, and learning to learn skills of students (Simões, 2021).

English camps typically involve short-term, intensive programs that immerse students in English through various interactive activities such as games, role-plays, group discussions, and cultural exchanges. These camps aim to create a low-pressure, enjoyable atmosphere that encourages spontaneous use of English, thus reducing communication apprehension and enhancing confidence. In fact, English camps have become a prominent trend in English language pedagogy, particularly among non-native speakers of English in Asian countries such as China (Friesen, 2023), Malaysia (Srisermbhok, 2020), Taiwan (Chien, 2020), and Thailand (Sunyakul & Teo, 2020). Their popularity stems not only from their enjoyable nature but also from their significant impact on various aspects of student development.

Several research highlights the efficacy of English camps in reducing students' anxiety levels (Jing & Junying, 2016) while concurrently enhancing their perception of English willingness to communicate (Noguchi, 2019). Additionally, studies by Rugasken and Harris (2009) and Srisermbhok (2020) underscore their positive influence on language acquisition and cultural understanding. Asmara et al. (2016) further demonstrated that students derive immense enjoyment from non-formal activities within English camps, such as games, competitions, and adventures, thereby reinforcing their enthusiasm for English learning. Children of all ages enjoy English camps as well. The study of Friesen (2023) proved that summer English camps

in China resulted in a high level of satisfaction among young English learners as they appreciate the importance of relationships in English language learning. As a result, Srisermbhok (2020) advocates for the integration of outdoor activities in English instruction, not only to bolster students' communication competence but also to foster good character, resilience, and a nuanced awareness of the ASEAN community in Thailand. Meanwhile, for non-English major students, who might not prioritize language learning in their regular curriculum, English camps offer an invaluable opportunity to practice and improve their English skills in a supportive and engaging environment.

Several research also focus on how primary school English teachers can apply the knowledge and skills they acquire from English boot camps to their classroom (Sunyakul & Teo, 2020) and even how these can further be applied for the professional development and further collaboration of Pre-Service English teachers (Hidarto & Christine, 2021). As a result, the study of Adipat et al. (2021) provided an innovative framework for the adoption of the educational games learning approach at the university level. This was done to ensure lifelong learning and interdisciplinary learning opportunities for students. The study introduces social skills and knowledge training to address topics of gaming and learning. It describes the point at which learning is expected to occur and the role that game elements play in relation to student engagement and educational gaming content interaction.

For language teachers, such English camps are unique experiences that enhance their professional development and often lead to incorporating camp strategies, approaches, and techniques into classroom lessons (Blackton & Mccaughey, 2024; Sunyakul & Teo, 2020). In fact, the educational game learning approach used to teach English to non-native English-speakers who use English as a second or foreign language has recorded great success (Adipat et al., 2021). To encapsulate, English camps benefit all stakeholders: language learners, their parents, schools, and language teachers (Blackton & Mccaughey, 2024).

English camps organized by universities not only promote English language learning, but also facilitate international collaborations between institutions. One such example is the partnership between a public university in Khon Kaen, Thailand and a private university in Baguio City, Philippines. In February-March 2023, the two universities jointly conducted a two-week English camp. Two faculty members and two English major students from the private university in Baguio City, Philippines were invited to Khon Kaen, Thailand to facilitate the program. The English camp aimed to train Thai and other international students to become effective, confident, and competent English speakers by engaging learning concepts and principles of effective oral communication through fun games, team-building activities, group works, and reflective dialogues. Beyond language acquisition, the camp also sought to cultivate mutual understanding among participants by providing insights into each other's cultures, religions, arts, and customs. This endeavor was significant as international graduate students from Myanmar and Indonesia also actively participated in the said event.

The concept of Willingness to Communicate (WTC) in Second Language Acquisition (SLA) is pivotal in understanding how and why language learners choose to engage in communication using the target language. There are several theories and models exploring the factors influencing WTC in Second Language Acquisition (SLA). However, this specific study is heavily anchored on MacIntyre's Heuristic Model of WTC (1998), which practically recapitulates the other theories, concepts, and models of SLA. MacIntyre et al. (1998) developed a comprehensive model that integrates psychological, linguistic, and social variables affecting a learner's willingness to communicate. Key components of this model include the following concepts, namely: a) Communication Confidence, which includes self-perceived communicative competence and communication anxiety. Learners who believe in their ability to communicate effectively and feel less anxious are more likely to engage in communication;

b) Desire to Communicate with a Specific Person, which is influenced by social, cultural, and situational factors such as the relationship with the interlocutor, the topic of conversation, and the context of the interaction; and c) Intergroup Motivation, which involves attitudes towards the language community and the desire for integration.

WTC plays a significant role in the development of English language skills of English as a foreign language (EFL) students in face-to-face and online English language lessons because they are usually required to use English to express their opinions, feelings, attitudes, and beliefs (Dariyemez & Yastibas, 2024). In relation, the study of Chavez-Yuste et al. (2024) states that English language anxiety significantly influences academic performance and has a medium effect on willingness to communicate in English.

Despite the increasing popularity of English camps, there is a lack of empirical research examining their impact on enhancing the willingness to communicate (WTC) among higher education students, particularly Thai and international students enrolled in Public Administration programs at universities in Thailand. Most existing studies focus on English camps conducted in primary and secondary schools, while other studies have centered on the English teachers' activities in English camps. Several subsequent research concentrated on more formal classroom settings, leaving a gap in understanding how informal, immersive experiences influence the communicative behaviors and attitudes towards English of non-English major university students.

Research Methodology

1. Research Design

This qualitative study employed the descriptive paradigm. Over the years, several studies have already been conducted on the effectiveness of English camps and most of these studies were quantitative in nature. Thus, for this study, the researcher maintained that a qualitative descriptive approach will help answer several gaps in the literature and would provide a more meaningful and in-depth understanding of the impact of English camps on the lifelong learning, communication skills, and intercultural competencies of the Public Administration students. Exploring the data in qualitative data analysis involves reading through all of the data to develop a general understanding of the database (Creswell & Plano Clark, 2011).

2. Research Instrument

A post-event evaluation was administered to the English camp participants which was composed of both quantitative and qualitative parts. The quantitative aspect included Likert-scale questions to measure their overall perception of the effectiveness of the English camp activities including the organization and logistic aspects. However, this study focused only on the qualitative aspect of the post-event evaluation which were the open-ended questions at the latter part of the post-evaluation tool. In qualitative research, open-ended questions are used to collect data without having the researcher use predetermined categories or scales to collect the data (Creswell & Plano Clark, 2011). In this study, the open-ended questions of the research tool encouraged participants to share their thoughts on specific aspects of the camp, such as their takeaways and suggestions for future topics and activities. The researcher maintains that this part of the post-evaluation tool delves more onto the English camp's impact on the participants' communication competence, willingness to communicate (WTC), and motivation in learning English as a Foreign Language (EFL), allowing for an in-depth exploration of students' experiences, perceptions, and reflections on the camp activities and their impact on communication competence and cross-cultural understanding.

3. Population

The study utilized total population sampling of the 23 Public Administration students from a public university in Khon Kaen, Thailand who participated in the English camp. Six of the participants were graduate students from Indonesia and Myanmar, while the rest were Thai undergraduate students. All of them were non-native speakers of English. Participants voluntarily completed a post-event evaluation to provide insights into their experiences.

4. Data Analysis

Qualitative data analysis involves coding the data, dividing the text into small units (phrases, sentences, or paragraphs), assigning a label to each unit, and then grouping the codes into themes (Creswell & Plano Clark, 2011). In this study, qualitative data from the post-evaluation were coded and analyzed thematically to extract meaningful insights with regard to the participants' language learning experiences and the effectiveness of the English camp activities in fostering communication competence and intercultural understanding. Contextual coding technique is proposed as an approach for capturing the underlying social and cultural meanings of qualitative data for qualitative research involving participants with diverse social and cultural backgrounds (Younas et al., 2022). Specifically, this study used an interpretation-focused coding technique, which refers to making meaning of the actual words and phrases of the participants and moving beyond mere description of empirical indicators of the data (Adu, 2019 as cited in Younas et al., 2022).

Findings and Discussion

Based on the participants' feedback from the English camps, several key themes were identified. These themes encapsulate the main takeaways and experiences shared by them. This study yielded the following salient findings which are presented in no particular order.

1. Confidence and Competence

Numerous participants emphasized the importance of building confidence in speaking English. They noted that through practice and interaction, they became more comfortable speaking with both peers and international friends. Phrases like "learning to have confidence to speak" and "building confidence in speaking English" highlight this theme. One participant shared:

"I learn many things about English, leadership, or anything related to my major. But the most one is my confidence in speaking has improved more."

Another participant narrated:

"I've learned how to have a confidence to speak English and learned how to participate in a team group work to finish the project."

One participant also disclosed:

"before I coming to this camp I'm not good at English and I don't have confidence to speak. but after I'm coming to this camp I feel I have improved my speaking and learning skills and more speak."

One participant emphasized the importance of overcoming fear associated with speaking the English language:

“Learn to be brave to speaking English to exchange our knowledge with international student, Thai student. Very useful!!!!”

Due to the overwhelming positive feedback, many participants suggested that English camps should be conducted more frequently. Cliche as it may sound, practice makes perfect. One participant explained:

“More times, do it regularly, because language is a habit and it’s daily activities. If we don’t do follow up for it, it will lose by time and time.”

Meanwhile, several responses from the students highlighted the acquisition of practical language skills, such as improved listening, speaking, pronunciation, and vocabulary as part of the outcomes of their participation in the English camp. Specifically, improved listening skills were frequently mentioned, with participants recognizing the importance of listening in effective communication. As one participant narrated:

“Before the camp my listening wasn’t good but afterwards I got a lot of lessons while I practice to listen.”

Statements about the need for good listening reflect an understanding of its role in language acquisition and interaction. Hence, correct pronunciation should also be prioritized in order to communicate effectively. As one participant put:

“Good pronunciation makes good understanding.”

In relation to this, a number of participants suggested more pronunciation drills in the future English camps. One participant shared:

“I want to learn new words and how to pronounce correctly.”

Due to this, one participant suggested that facilitators should speak slower to ensure comprehension on the part of the non-native English speaker participants of the English camp. He said:

“...maybe try to speak slowly to makes the students catch up”

The study by Kim and Lee (2023) highlights the essential role of pronunciation in oral communication for second language learners. Their research indicates that the growing interest in English language learning among elderly adults has resulted in increased participation in lifelong education programs in Korea. However, the researcher asserts that these findings are applicable not only to elderly learners but to EFL learners of all ages, underscoring the universal importance of pronunciation in effective communication.

More than enhancing their productive and receptive skills in communicating in English, several participants noted that they learned to communicate in real-life situations, which made the learning process more relevant and engaging. One participant disclosed:

“I feel I have improved my speaking and learning skills and more speak.”

Another participant explained:

“I have learned a lot of English and I learned about speaking English is very easy if you want to say you say because when you say everyone understand but you don't speak everyone don't understand”

Remarkably, many participants suggested that apart from daily conversations, the next English camps should have more oral presentations which is one of the common academic

requirements of Public Administration students that aims at improving their public speaking skills. One participant explained:

“Presentation. Because it cost much our time to spend a lot thinking, speaking and sharing our ability in English.”

Oral presentation is an example of authentic tasks in English language learning and assessment which positively impact engagement and confidence-building. These tasks facilitate meaningful discussions about learning preferences, enhancing linguistic competence as students report on topics of interest (Ramírez Ortiz & Artunduaga Cuéllar, 2018). This finds support in the research conducted by Pérez et al. (2024) which indicates that using authentic tasks in e-forums: (a) enhanced meaningful interactions among learners, supported by social, cognitive, and teaching presences; (b) facilitated the collective construction of significant and enduring knowledge; and (c) strengthened the learning community through participants' emotional and communicative engagement. Clearly, these findings are also relevant to in-person and informal learning environments such as English camps. Furthermore, the researcher underscores that the English camp participants' reflections and suggestions revealed their positive attitudes towards their presentation experiences, showing their efforts to prepare, practice, and deliver oral presentations.

Significantly, the study by Konchiab and Munpanya (2021) identified key strategies to enhance students' language proficiency and confidence in oral presentations, emphasizing the importance of focusing on pronunciation, vocabulary, and grammar. It suggested that practicing communication strategies to manage negative emotions and unexpected challenges during presentations is beneficial. Furthermore, engaging in extensive presentation practice across various learning contexts encourages authentic language use and improves students' flexibility and adaptability in employing these strategies. As a result, Konchiab and Munpanya (2021) even suggest that regular training and practice of self-assessment rubric and self-reflection would complement teacher assessments to improve students' oral presentation and continuously promote lifelong learning.

Consequently, Ramírez Ortiz and Artunduaga Cuéllar (2018) contend that while some grammatical errors may occur during oral presentations, participants tend to produce more coherent sentences with complex structures. Ultimately, authentic tasks boost students' confidence in speaking by allowing them to focus on achieving their objectives rather than solely on linguistic accuracy. Blackton and McCaughey (2024) support this by claiming that at EFL English camps, grammatical corrections are supposed to be minimized to foster an environment where campers feel encouraged to use new vocabulary, sentence structures, and verbal expressions without fear of judgment from facilitators or peers. Therefore, English camps should aim at providing language learners with an opportunity to engage with English through production and social interaction in a fun, correction-free setting, which helps lower their affective filter and promotes confidence in their language use.

2. Collaboration and Camaraderie

The English camp was described as an avenue for a fun and engaging learning environment, where games and interactive activities facilitated language learning. The emphasis on "learning English with fun" and "strategies for learning" indicates that the approach taken was effective and enjoyable. Some participants shared:

“Learning English with fun, teamwork and has a strategy.”

“Encouraging people that it's okay to make some mistakes and keep talking or doing something like speaking in English.”

Moreover, participants frequently mentioned teamwork as a crucial element of their experience. They learned to work together on projects, which enhanced their communication skills and ability to collaborate effectively. The importance of "teamwork" and "leading the team" indicates a focus on collective effort and shared learning. One participant shared:

"Teamwork, talk with many friends make me have to confidence speak more."

Aside from teamwork, some participants also uncovered their leadership potentials. One student proudly disclosed:

"I learned how to lead the team."

Notably, one of the participants shared that the English camp was instrumental in honing the students' sense of responsibility. He shared:

"Do your obligation well, pay attention to the instructor if you work in a team."

Adipat et al. (2021) emphasized that the principles of collaborative learning are fundamental for developing cognitive and social skills. They also highlighted that game-based learning contributes to enhancing mindset and personal growth. This was proven true by some participants who shared:

"Wish there were more fun games"

"I don't want too many academic activities."

Moreover, comments about making new friends and the importance of social connections reflect the value of interpersonal relationships during the camp. This only shows that the camp fostered a sense of community, with participants mentioning the friendships formed among themselves. Several student shared:

"I know a lot of new friends, both of Thai students and international students."

"I want more interaction with friends."

"A lot has been learned, my favourites are friendship, connection and kindness."

The study of Fan (2022) posits that positive emotions can expand individuals' capability to handle information. Individuals' positive affectivity can increase their contentment and subjective wellbeing. Thus, as made evident in the verbatim comments, the camaraderie that was built among the participants of the English camp immensely contributed to their friendship with one another, creating an opportunity for constant communication. In fact, friendship group activities, which is a learner-centered approach to collaborative learning, enhance learners' overall abilities and foster intimate and low-pressure environments (Wang, 2021).

Furthermore, Fan (2022) stated that teachers with higher positive affectivity tend to use and generate novel teaching approaches. Since the facilitators of the English camp were from the Philippines, the researcher presumes that certain cultural similarities between them and the participants from the Southeast Asian countries contributed to their bond and the eventual success of the EFL experience.

3. Cultural Cognizance

The English camp provided insights into multiculturalism, with participants learning to be mindful of different cultures and perspectives. Comments about learning from mistakes and understanding the importance of being open-minded suggest a growth in cultural competence. One participant explained:

"There are multi cultural in this world so you have to be mindful and wide to say or to do something."

Notably, several participants were zealous to have more culture-related topics related to public administration in the next English camps, as reflected in their topic suggestions. One participant shared:

"More about politics I wanna learn another country politics too but I know it sensitive too say."

Another participant suggested:

"Cultural related topic to show the diverse of ASEAN people"

One participant requested for very specific topics for the succeeding English camps:

"International Relationship, Cultural Exchange, and Governance of each country"

While learning and teaching English as an additional language are lifelong learning processes for both learners and teachers, these two sectors are largely dominated by West-centric linguistic and cultural imperialism, epistemic hegemony, racism, and neoliberalism, which are tied to colonialism and imperialism. Notably, one participant was knowledgeable about the varieties of English of every country. The student explained:

"because every country speaks in English in their own language ways so it might misunderstand the conversation."

This statement by the student participant highlights the need for teachers to also educate students about the cultural background of language usage. Teaching language without cultural context can lead to students learning meaningless symbols or misinterpreting meanings. Consequently, students may use the language inappropriately or in the wrong cultural context, undermining the purpose of language learning (Leveridge, 2019, as cited in Srisermbhok, 2020).

Meanwhile, despite the English camp facilitators being non-native English speakers, the English camp participants reported high levels of satisfaction with the camp's organization and implementation. In light of this finding, Suraweera (2022) contends that decolonizing and de-imperializing the teaching of English to speakers of other languages is necessary. Furthermore, Jumsai Na Ayudhya's (2021) study revealed that contemporary English language students are already cognizant of the distinctions between native and non-native English speakers. These students recognize that both groups possess unique linguistic, cultural, and pedagogical strengths and weaknesses, ultimately debunking the ideology of native speaker superiority. Nowadays, numerous international schools, public universities, and private universities in Thailand have already begun hiring English teachers from the Philippines (Nawamawat & Cedar, 2021; Ulla, 2021). In the Philippines, English is considered as a second language, an official language, and as a medium of instruction (Wa-Mbaleka, 2014).

4. Career Cultivation

Themes of resilience, determination, and self-belief were evident, with participants encouraged to appreciate their progress and keep striving for improvement. Several English camp participants mentioned personal development aspects, such as setting goals for the future, like plans of having their internships and future study plans abroad. One participant shared:

"I would like to do an internship abroad, and this is my first important step."

The same participant eventually completed his international internship program in the Royal Thai Consulate-General in Ho Chi Minh City, Vietnam. For him, motivation is his driving force in learning English. This finds support in the study of Hajmohammadi and Aghayani (2022) which shows that motivation and internal locus of control facilitate EFL learners' sense of self-determination, autonomy, competence, and relatedness. This can be specifically worthy of attention not only for EFL learners, but also for EFL teachers who play a significant role in developing English language learning. In short, motivation, whether intrinsic or extrinsic, plays a vital role in determining an EFL student's language learning success. Thus, EFL teachers should keep their students motivated to achieve desired results.

Another factor related to motivation is self-regulation. Wijaya (2022) found that EFL learners with a higher degree of self-regulation are more likely to become lifelong learners who achieve better language learning outcomes. To foster lifelong learning traits in EFL students, it is crucial to train them to maximize their self-regulation potential. By becoming more self-regulated learners, EFL students will be better able to manage their learning environments, resources, strategies, and time to achieve their desired learning goals. Thus, hard as it may seem for non-native speakers of English to learn a language, one student participant shared that determination is key in English language learning:

"You aren't going to improve if you're not believing in yourself."

Another student supported this by stating:

"Don't give up on yourselves."

Notably, another participant emphasized the importance of not being afraid of making mistakes and maintaining a positive mindset in learning English. He mentioned:

"Learn from the mistakes."

In fact, Dooly, Masats, and Mont (2021) argue that when young learners are assigned responsibilities and given opportunities to engage with socially relevant challenges, their learning becomes meaningful not only for themselves but also for those around them. This approach enhances the educational experience by fostering a sense of social responsibility and engagement with real-world issues. One student stated:

"Do your obligation well, pay attention to the instructor if you work in a team. The important thing in life is to have a great aim and the determination to achieve it."

Self-directed learning strategies can be effective options for motivated students, as they extend beyond specific educational levels and are applicable throughout life. Additionally, these strategies foster positive attributes in learners, such as discipline, attentiveness, responsibility, and creativity in setting their learning objectives (Adnan & Sayadi, 2021). Most of the time, self-directed learning strategies also teach proper time management since learners get to control the pace of learning. For instance, students could also explore Massive Open Online Courses (MOOCs), one of the most prominent trends of higher education courses online

which promotes learning through flexible participation and open access via web (Baturay, 2015 as cited in Nigar, 2020). MOOCs are now being offered by many universities to online learners worldwide -- including English Language learners -- and are seen to be effective in teaching academic writing skills for effective communication in university studies, professional life and lifelong learning (Nigar, 2020). These only prove that there are countless ways by which learning can take place beyond the four walls of the classroom.

Conclusion

This research aims to fill a critical gap in the literature by examining the role of English camps in enhancing WTC in English among non-English major students in Southeast Asia, particularly those taking up Public Administration. To encapsulate, this study was undertaken to investigate the impact of English camps on the lifelong learning of Public Administration students from the students' viewpoints.

By exploring the impact of these immersive programs, this study seeks to provide actionable recommendations for improving language education and fostering a more communicative and confident generation of English speakers in the ASEAN region especially for non-English major students who are trained to be the future leaders of local, regional, and national public offices. Public Administration students need to be proficient English speakers because their line of work entails them to possess communicative competence regardless of the people they interact with not only in the local level, but also in international arena especially when they partner with international leaders in looking for ways to improve the way of living of their constituents and the rest of their community. Hence, English language learning entails lifelong learning.

The themes which were generated from this study collectively illustrate the multifaceted benefits of the English camp experience, highlighting not only language acquisition but also personal and social development. Undoubtedly, the verbatim responses provide a rich insight into the participants' experiences and highlight the key themes that emerged from their time at the English camp. Each quote reflects the personal growth, social connections, and language skills developed during the program. Overall, the English camp participants emerged with enhanced communication skills, greater confidence, and a deeper appreciation for cultural diversity.

Nonetheless, school administrators should also expect realistic outcomes from these programs. Learning the English language is not easy for non-native speakers of the language. There is a fine line between teaching English as a Second Language and English as a Foreign Language. For most Southeast Asian EFL learners whose L2 is not English, being proficient in English can never be an overnight job. As the saying goes, practice makes perfect. Hence, school administrators should prioritize creating an environment that would encourage non-native English speakers to feel free in expressing their ideas without fear of judgment, and without making them subjects of ridicule based on their errors in grammar, accent, or pronunciation. It is imperative to note that even native speakers of English commit errors in using the English language. With the existence of numerous English varieties in Southeast Asian countries alone, it is essential to move beyond rigid grammatical rules and shift our focus toward the content of what is being communicated, rather than the manner in which it is expressed.

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Development of Augmented Reality Media for Film-Making Course in Vocational Certificate

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Abstract

This research aims to 1) develop Augmented Reality (AR) media for Film-Making Courses in Vocational Certificate, 2) compare the achievements before and after using Augmented Reality media for filmmaking training, and 3) investigate the sample group's satisfaction using the AR media for Film-Making Courses. There are 3 research instruments: 1) AR media for Film-Making Courses; 2) filmmaking workshop tests; and 3) the satisfaction survey of the student's group with AR media for training. The sample group was students at the vocational certificate level who studied in computer graphics program Ubon Ratchathani Vocational College, 2nd-3rd year student in the semester of 2/2023, 56 students with simple random selection method. Statistics used in data analysis were mean, standard deviation, and t-test. The results of the research found that 1) the AR media for Film-Making Course in Vocational Certificate consisted of 6 steps: (1) having the experimenter choose a camera angle; (2) having the experimenter read the information for understanding and test; (3) have the experimenter move the mobile phone's camera slowly to find a space to place the character; (4) have the experimenter click on a space to place the character; (5) have the experimenter shoot the camera angle as the specified content; and (6) when the experimenter shoot the correct camera angle according to the content, the LED screen will show a green frame. 2) The results of practical skills of the sample group after using the AR media are significantly higher than before using the media by 0.5, and 3) the sample group is satisfied with the AR media for Film-Making Course, it is at a very good level overall.

Keywords: Augmented reality, Filmmaking practice, Learning achievement, AR, Practice materials

Introduction

Augmented Reality (AR) is an important part of our daily lives since it is a type of information technology that allows you to enter another world, and experience things that do and do not exist in reality in a single blink. AR is the technology that merges the virtual and reality worlds, which can be applied to various uses. One of them is to enhance classroom learning by using AR to make teaching content more interesting and attract students' attention, encourage involvement, and create complex knowledge models to be replicas for learners to understand more easily. It is evident that applying AR in the classroom enhances student

learning and makes the material more engaging. This will prevent learner's bored and able to learn the complex lesson at the same time. From the current situation in teaching at Ubon Ratchathani Vocational College, problems were found in students' understanding of lessons in subjects related to film production, referring to the declining academic results and reduced attendance throughout the academic year 2023, due to complex content that is difficult to learn, because students need to learn about the film production process. In the filming process, learners must learn about camera angles, and the original curriculum may not be enough for some learners to understand in a short time because most of the problems are that learners do not understand the lesson or forget it. Therefore, learners feel bored with learning. Thanin Inthawiset et al. (2020) analyzed the problem of the media that responds to the potential and interests of learners. This sort of teaching and learning management is necessary to adjust the teaching methods to be consistent with the changing educational process and apply information technology to integrated education management. This is due to three main causes: 1) Individual differences due to the intelligence, basic knowledge, and previous experiences of learners. These differences in learners will prevent all learners from learning equally. 2) The study contents are complicated but there is limited time to study or practice each topic, causing learners to have different understandings of the content. 3) Lack of interaction with the lesson, which makes the lesson uninteresting. According to AR research from the Faculty of Science, Buriram Rajabhat University by Phichit Wandee, Keng Channoen, and Nattawut Chansila (2020) who developed a computer-assisted teaching lesson for Health Education and Physical Education on good health through exercise and sports using virtual reality (AR) technology. The study was conducted with a sample group of Mathayom 2 students at Nong Hong Pittayakhom School. Buriram Province, 30 people. The used tools were augmented reality (AR) media and student satisfaction questionnaires. The research results found that the overall quality was at a good level. Students were satisfied with the computer-assisted instruction lesson in Health Education and Physical Education on good health through exercise and sports and had significantly better academic results. This is why it is necessary to develop augmented reality media for filmmaking practice with students who were studying in the film production course. In summary, AR media is a technology with high potential that can be applied to develop education, encourage effective learning, and effectively respond to the needs of current learners. Therefore, the researcher was interested in developing augmented reality media for filmmaking practice to study the achievement in knowledge and skills of the sample group who used augmented reality media for filmmaking practice to solve problems in the classroom, create motivation for learning, and well understand the content, which responded to the 3 problems mentioned above. When this multimedia media is used in teaching in the form of an application, it will make the media accessible more wider learners. In addition, learners can study by themselves both in and out of the classroom or if the learners are slow learners, they can use the time to review their knowledge and understanding.

1. Research Objectives

- 1.1 To develop Augmented Reality Media for Film-Making
- 1.2 To compare the results before and after using Augmented Reality Media for Film-Making
- 1.3 To study the satisfaction of the sample group that used Augmented Reality Media for Film-Making

2. Review of Related Literatures

Nantita Khanthong, Ekkasit Thiamkaew, and Sanya Kreuhong (2020) studied the development of a virtual reality technology application for learning about elements and

chemical compounds. The purpose of the research was to develop a learning media application on atoms and the combination of atoms of chemical elements into compounds by using 44 main chemical elements and the combination of atoms of elements into 5 molecules of compounds to create a 3D animation model, used with a picture book of atom data and the combination of atoms of elements into components that were created by using a smartphone to scan to the picture book of data. This research was tested with a sample group of 33 Mathayom 4 students at Ban Klang Phitthayakhom School. The research results found that satisfaction with the content and the content delivery was at the highest level, and the results of the post-test learning were significantly higher than the pre-test scores. Therefore, it can be concluded that this learning media affects the development of learning about elements and chemical compounds.

From this research, the researcher is interested in applying augmented reality technology to enhance learning so that learners can learn by themselves effectively.

Phanuwat Ruangkulthap, Saranyu Butrakot, and Ittichai Inlupet (2022) developed a mobile application media for learning basic Japanese vocabulary with augmented reality technology. This research evaluated the efficiency and satisfaction of users of the developed media by evaluating the satisfaction of 40 students in the English Business Communication program, at the Faculty of Liberal Arts, Sripatum University, Khon Kaen Campus. The research instruments consisted of 1) Mobile application media for learning basic Japanese vocabulary with augmented reality technology, 2) an Efficiency assessment form, and 3) a satisfaction assessment form. The statistics used for data analysis were mean and standard deviation. The research results found that 1) The efficiency of mobile application media for learning basic Japanese vocabulary with augmented reality technology was at a high level ($\bar{x} = 4.49$). 2) Mobile application media for learning basic Japanese vocabulary with augmented reality technology It can be applied to students and has a high level of satisfaction ($\bar{x} = 4.49$).

From this research, the researcher is interested in applying augmented reality technology to design learning content sets about camera angles in filming to make students interested and satisfied with learning.

Pichit Wandee, Keng Channoen, and Nattawut Chansila (2020) developed a computer-assisted instruction lesson for Health Education and Physical Education on good health through exercise and sports with augmented reality technology using the ADDIE Model. The sample group used was 30 Mathayom 2 students at Nong Hong Pittayakhom School, Buriram Province. The results of the evaluation of the quality of the computer-assisted instruction lesson using augmented reality technology were at a high level ($\bar{x} = 4.35$). The learners were most satisfied with the computer-assisted instruction lesson ($\bar{x} = 4.50$).

From this research, the media developed used the ADDIE Model, resulting in high-quality media and the highest level of satisfaction. The researcher is interested in applying this model to develop augmented reality media for filming practice.

Sahin, D., & Yilmaz, R. M. (2020) studied the impact of learning media developed with augmented reality (AR) technology on academic achievement and attitude of middle school students. The quasi-experimental research design consisted of 100 middle school students. The experiment was divided into 2 groups: Group 1 used the curriculum using AR technology and Group 2 used traditional learning. The results of the research found that students in Group 1 had significantly higher academic achievement and positive attitudes towards the curriculum than students in Group 2. In addition, students in Group 1 did not show anxiety when using the AR application and students felt happy and wanted to continue using the AR application in the future.

From this research, the researchers were interested in applying the research procedures by separating students into two groups: the first group studied using the normal method, and

the second group studied using augmented reality media for filming practice to study the achievement in range skills and study the satisfaction of the learners.

Khan, T., Johnston, K., and Ophoff, J. (2019) studied the effects of augmented reality applications on students' learning motivation. The aim was to study the trend of students' interest in using augmented reality in teaching. The method used was to test the differences in students' learning motivation before and after using the augmented reality mobile application. A total of 78 participants used the augmented reality mobile application and completed questionnaires before and after use. The results of the study found that using the augmented reality mobile application significantly increased students' learning motivation and was an important factor that significantly increased their confidence in motivation.

In this research, the researchers were interested in applying augmented reality technology to present content about filmmaking practice in conjunction with traditional learning methods to motivate learners and affect their production.

Lin, H. C. K., Lin, Y. H., Wang, T. H., Su, L. K., & Huang, Y. M. (2020) studied the effects of integrating AR with board games on learning outcomes and emotions in health education, using Scaffolding theory, which is learning enabler theory, to improve learners' learning ability when learning new concepts or skills. The learning effectiveness was analyzed with 52 high school students from a school located in southern Taiwan. They were divided into two groups: Group 1, a control group, regular playing board games, 25 people; and Group 2, an experimental group, playing AR-based board games, 27 people. The post-experimental measurements showed that Group 2 had significantly more learning, less negative emotions, and higher playability than Group 1. In conclusion, the integration of AR technology with board games with Scaffolding theory results in players having a positive attitude, affecting learning, and enhancing attention and memory.

Research Methodology

1. The Research Procedure Includes 5 Steps which are:

1.1 Define content scope

The researcher studied the filming method by referring to the teaching plan of the short film production course, academic year 2019, of Ubon Ratchathani Vocational College, which teaches how to use various camera angles in filming. The details are in the content in the following table.

- 1) Study how to shoot video Normal angle shot
- 2) Study how to shoot video High angle shot
- 3) Study how to shoot video Low angle shot
- 4) Study how to shoot video Over Shoulder shot
- 5) Study how to shoot video Point of view
- 6) Study how to shoot video Extreme Long Shot
- 7) Study how to shoot video Long Shot (LS)
- 8) Study how to shoot video Medium Long Shot (MLS)
- 9) Study how to shoot video Medium Close Up (MCU)
- 10) Study how to shoot video Close UP (CU)
- 11) Study how to shoot video Extreme Close UP (ECU)
- 12) Study how to shoot video Dolly
- 13) Study how to shoot video
- 14) Study how to shoot video Tilt
- 15) Study how to shoot video Tracking
- 16) Study how to shoot video Booming / Craning

1.2 Conduct an experiment

The development of augmented reality Media for Film-Making has an experimental sequence divided into 3 phases: the pre-experimental phase, starting with studying the filming method and studying the development of augmented reality lesson media with Unity 3D, and studying the evaluation theory to create a test on knowledge, skills, and satisfaction. Then, it starts with a pre-test on knowledge of using camera angles and camera movement in filming, a total of 32 questions, and shooting a sample video of camera angles according to the received topics, a total of 16 camera angles with a sample group of students who are studying film production. Then, the researcher will collect the test data first. Then, the participants will use augmented reality Media for Film-Making by themselves. Then, the researcher will conduct the second test by collecting data on knowledge, practical skills, and satisfaction with the media of the sample group using a question-and-answer design and program format. Then, measured achievement results in learning range skills in camera angles and camera movement in filmmaking. After the post-experiment phases, according to analyzing the data before and after studying and student satisfaction. The results are summarized using a Paired T-Test statistical data analysis.

1.3 Data collection

In this section, the researcher will discuss the data collection process in the research, which is divided into 3 phases: 1) Data collection phase 1: Collect data on the use of AR media. After the application is developed, it is tested by 3 experts using a satisfaction questionnaire to collect the on using data. After being evaluated by the expert group, the media is tested and expanded with the next experimental group. 2) 2 Data collection phase 2: Collect data before using AR media by testing its use with a group of 56 students. The researcher used a random sampling method for both knowledge and practical skills. 3) Data collection phase 3: Collect data after using the prototype AR media in 3 topics: knowledge assessment, practical skills assessment, and satisfaction assessment with the student user group.

Independent variable

Augmented Reality Media for Film-Making

Dependent variable

Results of the use of media of the sample group using Augmented Reality Media for Film-Making

- Results of knowledge and skill range of the sample group
- Results of comparing students' scores with their understanding level
- Students' satisfaction with the use of Augmented Reality Media for Film-Making

Figure 1. Review of Related Literatures

1.4 Data analysis

The data analysis process uses the Paired T-test statistical analysis, which is a statistical analysis method used to compare the average values of the same sample group, but different periods or conditions. The data to be analyzed will be divided into 2 parts: Comparative analysis of skill ranges and test results by satisfaction with statistical methods in the form of calculating the average value by calculating the frequency of scores. The researcher used a

ready-made program to analyze statistical data to find the average value (\bar{X}) and standard deviation (S.D.) by the variable of the meaning score. The efficiency evaluation of the prototype media will be divided into 5 order of scores under each question. As follows:

- 1) Average 4.51-5.00 means very good at satisfaction
- 2) Average 3.51-4.50 means good satisfaction in using AR media
- 3) Average 2.50-3.50 means moderate satisfaction in using AR media
- 4) Average 1.51-2.50 means low satisfaction in using AR media
- 5) Average 1.00-1.50 means the lowest satisfaction in using AR media

The practical skills before and after using the media by the experimental group will do a test with details of shooting video camera angles to match the number of camera angles in the test. Then take the video that the experimental group sent to evaluate using a list format by defining right and wrong using the frame of the video size, the end level, and the line level of the character to draw a line to compare with the answer sample to see how much it matches.



Figure 2. Examples of practical skills assessment criteria

score	level	define
5	Very good	Students can take more than 15 correct camera angles.
4	Good	Students can take more than 12 correct camera angles.
3	Average	Students can take more than 7 correct camera angles.
2	Improve	Students can take more than 5 correct camera angles.
1	Fail	Students can take more than 1 correct camera angles.

2. Research Instrument

2.1 Augmented Reality Media for Film-Making

2.2 Filming Practice Test

2.3 Sample Group Satisfaction Assessment on Augmented Reality Media for Film-Making

3. Target Group

1) Population: 56 2nd-3rd year students of the Vocational Certificate Program in Computer Graphics at Ubon Ratchathani Vocational College.

2) Sample: Students studying in the Film Production course.

3) Research location: Ubon Ratchathani Vocational College, Mueang District, Ubon Ratchathani Province.

4. Statistics for Data Analysis

The data analysis was conducted using the Paired T-Test, a statistical method used to compare the mean values of the same sample group under different conditions or time periods. The data for analysis was divided into two sections: (1) a comparison of skill-based performance and (2) an evaluation of satisfaction using statistical methods. The satisfaction analysis involved calculating the mean scores based on frequency distributions. A statistical software program was used to determine the mean (\bar{X}) and standard deviation (S.D.). The evaluation of the prototype media's effectiveness was categorized into five levels based on the mean score for each group of questions, as follows:

A mean score of 4.51–5.00 indicates very high satisfaction.

A mean score of 3.51–4.50 indicates high satisfaction with the use of AR media.

A mean score of 2.50–3.50 indicates moderate satisfaction with the use of AR media.

A mean score of 1.51–2.50 indicates low satisfaction with the use of AR media.

A mean score of 1.00–1.50 indicates very low satisfaction with the use of AR media.

Results

1. The results of the development of the Augmented Reality Media for Film-Making

In terms of developing augmented reality Media for Film-Making, the researcher has developed a usage model that is consistent with the working principles of filming. The working principles of augmented reality media include a system that allows learners to select any camera angle lesson from a total of 16 items, and each item contains information for learning and practice. The working principles of augmented reality media include a total of 6 steps as shown in the following figure.

- 1) Let the experimenter choose a camera angle.



Figure 2. Example of selecting a lesson in the application

- 2) Let the subjects read the information for comprehension and take the test.



Figure 3. Examples of data in each lesson

3) Let the tester move the mobile camera slowly to find a place to place the character.



Figure 4. Example of creating a simulation map to place a model

4) Let the tester click on an empty space to place the character.



Figure 5. Example of placing a model on a map

5) Let the tester take pictures from the camera angles according to the specified content.



Figure 6. An example of how to position your camera correctly for that lesson.

6) When the subject takes a photo of the camera angle according to the content correctly, the LED screen will display a green frame.



Figure 7. Example of entering the next content

2. The results of the system trails Augmented Reality Media for Film-Making

The development of augmented reality media for filming practice is a self-learning learning media. It is a teaching method that allows learners to have freedom in learning and self-management. They can decide what to learn, how to learn, when to learn, and where to learn according to their own potential, interests, and abilities. It emphasizes learning about camera angles and camera movement, which can be applied in real work to benefit the professional field they are studying. This chapter presents the research results in the following order:

Table 1. Media quality assessment developed by experts

Details	\bar{X}	S.D.	Level
Appropriate use of learning time in each unit	4.67	0.58	Very good
Clarity and relevance of information	4.00	0.00	Good
Content consistency with the purpose to be presented	4.00	0.00	Very good
Importance and timeliness of content in the application	4.67	0.58	Very good
Ease of use, not complicated	5.00	0.00	Very good
Appropriate placement of information on the screen	5.00	0.00	Very good
Appropriate placement of buttons on the screen	5.00	0.00	Very good
Appropriateness of font size used in presentation	5.00	0.00	Very good
Appropriateness of colors used to indicate right or wrong	5.00	0.00	Very good

From Table 1, it was found that the experts who evaluated the quality of media using augmented reality media for filming practice of the vocational certificate students in the field of computer graphics, Ubon Ratchathani Vocational College, 2nd-3rd year, were all satisfied. Overall, the average in terms of learning time use in each unit was at a very good level ($X=4.67$, $SD.=0.85$). The clarity and directness of information provided was at a very good level ($X=4.00$, $SD.=0.00$). The consistency of the content with the purpose of presentation was at a very good level ($X=4.00$, $SD.=0.00$). The importance and timeliness of the content in the application was at a very good level ($X=4.00$, $SD.=0.00$). The ease of use and simplicity was at a very good level ($X=4.67$, $SD.=0.85$). The appropriate placement of various information on the screen was at a very good level ($X=5.00$, $SD.=0.00$). The appropriate placement of various information on the screen was at a very good level ($X=5.00$, $SD.=0.00$). The appropriateness of the font size used in the presentation was at a very good level ($X=5.00$, $SD.=0.00$). The appropriateness of the color used to indicate correctness or incorrectness was at a very good level ($X=5.00$, $SD.=0.00$).

3. The results of Augmented Reality Media for Film-Making)

The comparative results of academic achievement scores before and after studying with the results of the test using augmented reality media for filming practice of 56 vocational certificate students in Computer Graphics, Ubon Prachathani Vocational College, 2nd-3rd year, are shown in Table 3. Comparative analysis of academic achievement scores in terms of mean (X), standard deviation ($SD.$) and t-test (dependent) between the scores before and after studying using augmented reality media for filming practice.

Table 2. Knowledge test results

Test results	\bar{X}	S.D.	t	Sig.
Before using augmented reality	17.39	5.79	-12.26	0.00
After using augmented reality	26.48	6.35		

From Table 2, it was found that 56 students had different filmmaking knowledge scores before and after using augmented reality media, and the filmmaking knowledge scores of the students after using augmented reality media were significantly higher than ($\bar{x} = 26.48$) before using ($\bar{x} = 17.39$) at a statistical significance level of .05.

Table 3. Comparison of filmmaking skill scores before and after using augmented reality media

Test results	\bar{X}	S.D.	t	Sig.
Before using augmented reality	6.44	1.64	-19.87	0.00
After using augmented reality	13.25	6.35		

From Table 3, it was found that 56 students had different filmmaking skill scores before and after using augmented reality media and the filmmaking skill scores of students after using augmented reality media were significantly higher than ($\bar{x} = 13.25$) before using ($\bar{x} = 6.44$) at the statistical significance level of .05.

Table 4. Satisfaction of sample group towards augmented reality media for filming practice training

Details	\bar{X}	S.D.	Level
Appropriate use of learning time in each unit	4.59	0.65	Very good
Clarity and relevance of information	4.64	0.55	Very good
Content consistency with the purpose to be presented	4.75	0.48	Very good
Importance and timeliness of content in the application	4.70	0.60	Very good
Ease of use, not complicated	4.48	0.85	Good
Appropriate placement of information on the screen	4.45	0.85	Good
Appropriate placement of buttons on the screen	4.54	0.81	Very good
Appropriateness of font size used in presentation	4.43	0.95	Good
Appropriateness of colors used to indicate right or wrong	5.54	6.49	Very good

From Table 4, it was found that students who received the learning management and the use of augmented reality media for film shooting practice of the vocational certificate students in the field of Computer Graphics. All 2nd-3rd year students of Ubon Ratchathani Vocational College had an average overall satisfaction in terms of appropriate learning time in each unit at a very good level ($X=4.59$, $SD.=0.65$), clarity and directness of information provided at a very good level ($X=4.64$, $SD.=0.55$), consistency of content with the intended purpose at a very good level ($X=4.75$, $SD.=0.48$), importance and up-to-dateness of content in the application at a very good level ($X=4.70$, $SD.=0.60$), ease of use and simplicity at a very good level ($X=4.48$, $SD.=0.85$), appropriate placement of various information on the screen at a very good level ($X=4.45$, $SD.=0.85$), appropriate placement of various information on the screen at a very good level ($X=4.54$, $SD.=0.81$), and appropriateness of font size used in the presentation at a very good level ($X=4.43$, $SD.=0.95$). The appropriateness of the colors used to represent right or wrong was at a very good level ($X=5.54$, $SD.=6.49$).

When considering each item, it was found that the top 3 items that students were most satisfied with were: 1. Students liked the consistency of the content with the purpose that was

to be presented ($X=4.75$, $SD.=0.55$); 2. The importance and timeliness of the content in the application ($X=4.70$, $SD.=0.60$); and 3. The importance and timeliness of the content in the application ($X=4.64$, $SD.=0.55$).

When considering each item, it was found that the top 3 items that students were most satisfied with were: 1. Importance and timeliness of the content in the application ($X=4.67$, $SD.=0.58$), 2. Appropriate use of learning time in each unit ($X=4.67$, $SD.=0.58$), and 3. Content consistency with the objectives to be presented ($X=4.00$, $SD.=0.00$).

Discussion

The result of the development of augmented reality media for film production training has shown that students who participated in learning activities and used augmented reality media for film production training expressed high overall satisfaction. This study focused on vocational certificate students in the Computer Graphics program at Ubon Ratchathani Vocational College, specifically second and third-year students. When considering specific aspects of satisfaction, the three highest-ranked factors were:

1. Students wanted additional lessons in other learning activities.
2. The application was easy to use and not complicated.
3. The learning activities could be applied to daily life.

In terms of learning achievement, a comparison was made between pre-test and post-test scores using augmented reality media for film production training. The study analyzed the students' learning outcomes using measures such as mean scores (\bar{X}), standard deviation (SD), and a Paired T-Test. The findings, as presented in Table 1, indicated a significant improvement in students' academic performance after using augmented reality media for film production training.

The comparison of pre-learning and post-learning, achievement scores showed that the students' knowledge significantly increased after participating in the learning activities. The statistical analysis confirmed a significant improvement, particularly in knowledge acquisition. Additionally, the skills-based achievement scores were rated at a good level.

Regarding student satisfaction, It was found that the academic achievement score by using augmented reality media for film production training. the highest-rated aspect was the relevance and modernity of the content within the application. The second highest-rated factor was the appropriateness of the learning duration for each unit, while the third was also related to the relevance and modernity of the content. while the aspect with the lowest score was the suitability of color usage in indicating correct and incorrect actions.

Conclusion

This research was tested with a group of vocational certificate students in Computer Graphics, at Ubon Ratchathani Vocational College. In testing the efficiency, there were limitations in the use of some participants because the participants used mobile phones with low performance to use AR mode. And the augmented reality media for filming practice can only work with Android phones. If there is next research, the media should be developed to take into account those who use mobile phones with other operating systems and those who use mobile phones with low performance.

Suggestions for future research

This research is an adapt of augmented reality for filming practice. In the future, there should be promotion and support for the production of augmented reality media to be more used in various subjects teaching. However, the suitability of the subject must be considered,

and there should be development of media that can access mobile phones of all operating systems and those who use mobile phones with low performance to reach a wider group of users.

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The development of virtual reality for the Candle Festival at Ubon Ratchathani Province

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Abstract

The Candle Festival of Ubon Ratchathani is a significant cultural heritage that has been passed down for generations, deeply rooted in Buddhist traditions. This festival serves not only as a symbol of faith and spirituality but also as a reflection of the unity and active participation of the local community. However, access to comprehensive information about the festival remains limited. This study aims to develop a virtual museum application and website utilizing Virtual Reality (VR) technology and 3D scanning to digitally preserve and present the festival's narratives, artistry, and cultural significance. This approach not only aids in the conservation and continuation of this valuable tradition but also serves as a crucial tool for promoting cultural tourism and enhancing the local economy in the future.

Keywords: Candle Festival, Ubon Ratchathani, Cultural Heritage, Buddhist Tradition, Virtual Museum

Introduction

The Candle Festival of Ubon Ratchathani is one of Thailand's most significant cultural traditions, celebrated annually during the Buddhist Lent. This festival, deeply intertwined with Buddhist beliefs, showcases the craftsmanship, artistic excellence, and spiritual devotion of the local community. It plays a crucial role in fostering communal unity and preserving cultural heritage. Over the years, the festival has evolved, incorporating modern artistic expressions while maintaining its deep-rooted traditions.

Despite its cultural significance, access to detailed information about the festival remains limited, particularly for individuals unable to attend in person. Traditional methods of documentation and dissemination, such as print media and physical exhibitions, do not fully capture the intricate details and immersive experience of the event. The advancement of digital technologies, particularly Virtual Reality (VR) and 3D scanning, presents an innovative opportunity to preserve and present cultural heritage in an interactive and engaging manner.

This study aims to develop a virtual museum application and website incorporating VR and 3D scanning technologies to enhance accessibility to the Candle Festival's historical, artistic, and cultural narratives. By leveraging digital technology, this initiative seeks to bridge the gap between tradition and modernity, ensuring the sustainability of cultural heritage while promoting cultural tourism. Additionally, it offers a new educational platform for students,

researchers, and cultural enthusiasts to engage with and appreciate the festival in a more interactive and immersive way.

1. Research Objectives

1.1 To develop a virtual reality (VR) media representation of the Candle Festival in Ubon Ratchathani.

1.2 To evaluate users' experience and perception of the developed VR media.

1.3 To assess audience satisfaction with the developed VR media.

2. Review of Related Literatures

Chanchai Namphon, Veerawat Kahphu, and Sutip Petthong (2022) developed a 3D media using augmented reality technology to promote tourism in Ubon Ratchathani province, focusing on Buddhist tourism and Buddhist sites. This research developed 3D media using augmented reality technology to enhance tourism in Ubon Ratchathani. The study evaluated the satisfaction of tourists and the appropriateness of the 3D media through expert assessments. The sample group for the research consisted of experts who evaluated the media in three areas: functionality, performance, and usability. The results of the evaluation of the appropriateness of the 3D media using augmented reality technology by experts showed that the average score across all areas was at a very high level ($\bar{x} = 4.38$, S.D. = 0.78). Additionally, the evaluation of tourist satisfaction, based on a sample of 100 tourists in Ubon Ratchathani, revealed that the satisfaction with the use of the augmented reality 3D media had an overall average score at a good level ($\bar{x} = 4.34$, S.D. = 0.82).

From this research, the researchers are interested in applying virtual reality technology for measuring the average satisfaction score of the sample group and evaluating the effectiveness through expert assessment.

Apichat Kampaliw, Chanintr Chaloemsuk, and Kriengsak Chueamsombat (2018) developed a virtual reality-based application to recommend tourist destinations in Thailand. This research applied technology known for its ability to display virtual environments in 3D, allowing users to feel as if they are physically present in real tourist locations and interact with the surroundings. The tools used to develop the application included Unity software combined with virtual reality processing equipment (Oculus) and C# programming language.

The satisfaction evaluation was conducted by 5 experts and 30 users of the application. The results indicated that the developed application provided users with a novel and realistic experience. The satisfaction evaluation of the application was rated positively, with an average score of 4.43 and a standard deviation of 0.52.

Based on this research, the researchers are interested in applying virtual reality technology to enhance the tourist experience by providing a new form of interaction.

Inchaya Kapahla and Wallop Srisamran (2019) developed a 360-degree interactive website to promote temple tourism in the Old City area of Nakhon Ratchasima. This research focused on developing an interactive 360-degree virtual environment website to promote temple tourism in the Old City area of Nakhon Ratchasima. The study integrated panoramic photography with high-resolution imagery and produced the content using software designed for developing virtual tour systems. The result was a virtual tour system that could display real locations in 360 degrees, with the key feature being that users could navigate and explore the virtual tour system on their own.

The research tools included the 360-degree interactive environment website developed by the researchers. The sample group consisted of 30 faculty members and students from the Faculty of Fine Arts and Industrial Design at Rajamangala University of Technology Isan, chosen through purposive sampling. The research findings showed that the quality of the 360-

degree interactive website was rated highly, with an average score of 4.22, indicating its suitability and usefulness for promoting tourism. Satisfaction levels were also high, with an average score of 4.26.

From this research, the researchers are interested in applying virtual reality technology to create promotional media for the Candle Festival tradition in Ubon Ratchathani, to be hosted on an online platform.

Aznoora Osman, Nur Izlin Iskak, Nadia Abdul Wahab, and Norfiza Ibrahim (2020) developed an interactive virtual campus tour using panoramic video. This research aimed to help users navigate university campuses by providing a virtual map that guides students within the university. The tour not only assists users with a 2D map but also develops a system that allows users to explore campus destinations through 360-degree panoramic videos and images. A heuristic evaluation was conducted by five expert professors in the field of computer science to identify usability issues and improve the design before further testing with actual users.

The sample group for the research consisted of university students, staff, and visitors to the campus. The findings showed that the satisfaction evaluation of students, staff, and visitors toward the interactive virtual campus tour using panoramic video was rated positively, with an overall average score at a good level. Suggestions for future research include enhancing the system so that users can use their devices, such as tablets or smartphones, to point at selected buildings to view key information and images on their devices.

Based on this research, the researchers are interested in applying virtual reality technology to enhance a navigation map for visitors touring the Ubon Ratchathani Candle Festival Museum. The use of 360-degree panoramic images will provide historical information about the candle festival as visitors explore the museum in a virtual reality setting.

Tudor Caciara, Grigore Vasile Herman, Alexandru Ilies, Ștefan Baias, Dorina Camelia Ilies, Ioana Josan, and Nicolae Hodor (2021) used virtual reality to promote sustainable tourism. A case study of historical monuments of wooden churches from Romania. This research aimed to explore the most appropriate methods to utilize tourism related to wooden churches, which are considered tangible cultural heritage structures that contribute to the protection and preservation of cultural heritage. The study involved the development of a web portal that incorporated 3D models related to the history of wooden churches in Romania as an additional channel for disseminating historical information.

The sample group for the research consisted of tourists visiting the historical wooden church monuments in Romania. The results of the research showed that:

1. The virtual reality media used to promote sustainable tourism, with the case study of the historical wooden churches in Romania, was highly effective overall.
2. Users were highly satisfied with the virtual reality media used to promote sustainable tourism related to the historical wooden churches in Romania.

Based on this research, the researchers are interested in applying virtual reality technology by photographing the Candle Festival trees in the museum and creating 3D models of the candle trees from each community in Ubon Ratchathani province. This would promote the preservation of cultural heritage.

Yusep Rosmansyah (2021) designed and developed an augmented reality mobile tour application using 360-degree photos of the National Museum. This research allows users to interact with the augmented reality environment in the form of a virtual tour, enabling tourists to explore the National Museum for educational purposes. The sample group for the research consisted of 20 tourists aged between 18-25 years. The research findings revealed that the application created a valuable experience in both education and entertainment during the visit to the National Museum, with an overall satisfaction rate of 81.4%.

Based on this research, the researcher is interested in applying virtual reality technology to enhance media development by adding historical knowledge about the Candle Festival trees of each community in Ubon Ratchathani province into the project.

Research Methodology

1. Study of the Candle Festival Tradition in Ubon Ratchathani.

The researcher studied the Candle Festival tradition in Ubon Ratchathani by referencing the book *"Evolution from Candle to Candle Sculpture of Ubon Ratchathani Province"* by Prayong Muttasen and information from the Ubon Ratchathani City Municipality as follows:

1. Study the history of the Candle Festival tradition in Ubon Ratchathani
2. Study the format of the Candle Festival event in Ubon Ratchathani
3. Study the local culture and wisdom
4. Study the information of temples that create the Candle Festival sculptures in Ubon Ratchathani Municipality
5. Study the candle sculptures of various types

2. Study of Media Development.

The researcher studied the development of augmented reality media for the Candle Festival tradition in Ubon Ratchathani in the form of applications and websites. The steps and methods were as follows:

1. Study the characteristics of augmented reality in the form of applications and websites
2. Study documents and collect data from related concepts, theories, and research, such as principles of virtual reality technology, benefits of virtual reality, components of virtual reality technology, the application of virtual reality, design thinking process, and user experience design, etc.
3. Study how to create applications using Figma and Android Studio
4. Study how to create websites using WordPress
5. Study how to scan 3D images of Candle Festival sculptures using photogrammetry software and how to create a 360-degree virtual museum using 3DVista Virtual Tour, including setting up the platform for display

3. Design and Develop Media, Reviewed and Evaluated by Experts.

The researcher used photogrammetry software to scan 3D images of the award-winning Candle Festival sculptures and created a system using 3DVista Virtual Tour to control the operation of objects in the VR world, such as movement, interaction with other objects, and displaying information through the platform in the application with Figma and Android Studio, as well as through the website platform using WordPress. The system was reviewed and evaluated by four experts: 1) an expert in application development, 2) an expert in website development, 3) an expert in virtual reality media production, and 4) an expert in the Candle Festival tradition of Ubon Ratchathani. Their feedback was collected through interviews to measure perception and satisfaction, which was used to improve and further develop the virtual reality media.

4. Research Instrument

4.1 Virtual reality media of the Candle Festival tradition in Ubon Ratchathani Province in the form of an application and website.

4.2 User experience perception assessment form.

4.3 Satisfaction assessment form.

5. Target Group

The students from the Department of Computer Graphics, Ubon Ratchathani Vocational College, in the second semester of the academic year 2024, total 100 students. The sample size calculation is done using Cochran's formula (Cochran, 1977 as cited in Akakul, 1999), and a Convenience Sampling method is applied for selecting the sample group.

6. Statistics for Data Analysis

The steps for data analysis are as follows:

User Experience and Satisfaction Analysis.

User experience perception and satisfaction were analyzed by calculating the mean and standard deviation. The frequency of scores obtained from the Rating Scale (Chamat Chantrasombat et al., 2011) was used. The researcher utilized statistical software to calculate the mean (\bar{x}) and standard deviation (S.D.). The mean score for evaluating user experience perception of the prototype media was divided into 5 levels based on the question group details as follows:

- Mean score 4.51–5.00: User experience perception level is very good
- Mean score 3.51–4.50: User experience perception level is good
- Mean score 2.50–3.50: User experience perception level is fair
- Mean score 1.51–2.50: User experience perception level is low
- Mean score 0.00–1.50: User experience perception level is very low

The mean score for evaluating user satisfaction with the prototype media was divided into 5 levels based on the question group details as follows:

- Mean score 4.51–5.00: User satisfaction level is very good
- Mean score 3.51–4.50: User satisfaction level is good
- Mean score 2.50–3.50: User satisfaction level is fair
- Mean score 1.51–2.50: User satisfaction level is low
- Mean score 0.00–1.50: User satisfaction level is very low

Results

1. The results of The development of virtual reality for the Candle Festival at Ubon Ratchathani Province

In the development of virtual reality media to present the Candle Festival tradition of Ubon Ratchathani Province, the researcher has created a virtual reality medium that simulates the experience of participating in the Candle Festival in an engaging and realistic way. The working principle of this virtual reality media consists of four main steps, which enable the creation of an immersive experience and allow users to interact with the local tradition in a meaningful way.

2. Environment Design: The researcher studied and simulated the environment of the Candle Festival in Ubon Ratchathani in virtual reality, striving to make every element of the media as close to reality as possible. This includes the locations, buildings, and costumes used in the festival, so that users can truly feel the atmosphere of participating in this cultural event.



Figure 1. Example of capturing the atmosphere at the 2024 Candle Festival for the production of virtual reality media

3D Modeling : High-quality 3D models of the candles and various locations were developed, allowing users to see intricate details clearly. The models also showcase the various components of the Candle Festival in a realistic manner.

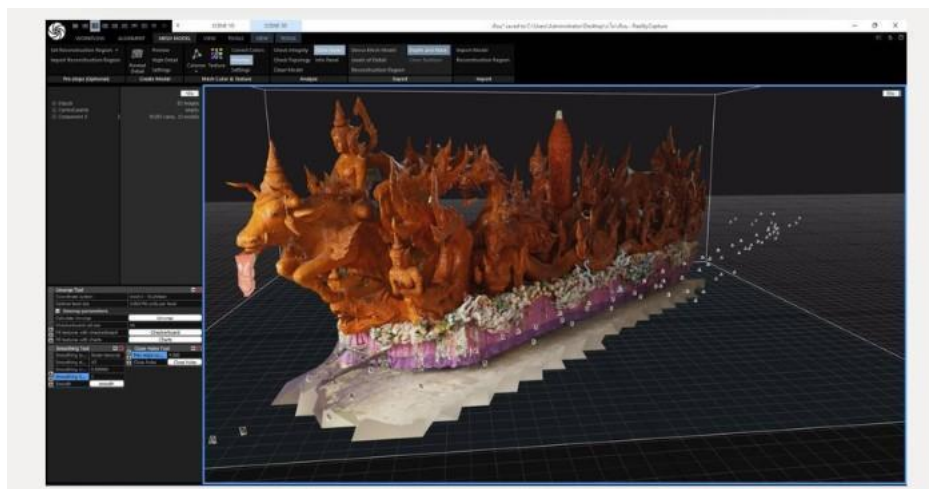


Figure 2. Example of 3D model creation using photogrammetry technique for large sculpture type, Grand Prize Winner, Wat Phra That Nong Bua

3. Interactivity Development : The virtual reality media is designed to be interactive, enhancing the user’s experience of learning and enjoyment. Users can choose specific points to explore or engage in activities within the virtual environment during the festival.

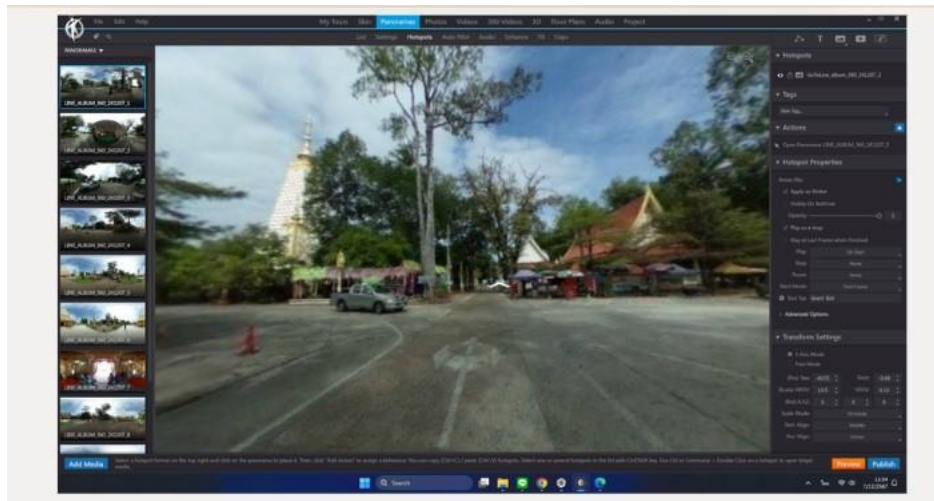


Figure 3. Example of Take a 360-degree photo at Wat Phra That Nong Bua using the 3D Vista program.

4. Data Integration : To ensure the media is comprehensive, the researcher integrated information about the Candle Festival tradition of Ubon Ratchathani into the virtual reality experience. This allows users to learn about the tradition and culture in greater depth as they interact with the medium.

Discussion

Analysis of the Research and Opinions on the Research Work in the Media Development Stage:

In analyzing the research and expressing opinions on the development of virtual reality media about the Candle Festival tradition of Ubon Ratchathani Province, the activities in this stage are crucial because they lay the foundation for a media product that can effectively and realistically convey experiences and knowledge to users.

Analysis of the Research:

1. Appropriateness of the Chosen Development Method: The use of virtual reality (VR) as a medium to convey the Candle Festival tradition is an appropriate approach. VR can simulate experiences in a way that is close to reality, allowing users to feel immersed in the event. This is particularly effective in an era where technology plays an important role in education and learning.

2. Development Process: The various steps of development, including environment design, 3D modeling, interactivity development, and data integration, were carefully planned. By creating a realistic environment and adding interactive experiences, users can learn and access information from multiple perspectives. The integration of the Candle Festival tradition with technology helps deepen the understanding of cultural content.

3. Limitations of the Research: While the media development has been successful in creating a realistic experience, limitations may arise from the accessibility of the required equipment, such as VR headsets or high-performance computers, which could restrict certain target groups from accessing the media.

Opinions on the Research:

1. Benefits and Impact: This research is highly beneficial in terms of preserving and promoting local culture. In a time when people increasingly use technology for learning, using virtual reality helps users experience and understand the Candle Festival tradition of Ubon

Ratchathani in depth. It also encourages interest in preserving and promoting local culture on a global scale.

2. Future Directions: The development of such media can expand to include other significant cultural and historical traditions. Using VR for the study of traditions could become an essential tool for preserving cultural heritage and enhancing the effectiveness of learning in an engaging way.

3. Suggestions: For future research, it would be beneficial to consider adding new features that can enhance the user experience, such as incorporating sound or more interactive displays. Additionally, making the media more accessible to users who are unfamiliar with virtual reality technology should be a priority.

Conclusion

Conclusion: Development of Virtual Reality Media for the Candle Festival Tradition of Ubon Ratchathani Province

This research aimed to develop virtual reality (VR) media to preserve and promote the Candle Festival tradition of Ubon Ratchathani Province, offering an immersive learning experience for users. The primary objective was to create an interactive and realistic environment where users could engage with and explore the cultural and historical significance of this tradition.

Through the research process, the media development was structured around four main stages: environment design, 3D modeling, interactivity development, and data integration. The environment was carefully modeled to reflect the actual locations and traditions associated with the Candle Festival, while the 3D models of the candles, costumes, and other elements of the event were designed to create a high level of detail and realism. The interactivity of the media allowed users to explore and engage with the content, offering a dynamic learning experience. Furthermore, integrating detailed cultural data into the VR platform allowed users to not only experience the event but also learn about the traditions, customs, and values surrounding the Candle Festival.

The development of this VR media holds significant potential for the preservation of cultural heritage. By using VR technology, the research has provided a novel method for people to experience and understand the Candle Festival tradition, especially for those unable to attend the event in person. This research underscores the importance of technology in bridging the gap between traditional cultural practices and modern educational methods. Additionally, the use of VR as an educational tool for cultural transmission opens up possibilities for future projects to focus on other traditional events or heritage sites.

However, there are certain limitations to the research, primarily related to the accessibility of the required technology. VR equipment, such as headsets and high-performance computers, may not be readily available to all users, which could limit the reach of the project. As a result, efforts should be made to explore ways to make the media more accessible to a broader audience, including those with limited access to high-tech resources.

In conclusion, this research contributes to the field of cultural preservation and education by demonstrating the effective use of virtual reality in transmitting traditional knowledge. The findings of this study can serve as a foundation for further research and the development of other VR-based cultural heritage projects, offering significant benefits to both the preservation of cultural practices and the enhancement of global understanding of diverse traditions. Future research should consider expanding the interactive features of the media and ensuring wider accessibility for users unfamiliar with VR technology.

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Perceived Employability for Vietnamese Students in High Education – an Analysis of the Impact of Global Mindset on Perceived Employability

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Abstract

In the context of globalization, employers increasingly seek candidates with diverse experiences and adaptability to multicultural environments. As a result, students need to develop a global mindset alongside their knowledge and skills to enhance employability. This research explores the relationship between global mindset and perceived employability, as well as factors influencing students' global mindset. Data was collected through an online survey of 302 Vietnamese university students. The findings reveal that Vietnamese students generally exhibit a high level of global mindset, which positively influences their perception of employability. Additionally, social and intellectual capital are found to significantly impact both students' global mindset and their perceived employability. These insights underscore the importance of incorporating global mindset development into educational curricula to better prepare students for the global job market. This research contributes to the literature by integrating the concept of global mindset into the cognitive model of employability, providing a new perspective on its role in shaping students' career prospects. Practical implications are provided for educational institutions, policymakers, and organizations to enhance employability strategies for future graduates.

Keywords: Perceived employability; global mindset; intellectual capital; social capital; psychology capital.

1. Introduction

The global economic crisis and recession have intensified pressures on employment, leading companies to cut labor costs through layoffs, salary reductions, and other personnel changes (Dobbins et al., 2023; Stewart, 2024). The COVID-19 pandemic caused 100 million job losses worldwide (ILO, 2021), and university graduates face increasing unemployment due to inadequate skills for the 21st-century job market (Hoole et al., 2024). In Vietnam, businesses and labor markets are similarly affected, reducing job opportunities for new graduates and heightening competition (General Statistics Office, 2023). This situation highlights the importance of students' awareness of their employability, defined as their perception of maintaining or finding employment (Zuluaga & Yepes, 2024).

Globalization presents both opportunities and challenges, requiring workers to accumulate knowledge in areas such as international policies, cultural understanding, and language proficiency (Lam, 2022). A global mindset is crucial for success in this context. Although perceived employability has been widely studied, particularly in relation to medical conditions (Francis et al., 2013; Silvaggi et al., 2020), the relationship between global mindset and employability remains unclear. This research addresses this gap by evaluating the contribution of a global mindset to perceived employability, analyzing influencing factors, and offering insights for educational strategies to enhance Vietnamese students' employability in a globalized world.

2. Literature review

2.1. Perceived Employability

There has been no consensus on the definition of perceived employability (Andrews & Higson, 2008; Pool et al., 2014), though many researchers agree that it refers to an individual's perception of their ability to secure and maintain employment (Vanhercke et al., 2014). Rothwell et al. (2008) expand this by defining it as awareness of employer expectations and efforts to meet those needs. In this study, perceived employability is defined as students' perception of their ability to keep or find new employment, work hard, and leverage resources for career success (Zuluaga & Yepes, 2024).

2.2. Thunderbird's Global Mindset Research

The Thunderbird School of Global Management's global mindset model has been widely validated (Javidan & Bowen, 2013). Developed in 2004, the model evaluates global mindset through research, practical applications, and business experience (Javidan et al., 2010). The model identifies intellectual, social, and psychological capital as key components of global mindset (Lang & Rybnikova, 2012).

2.2.1. Global Mindset

Definitions of global mindset fall into three categories: cultural mindset (understanding cultural differences), strategic mindset (analyzing global business complexity), and integrative mindset (combining cultural and market knowledge to address global changes) (Gupta & Govindarajan, 2002). This study focuses on the integrative mindset, which involves openness to cultural diversity and the ability to synthesize across markets.

2.2.2. Intellectual Capital

Intellectual capital refers to non-physical assets like knowledge, expertise, and learning ability, which create value for organizations (Snyder et al., 2017). It has been shown to positively impact organizational performance and sustainability (Mehralian et al., 2018). However, research on intellectual capital from an individual perspective remains limited.

2.2.3. Social Capital

Social capital encompasses social trust, norms, and networks that individuals can leverage to address challenges (Lang & Hornburg, 1998). In this study, it refers to an individual's relationships, including personal and professional networks (Donald et al., 2019). Social capital has been studied at various levels: individual (Burt, 1992), organizational (Nahapiet & Ghoshal, 1998), and societal (Putnam et al., 1993). Additionally, research on transnational social capital explores its role in occupational mobility (Mäkelä & Suutari, 2009). However, its influence on students' global mindset remains underexplored.

2.2.4. Psychological Capital

Psychological capital, as defined by previous studies, refers to self-efficacy, optimism, hope, and resilience (ÇAVUŞ & Kapusuz, 2015). It encompasses confidence in facing

challenges, maintaining a positive outlook on success, persistence toward goals, and the ability to recover from adversity (Luthans et al., 2007). Studies indicate that psychological capital positively influences career paths, helping individuals manage stress and improve perceived employability (Chen & Lim, 2012). Despite its importance at the individual and business levels (Petticrew & Roberts, 2006), few studies have examined psychological capital's impact on students, a critical future workforce.

2.3. Research model and hypotheses

There is limited research on the relationship between global mindset and perceived employability. Previous studies suggest that students with higher cultural intelligence tend to have increased perceived employability (Gooden et al., 2017; Silvallana et al., 2023). Individuals who can adapt, solve problems, and communicate effectively in multicultural environments are more career-oriented, advance faster, and achieve greater success in globalized settings. Cultural intelligence refers to the ability to succeed in complex multicultural contexts through knowledge, cognition, motivation, and behavior. According to Bergdolt and Andresen (2017), global mindset encompasses cultural intelligence, enabling individuals to make strategic decisions in global contexts. While both concepts overlap, global mindset extends beyond cultural intelligence by addressing global management and leadership challenges. Based on this, the following hypothesis is proposed:

H1: Global mindset has a positive effect on perceived employability.

Thunderbird's research also shows that improving intellectual capital helps improve an individual's global mindset. Sharing the opinion, Javidan & Bowen (2013), Olson et al. (2015) also suggest that intellectual capital has a key role in promoting global mindset and is a fundamental prerequisite for success, thanks to the significant diversity in business practices worldwide in the context of globalization. Based on those arguments, this research proposes the following hypothesis:

H2: Intellectual capital has a positive effect on global mindset.

Students' perceived employability increases during their college years, which is consistent with the accumulation and continual development of self-esteem, and experience gained through personal growth, and support from university career development programs (Donald et al., 2018). Research by Baruch et al. (2005) has indicated that intellectual capital is a significant determinant of perceived employability. As a result, graduated students confirmed a positive impact of intellectual capital on their perceived employability (Caballero et al., 2021). Based on those arguments, this study proposes the following hypothesis:

H3: Intellectual capital has a positive effect on perceived employability.

Research by Snook & Khurana (2011) has shown that social capital impacts the behavioral aspect of global mindset. Agreeing with that view, research by Javidan et al. (2010) also verifies that improving social capital will help enhance an individual's global mindset. This means that social capital prompts students to develop better social networks in order to build relationships and thereby develop a global mindset (Pike et al., 2012). Based on those arguments, this study proposes the following hypothesis:

H4: Social capital has a positive effect on global mindset.

Social capital is important in an individual's perceived employability because social capital gives individuals more opportunities to obtain the information they need about careers (Fugate et al., 2004; McArdle et al., 2007), advancement opportunities, leads, and investment opportunities (Forret & Sullivan, 2002). Besides, social capital also promotes the development of individuals, so it can strengthen an individual's ability to identify, create and realize career opportunities (Dess & Shaw, 2001; Higgins & Kram, 2001; Fugate et al., 2004). Research by Drenzo et al. (2015) also confirms that social capital has a positive relationship with perceived

employability. Based on those arguments, this study proposes the following hypothesis:

H5: Social capital has a positive effect on perceived employability.

Research by Vogelgesang et al. (2014) has shown that positive psychological capital can accelerate the development of a global mindset. Additionally, in Clap Smith's research, the role of positive psychological resources has been demonstrated that be crucial in the connection between different aspects of global mindset, such as internationalism and cognitive complexity as well as competencies important for global leaders such as non-judgment, curiosity and effectiveness. Another study by Zacriti (2018) also shows that psychological capital is the foundation of global mindset. Based on those arguments, this study proposes the following hypothesis:

H6: Psychological capital has a positive effect on the global mindset.

Chen & Lim (2012) found that psychological capital is necessary to enhance perceived employability because it predicts career outcomes such as adjustment to transitions and success in individual's career (Baluku et al., 2021; Jonathan et al., 2017). Baluku et al. (2021) have suggested that psychological capital serves as an essential resource for achieving exceptional outcomes in various career contexts and maintain a higher perception of employability (Baron et al., 2016; Luthans & Youssef-Morgan, 2017; Newman et al., 2014). For students, psychological capital serves as an important asset, motivating them to engage in career pursuits, thereby enhancing their employability (Baluku et al., 2021). Based on those arguments, this study proposes the following hypothesis:

H7: Psychological capital has a positive effect on perceived employability.

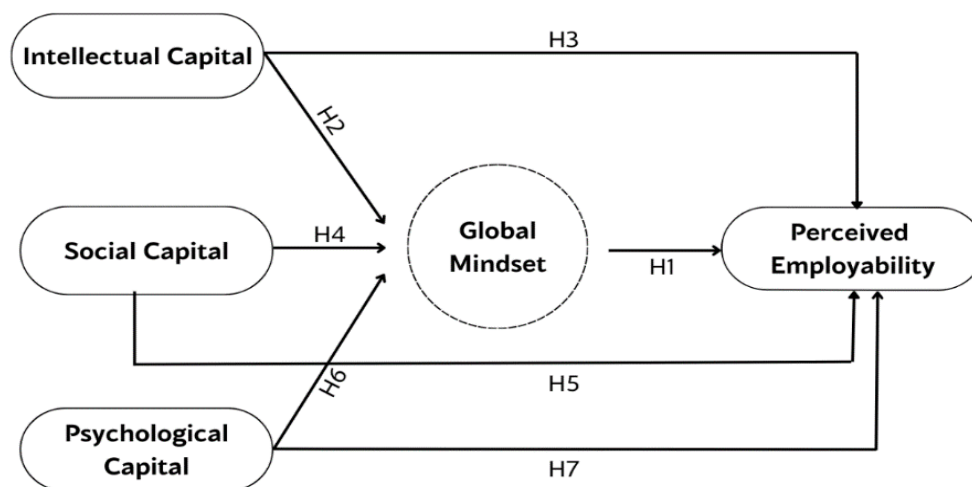


Figure 1. Research model

3. Research methodology

3.1. Measurement instruments

Measurement scales for the five constructs in the proposed model were adapted from the prior literature and modified by expert panel review. Based on the construct conceptualization and prior validated scales of constructs, five constructs in the model were measured reflectively which means that indicators associated with a particular construct should be highly correlated with each other (Hair et al., 2014) Regarding the three prefix factors of global mindset, the study utilized 11 items to measure intellectual capital, adapted from Frutos-

Belizón et al. (2020) and Hsu & Sabherwal (2011) 11 items to measure social capital adapted from Frutos Belizón et al. (2020) and 4 items to measure psychological capital, adapted from Clapp-Smith et al. (2015).

Table 1 presents all 39 items for measuring five constructs in the proposed model. Respondents were asked to evaluate the level of agreements on each measurement items using a five-point Likert scale (1 = strongly disagree and 5 = strongly agree). A structured questionnaire was then designed with three main parts: (1) socio- demographic information of respondents, (2) the evaluation of respondents on 39 items and (3) closing statement. A pilot study with a sample of 20 students was conducted to clarify the structure of the questionnaire as well as check the weakness and ambiguities of the language used in the questionnaire.

3.2. Data collection

An online questionnaire was distributed to Vietnamese students studying at universities including students from private and public universities, who will become global workforce in the future. Then, a pilot study with 20 respondents was conducted to clarify the structure of the questionnaire as well as check for ambiguities in the language of the questionnaire. Data collected from January 20, 2024 to February 19, 2024.

A total of 302 responses were collected. After the data screening process, 5 answer sheets were eliminated due to missing data and no response. Therefore, the final sample of 297 responses was qualified for data analysis using the PLS-SEM method.

4. Result

4.1. Exploratory factor analysis (EFA)

Table 2. EFA Analysis Result

Kaiser-Meyer-Olkin	sig Bartlett's Test	Eigenvalue	Total Variance Explained
0.915	0	2.631	58.275

Table 2 shows a KMO value exceeding 0.5, indicating suitability for factor analysis, and Bartlett's test (Sig. = 0.000 < 0.05) confirms variable correlation, meeting the prerequisites for analysis (Hair et al., 2006). Total Variance Explained = 58.275%, suggesting the factors explain 58.275% of the data variation. Four factors were extracted, each with an eigenvalue exceeding 1, using Principal Components and Promax rotation.

Through iterative refinement during EFA, variables IC2, IC3, and IC5 were eliminated after three analyses. The rotated matrix categorized 23 observed variables into three factors, with Factor Loading coefficients exceeding 0.5. The KMO value for dependent variables also exceeded 0.5, affirming the appropriateness of the analysis. Eigenvalues for GM (3.191 > 1) and PE (4.212 > 1) further confirm the reliability of observed variables, which will be retained for the structural model evaluation.

Table 3. Demographic Profile of Respondents

Criteria		Sum	Percent (%)
Academic level	Freshman	41	13.8
	Sophomore	59	19.9

Criteria		Sum	Percent (%)
Gender	Junior	116	39.1
	Senior	79	26.6
	Other	2	0.7
	Male	115	38.7
	Female	182	61.3
Hometown	City	101	34
	Countryside	196	66

Table 4. Measurement Scales for Constructs in the Model (n=297)

Constructs/Dimensions	Item codes	Sources
<i>Intellectual Capital</i>		
I know the most relevant publications in my scientific field	IC1	IC1 --> IC8: Adapted from (Frutos-Belizón et al., 2020) IC9--> IC11: Adapted from (Hsu & Sabherwal, 2011)
I consider myself a creative and bright person	IC2	
I consider myself a person with initiative	IC3	
I have the required capacity to obtain and manage the information necessary for the major	IC4	
I consider myself a self-critical person	IC5	
I have the necessary training in research methodologies and techniques	IC6	
I have the theoretical training necessary to research in my scientific field	IC7	
I master the language usually used in journals/books and in scientific meetings in my academic field	IC8	
I consider myself a highly skilled employee	IC9	
I consider myself a competent person in my major	IC10	
I consider myself an expert in my particular jobs and functions	IC11	
<i>Social Capital</i>		
I can trust that others in a team will help myself if necessary	SC1	SC1-SC11: Adapted from (Frutos-Belizón et al., 2020)
I can trust member in a team will make work easier	SC2	
I enjoy a good interpersonal climate in a team	SC3	
I try to help each other if they have any difficulties in a team	SC4	
I am excited to achieve the goals and objectives of the team	SC5	
I maintain interpersonal relationships very often	SC6	
I exchange our knowledge and experiences	SC7	

Constructs/Dimensions	Item codes	Sources
I am willing to share information	SC8	
I look for and take advantage of synergies	SC8	
I discuss the process of assignments theses directed by team members	SC10	
I exchange ideas with a large number of colleagues outside the team.	SC11	
<i>Psychological capital</i>		
Having confidence (self-efficacy) to take on and put in the necessary effort to succeed at challenging tasks	PC1	PC1 --> PC4: Adapted from (Clapp-Smith et al., 2015)
Making a positive attribution (optimism) about succeeding now and in the future	PC2	
When beset by problems and adversity, sustaining and bouncing back and even beyond (resiliency) to attain success	PC3	
Persevering toward goals and, when necessary, redirecting paths to goals (hope) in order to succeed.	PC4	
<i>Global mindset</i>		
I see the world as single, vast market	GM1	GM1 ->GM3: Adapted from (Ali et al., 2023) GM4-> GM6: Adapted from (Sihombingb, 2018)
I consider firm internationalization as a means to achieve growth objectives	GM2	
If I were a manager, I would lead the company to expand its global market	GM3	
When I am in another culture, I become sensitive to differences without feeling disturbed.	GM4	
I consider myself open to attitudes from other countries as well as attitudes from my own country	GM5	
When I interact with people from different cultures, I see them as individuals rather than just looking at them as representatives of their national culture	GM6	
<i>Perceived employability</i>		
I'm confident that I would find another job if I started searching	PE1	PE1-PE3: Adapted from (Wittekind et al., 2010)
In case I'm dismissed, I'll immediately find a job of equal value	PE2	
I can perform a successful job search	PE3	PE4 --> PE8: Adapted from (Rottinghaus et al., 2012)
I can overcome potential barriers that may exist in my career	PE4	
I am good at understanding job market trends	PE5	
I keep up with trends in at least one occupation or industry of interest to me	PE6	
I understand how economic trends affect career opportunities available to me	PE7	

4.2. Evaluation of measurement model

4.2.1. Indicator Reliability

This research completely removes observed variables with an outer loading of less than 0.7, only retaining observed variables with an outer loading of 0.7 or higher (Hair et al., 2013). In this study, the external loadings for all constructs were above 0.7, with items GM1, GM4, PC4, PE2, SC1, SC11, SC2, and SC3 having loadings less than 0.7, thus considered unreliable and subsequently removed from the measurement model (see Table 4).

Table 5. Outer Loading Matrix

Variable	Items	Outer loading	Cronbach's Alpha	Composite reliability (CR)	Average Variance Extracted (AVE)
Intellectual capital	IC1	0.772	0.908	0.926	0.609
	IC4	0.757			
	IC6	0.777			
	IC7	0.774			
	IC8	0.790			
	IC9	0.789			
	IC10	0.806			
	IC11	0.776			
Social capital	SC4	0.760	0.906	0.921	0.517
	SC5	0.713			
	SC6	0.790			
	SC7	0.772			
	SC8	0.770			
	SC9	0.762			
	SC10	0.767			
Psychological capital	PC1	0.798	0.837	0.867	0.642
	PC2	0.923			
	PC3	0.818			
Global mindset	GM2	0.783	0.823	0.871	0.532
	GM3	0.792			
	GM5	0.789			
	GM6	0.779			
Perceived employability	PE1	0.801	0.889	0.913	0.602
	PE3	0.813			
	PE4	0.774			

Variable	Items	Outer loading	Cronbach's Alpha	Composite reliability (CR)	Average Variance Extracted (AVE)
	PE5	0.801			
	PE6	0.794			
	PE7	0.793			

4.2.2. Convergent Validity

According to Cheah et al. (2018), assessing convergence is crucial in formative measurement models using PLS-SEM. The first criterion, indicator reliability, requires factor loadings above 0.7 (Hulland, 1999). Indicators with loadings below 0.4 must be removed (Hair et al., 2011), while those between 0.40 and 0.70 require careful evaluation.

Convergent validity is further established by the Average Variance Extracted (AVE), which measures the variance captured by a construct (Fornell & Larcker, 1981). An AVE value of 0.5 or higher (Hair et al., 2014) indicates sufficient variance explanation. As shown in Table 4, all factor structures meet this criterion, with AVE values exceeding 0.5.

4.2.3. Reliability of the resulting scale

The next criterion for establishing convergent validity is AVE, which serves as a standardized measure of the variance captured by a construct (Fornell & Larcker, 1981). As a general rule, an AVE value of 0.5 or higher (Hair et al., 2014) indicates that a latent variable accounts for more than half of the variance in its indicators. The results show that all factor structures ensure convergence when the AVE indexes are 0.5 or higher, as shown in Table 4. The next criterion for establishing convergent validity is AVE, which serves as a standardized measure of the variance captured by a construct (Fornell & Larcker, 1981). As a general rule, an AVE value of 0.5 or higher (Hair et al., 2014) indicates that a latent variable accounts for more than half of the variance in its indicators. The results show that all factor structures ensure convergence when the AVE indexes are 0.5 or higher, as shown in Table 4.

Table 6. Correlations Between Latent Constructs (Fornell - Larcker Criterion)

Variables	AVE	GM	IC	PC	PE	SC
GM	0.532	0,786				
IC	0.609	0,669	0,78			
PC	0.642	0,053	0,012	0,848		
PE	0.602	0,71	0,68	0,101	0,796	
SC	0.517	0,701	0,496	-0,008	0,640	0,762

4.3. Evaluation of structural model

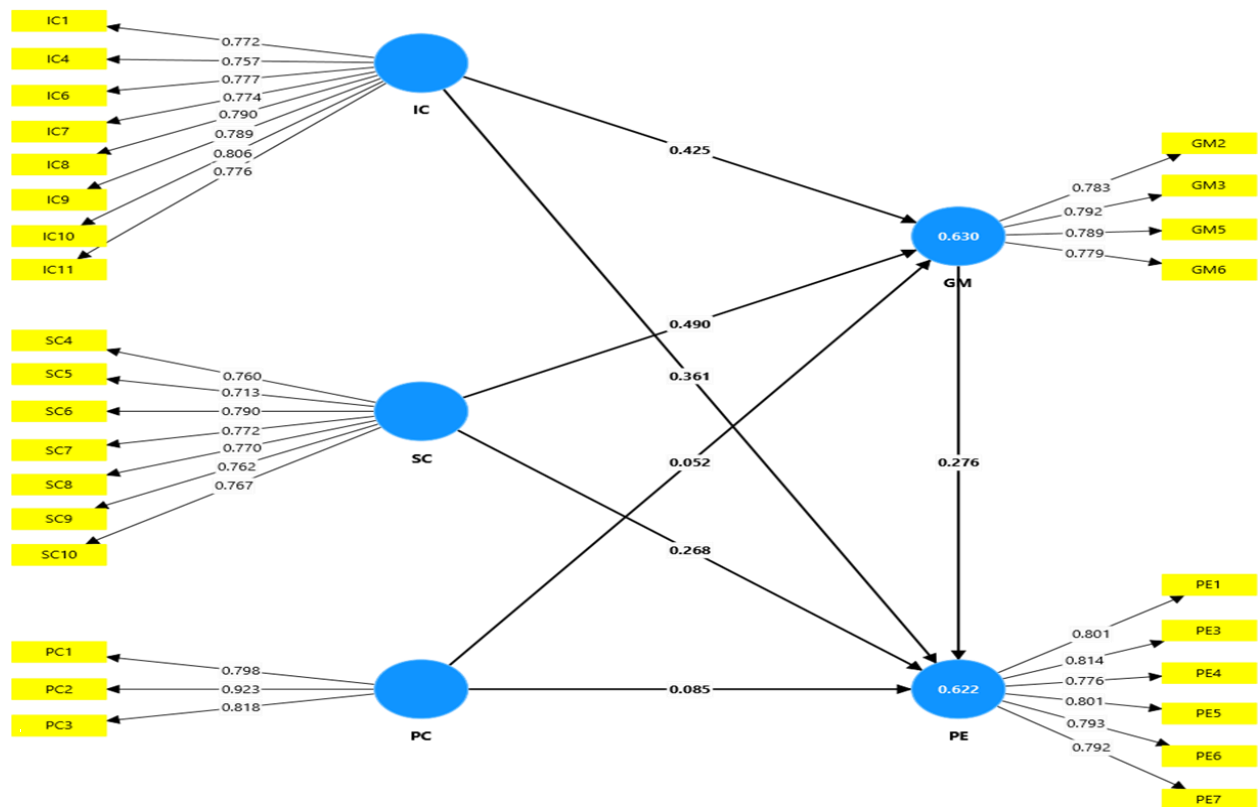
4.3.1. Evaluate the significance of direct impact relationships

This study uses the p-value to assess the statistical significance of relationships, as recommended by SMARTPLS. A path coefficient p-value below 0.05 indicates a statistically significant effect (Hair Jr et al., 2021). Results confirm 5 out of 7 hypotheses. Specifically, intellectual and social capital significantly impact global mindset and perceived employability

($p < 0.05$). However, H6 and H7, regarding psychological capital, were rejected, showing no direct impact on global mindset or employability.

4.3.2 Evaluate of Predictive Capability

The model’s predictive capability was assessed using the Coefficient of Determination (R^2), where values of 0.67, 0.33, and 0.19 represent substantive, moderate, and weak levels (Hair et al., 2014; Henseler et al., 2009). The R^2 values for global mindset (GM) and



perceived employability (PE) exceed moderate levels, with 63% of GM variance and 63.5% of PE variance explained by the independent variables.

4.3.3. The mediating role of global mindset

Indirect relationships between intellectual capital (IC), social capital (SC), psychological capital (PC), and GM were significant at a 10% level, with t-values of 3.905, 1.000, and 4.124. Global mindset fully mediates the relationship between IC, SC, and PE, while psychological capital influences PE only partially through GM. These findings underscore the critical role of global mindset in mediating employability among Vietnamese students.

5. Discussion

5.1. Discussion and theoretical implications

This study pioneers the integration of the “global mindset” concept into the “perceived employability” model, providing new insights into the role of a global mindset in students' job search process. The findings reveal a positive relationship between global mindset and perceived employability, indicating that students with a global mindset are more confident and prepared to enter the international labor market. Intellectual capital, comprising knowledge, skills, and personal abilities, plays a significant role in enhancing global mindset and perceived employability. This aligns with previous studies on intellectual capital's influence on global

mindset (Javidan & Bowen, 2013; Olson et al., 2015) and employability (Caballero et al., 2021; Donald et al., 2018).

The study also identifies the positive impact of social capital on global mindset and employability. Students with robust social networks are more likely to engage with diverse environments, fostering a global perspective. This supports earlier research on social capital's role in cross-cultural collaboration and employability (Fugate et al., 2004; McArdle et al., 2007). Contrary to previous studies (Clapp-Smith et al., 2015), no link between psychological capital and global mindset was found, likely due to differences in research subjects and context. Similarly, the hypothesis that psychological capital influences perceived employability was not supported, reflecting cultural and contextual differences between Vietnamese students and previous global samples.

5.2. Managerial implications

The study highlights positive relationships between global mindset, intellectual capital, social capital, and perceived employability, offering recommendations for stakeholders, including governments, universities, and students.

Government: Strategic policies are crucial for enhancing intellectual and social capital. The government should support international exchange programs, language development, and intercultural training. Investing in education to promote critical thinking and soft skills is also essential. Strengthening international cooperation and diplomatic relations can promote cross-cultural integration, enhancing the global mindset and fostering sustainable national development.

Universities: Educational institutions must integrate global mindset development into curricula, ensuring students gain both professional knowledge and international perspectives. Universities should encourage participation in extracurricular activities, which builds social capital and leadership skills. Collaborating with international institutions through study abroad and exchange programs further helps students become global citizens, preparing them for the global workforce.

Students: Proactive learning is key to building intellectual and social capital. Students should engage in research, seminars, and certifications to enhance problem-solving and professional skills. Expanding networks through domestic and international connections enriches students' knowledge and experience. Exposure to diverse cultures through travel, language learning, and cultural events helps students develop a global mindset.

Enterprises: Businesses should align recruitment strategies with global skills by collaborating with universities, organizing workshops, and incorporating global mindset criteria in hiring processes. Companies can offer training in cross-cultural management, support internships, and provide learning opportunities through sponsorships and mentoring programs. These efforts create a skilled workforce capable of competing in a globalized economy.

6. Conclusions, limitations and further research

While this study provides valuable insights, its generalizability may be limited to Vietnamese and similar educational contexts. Future research can address this limitation by expanding the scope to include Western countries. Deepening the analysis to explore how demographics and learning environment factors influence the relationships observed. Additionally, examining the effectiveness of introducing employability skills at different stages of the program and investigating faculty-employer collaboration in developing these skills could offer valuable insights for enhancing perceived employability across diverse educational settings.

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Interlingual Analysis of EFL Learners’ Translation: Its Implications to Thai EFL Learners

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Abstract

Interlanguage refers to the evolving linguistic system that second-language learners develop as they progress from their native language (L1) toward full proficiency in a target language (L2). This concept was introduced by linguist Larry Selinker in 1972. The study of interlanguage is also important for the students who learn English as a foreign language. Translation is a field of study that is influenced by interlanguage because translation is the replacement of text in first language (source language) with a second language (target language). It is also difficult for the translator to translate correctly and preserve the meaning of the source language. This is due to the linguistic differences between the source and target languages. Moreover, cultural differences are also considered to be important obstacles in translation. The novice translator who is not careful often makes mistakes in translation. Thus, this present study aims to examine interlanguage characteristics that affect the translation of Thai EFL learners and to analyze the mistakes in translation made by Thai EFL learners. The characteristics of interlanguage include language transfer, literal translation, collocation choice, semantic transfer, cultural transfer, and L1 interference. Moreover, this study also provides practical suggestions to help learners overcome obstacles that cause errors in Thai to English translation.

Key words: Interlanguage, translation, characteristics of interlanguage

Introduction

English plays a crucial role of global communication. It becomes the dominant language in various fields such as business, education, technology, and international diplomacy (Khan et al., 2020), Li et al. (2014). The rapid spread and dominance of English have raised concerns among scholars and policy makers about its impact on local languages and cultures (Mustafawi et al., 2021), (Al-Issa et al., 2017). The increasing demand for English language skills has led to a significant focus on English language teaching in many countries, including

Thailand. However, the challenges faced by Thai EFL learners in achieving intelligibility and comprehensibility in their English skills have been a subject of considerable research interest. The English language has gained unprecedented importance in today's world, not only as a means of international communication but also in the domains of education and advancing research and technology (Qadhi & Abu-Shawish, 2020). In academic contexts, it estimates that more than 50% of the millions of academic papers published each year are written in English, and the percentage is growing year by year (Tosun, 2013). The widespread use of English as the language of instruction in higher education institutions worldwide has made proficiency in English a prerequisite for academic and professional success.

The influence of English on non-native speakers—especially in countries where it is taught as a second language (ESL)—has led to the formation of a variety of Englishes. The spread of English has reshaped the linguistic landscapes of many countries, particularly those in the Middle East and North Africa region (Gotti, 2020) and they are also in Asia where English is either an official language and is taught in schools. The people in these countries learn English as a second language, they are non-native speakers who have learnt English almost at the same time as their mother tongue (Kachru, 1992). These countries are facing a challenge between preserving their local languages and cultures or adopting English as a medium of instruction in higher education (Al-Hammadi, 2013), (Latif & Alhamad, 2023). There are many issues that cause problems in language learning for learners of English as a second language. In the field of translation, many studies indicate the difficulties that students have in translating their own language into English. It must be caused by the interlanguage causing the problem. Usman et, al, (2022) studied the influence of background knowledge on students’ translation results: an interlingual translation. The result revealed that in an interlingual translation, even though, translators can speak in first and second language fluently and know the rule of grammar of both language, background knowledge of a text should also be dominated. Some researchers (De Leon & De Roxas (2024) studied the interlingual and intralingual analysis of ESL learners’ translation: its implications to English language education. It showed that L1 and L2 knowledge interference was highlighted in the data. Interference patterns were evident across various linguistic elements. Despite expectations to learn both Filipino and English, participants still lack proficiency.

English doesn’t affect only on the counties that use English as a second language but also affects to the counties in expanding circle model (Kachru, 1992) as China, Russia, Brazil, Japan, Turkey, Korea, Saudi Arabia, and The Emirates, etc. The people in these countries use English as a foreign language (EFL) that refers to the variety of English contexts are not usually spoken in their countries. The learners usually acquire the language in formal education setting with limited exposure to native speakers (Brown, 2007). According to the studied on “*A Modular Representation of Interlingual Errors: The Causes of Crosslinguistic Influence*” the result revealed that the scholars agree about the factors that lead to the surfacing of interlingually-induced production errors, but disagreements regarding the modularity of second language acquisition, (Mhamedi & Ibrir 2024). In the field of translation, many studies indicated the problems that the EFL learners faced in their translated works. (Sabilla, 2024) conducted the research with translation difficulties faced by the English Education study program students of FKIP UNSRI. The result revealed that Cultural difficulties were the main cause of translation problem experienced by most English education students. In line with the research result of (Inphen, 2022) suggests that the culture-specific items of source language and target language are different. Choosing the right way to translate makes the translation more accurate. So, students should be aware of the difference loan word and transliterations. In addition to cultural differences, the different nature of source (SL) and target language (TL) is also an important factor causing translation problems for learners of English as a foreign

language. (Akki, 2021) claimed that the participants’ scores in English-Arabic translation and Arabic-English translation are not at the expected ability level due to the obstacles they encounter in the translation process because of the different natures of the two languages.

Additionally, Thai learners of English encounter difficulties related to the linguistic distance between Thai and English, which differ significantly in terms of syntax, vocabulary, and phonology. As a result, learners frequently struggle with producing accurate translations, as they attempt to map the structures of their native language (Thai) onto the structures of English. This issue is compounded by cultural differences, as Thai culture often emphasizes indirectness, politeness, and respect for hierarchy—features that do not always have direct equivalents in English. Thus, the process of translation becomes an intricate task, requiring not only linguistic competence but also a deep understanding of cultural difference.

The significance of translation in EFL Learning is undoubted. The ability to effectively translate from one language to another is a crucial skill for EFL learners, as it enables them to engage in cross-cultural communication, access knowledge and resources, and navigate academic and professional contexts. However, the process of translation is inherently challenging, as it requires learners to navigate the complexities of linguistic and cultural differences.

Objectives

- 1) To examine interlanguage characteristics that affect the translation of Thai EFL learners.
- 2) To analyze the mistakes in translation made by Thai EFL learners

Methodology

This article adapted the literature review method as the authors collected the data by conducting the following steps: reading, identifying, recording, understanding, transmitting information pertinent to a topic of interest. The instrument used in this study is document that is in the field of translation. It consists of 15 articles from the Scopus and Thai journals. These articles were published in the year of 2018 – 2024. Therefore, the data analysis technique used is document analysis. The data is explained by relevant to interlanguage theory included transfer of structures, literal translation, collocation choices, semantic and pragmatic transfer, and influence of L1 (Selinker, 1972). The authors explain how to use the words in the sentences, and find out the point mistake or error in translation.

Result And Discussion

Second language acquisition (SLA)

Second language acquisition is a complex theory of the study. It is multifaceted field that aims to understand how individuals learn and acquire other language than their native or first language. These are several important aspects of this theory, including creative construction theory, the sociocultural theory, and the constructivism theory (Mahmoud, 2018). The creative construction theory focuses on the natural language system that individuals possess. It facilitates the acquisition of a foreign language. This theory consists of two essential components: the organizer which highlights how learners organize their language system, and the monitor which focuses on how learners detect and correct their errors. The sociocultural theory, on the other hand, notice that language acquisition is a social phenomenon. The development of learners’ abilities arises from interpersonal interaction. This theory argues that learning is a social process. Language is acquired through exposure to contexts, understanding

discourse, and using language in natural communicative contexts. In contrast, the constructivism theory suggest that learning is a process in which learners actively construct meaning. It means that language acquisition is a dynamic process in which the learners play an active role in constructing their own understanding of the language.

The role of first language (L1) in the second language (L2) is also a key consideration in the theory of second language acquisition. L1 and L2 have both similarities and differences, and the relationship between the two can significantly influence the success of language acquisition or learning (Nor & Rashid, 2018). Overall, the theory of second language acquisition is a multifaceted field of encompasses a variety of perspectives and approaches. (Pinker, 1979), (Shadiev & Wang 2022) provide valuable insights into the different theoretical frameworks that underpin the process of second language acquisition. In the prevalence of analysis, error analysis is over contrastive analysis. A great number of empirical studies indicated that first language and second language are always responsible for learners' errors (Duklim, 2022), (Telaumbanua, 2019), (Islam M. S., 2022). Thus, contrastive analysis and error analysis are the way for interlanguage theory to take place in describing learners' errors in acquisition process of second language (L2) (Al-khresheh, 2015).

Interlanguage Theory

The term ‘interlanguage’ was first introduced by Selinger (1972). He referred interlanguage (IL) as systematic knowledge of L2 that was independent of both the learner's first language (L1) and second language (L2). He also adapted the norm to refer to the interim grammars constructed by second language learners on their way to the target language (TL). According to Richards et al. (1996), interlanguage is the type of language for the learners who use other language as foreign language or second language. They are in the process of acquiring and learning a new language. Within the cognitive perspective, IL refers to the separateness of a second language learner's system, a system that has a structurally intermediate status between the native (NL) and target language (TL) (Brown, 1994). IL represents the efforts made by L2 learners to develop a linguistic system that gradually gets closer to the target language (Fauziati, 2011). IL is the type of language produced by second language learners who are in the process of learning a language. While learning a language as L2, they construct a system of abstract linguistic rules which focuses on comprehension and production of the L2. This system of rules is viewed as a mental grammar and is referred to as an interlanguage (Ellis, 1997).

Before the term of interlanguage was used and gained its wide popularity, many other scholars have used various terms to refer to the same phenomenon. They are ‘transitional competence’, ‘an idiosyncratic dialect’, and ‘an approximative system’ by Nemser (1971) who stressed the successive approximation to the target language (TL). Corder (1971) used the phrase "idiosyncratic dialect" to describe the idea that a learner's language is specific to them and their language rules are unique to the language of individual alone. In linguistic sense, learners' language could be considered as a dialect language. It means that two share some rules of grammar becoming dialects. He also states that language A and language B are in a dialect relation which leads to interlanguage.

As opposed to contrastive analysis (CA) and errors analysis (EA), IL is not considered an L1 or L2 influenced process in second language acquisition. In other words, it is a separate linguistic system that exists on its own and is not the system of first language, second language, or target language. IL is found where L2 learners express the knowledge that they already have in the new language that they are trying to learn (Al-khresheh, 2015). It conforms to Brown (2002) IL refers to the separateness of a second language learners' system, a system that has a structurally intermediate status between the native and target language. According to Selinger

(1972), interlanguage can be observed in a learner's language and investigated as the processes that occur between L1 and L2. He considers IL as ‘a dialect whose rules share characteristics of two social dialects of language, whether these languages themselves shore rules or not’.

Characteristics of Interlanguage

The concept of interlanguage is presented by Selinker in the 1972. It evolves Linguistic system that second language learners develop as they progress from their native language toward full proficiency in a target language. According to Selinker's interlanguage theory, interlanguage is natural language that exhibit systematic development. Interlanguage system have unique characteristics that have been the subject for doing research by numerous scholars. The study of interlanguage offers valuable insights into the dynamic and complex nature of second language learning, highlighting the learner's active role in constructing their own linguistic system (Jiang et al., 2019), (Selinker & Lamendella, 1981).

Interlanguage exhibits several key characteristics: They are:

1. **Dynamic:** The L2 learner's interlanguage is dynamic and constantly changing (Selinker, 1972). The learners do not stop learning from one stage to the next, but rather slowly revises the system. This occurs when a new rule is introduced, initially in one situation, then in another, and so forth. A new rule spreads as its application progressively broadens across a variety of language settings. Thus, a number of overlapping "grammars" make up the interlanguage continuum. Each grammar has some new or updated rules in addition to some rules that are shared with the grammar that was previously developed. Interlanguage is constantly changing and evolving as learners acquire new knowledge and refine their understanding of the L2. It's a dynamic system characterized by periods of stability, instability, and progression towards the target language. Zhu, (2003) describes this dynamic nature, highlighting how interlanguage changes slowly to adapt to new hypotheses about the target language.

2. **Unique to the Learner:** Interlanguage is a unique system created by each individual learner. It reflects their current understanding of the target language (L2) and is shaped by their native language (L1), learning experiences, and cognitive processes. It's a personal linguistic system distinct from both the L1 and L2.

3. **Systematic and Rule-Governed:** While containing errors, interlanguage isn't a random collection of mistakes. Learners create and apply their own internal rules, demonstrating an evolving systematicity as they progress. These rules, though sometimes deviant from the target language norms, reflect the learner's attempt to organize and make sense of the L2. and mention how learners follow predictable applications of L2 rules.

4. **Influence of First Language:** The learner's L1 often influences their interlanguage. This influence can manifest as positive transfer (facilitating learning when L1 and L2 structures are similar) or negative transfer (interference) leading to errors when L1 patterns are inappropriately applied to the L2. (Altheneyan & Boayrid, 2019) discuss the negative influence of L1, termed interference.

5. **Simplification and Avoidance:** Interlanguage is often characterized by simplification strategies, where learners avoid complex grammatical structures or lexical items, and generalize rules beyond their appropriate usage (Suteerapongsit, 2020). Learners may simplify L2 structures in their interlanguage, particularly in the early stages of acquisition. This simplification can involve omitting grammatical elements, using less complex sentence structures, or substituting simpler vocabulary. (Mahmoud, et al., 2020) suggests that omission errors can reflect learners' attempts to simplify language learning.

6. Errors are an inherent part of the interlanguage system and provide valuable insights into the learner's current understanding of the target language. Analyzing these errors can help identify specific areas where learners are struggling, which in turn can inform instructional strategies and interventions to support their language development. Error analysis examines the faults between the norms of second language learners and the norms of the target language. It attempts to clarify the mistakes made by the second language learners (Haristiani & Christinawati, 2024). The scholars discuss how errors are viewed as evidence of the learner's evolving language system, reflecting their active attempts to make sense of the target language and construct their own unique linguistic framework Lestari and (Chojimah, 2023). Khansir mentions the ways to study the errors as there are two major approaches to the study of learner's errors, namely contrastive analysis and error analysis. Error analysis cannot be studied properly without touching upon the notion of contrastive analysis. Contrastive analysis and error analysis have been commonly recognized as branches of Applied Linguistic Science (Khansir, 2012).

7. Fossilization: Sometimes, certain features of a learner's interlanguage may become resistant to change and persist even with continued exposure to the target language. This phenomenon, known as fossilization, occurs when particular linguistic structures or errors become entrenched in the learner's interlanguage system and are difficult to eradicate, even with further learning or instruction (Selinker, 1972). As Selinker notes, fossilization is one of the key principles underlying the concept of interlanguage, highlighting the fact that second language acquisition is not always a linear process leading to complete mastery of the target language. Zhu, (2003) suggests that Language fossilization is a slow process and an inevitable phenomenon in language learning. It can occur at any stage of second language learning. Qian & Xiao, (2010), state that temporary fossilization is the greatest obstacle in second language acquisition. Yuxiaolin, (2023) mentions that fossilization of interlanguage is a common phenomenon in second language acquisition. It is also an inevitable problem for language learners. Moreover, Li & Ren, (2023) conform that the field of language fossilization deserves further study. Structures that have been preserved throughout time, is called fossilized structures. It may be understood as mistakes or as correct forms in the target language.

In summary, the concept of interlanguage provides a valuable framework for understanding the dynamic and complex nature of second language acquisition. By recognizing the systematic and rule-governed nature of interlanguage, as well as its evolving and variable characteristics, educators can better support learners in their language development (Johansson, 1978), and (Herlinawati et al., 2020).

Interlanguage affect to translation of Thai EFL learners

Interlanguage, the intermediate stage of language development in second language (L2) learners, significantly influences translation, especially when the translator's L1 interferes with the target language. Thai EFL learners often face challenges in learning English due to the significant differences between Thai and English grammar, syntax, and vocabulary. Previous research has explored the perceptions and attitudes of Thai learners towards different varieties of English, which can influence the direction of language policy and institutional practices in Thailand. One study found that Thai university students have preferences for certain 'native-speaker' varieties of English, such as American or British English, over other international varieties (Snodin & Young, 2015). This suggests that Thai learners may still view these traditional “*standard*” accents as the ideal target models, despite the growing recognition of English as a pluralistic global language. The interlanguage characteristics affect to the learners’ translation include: transfer of language, literal translation, collocational choices, semantic and pragmatic transfer, cultural transfer and influence of L1. They can be explained as follow:

1. Transfer of language: L1 syntactic structures often get transferred to the L2 during translation. This can lead to grammatical errors or unnatural phrasing in the target language. Although the basic sentence structure of Thai and English have some similarities, when considering the details, there are other differences. The structure of subject-verb agreement is one of the problems of EFL learners. According to Takahashi, (2023) for example, in sentence “เราได้ซื้อสินค้าและอาหารที่บ้านที่อร่อยมากๆ”. The learner writes the sentence as “*We bought local things and food, which was very delicious*”. This error is caused by the learners failed to apply the subject-verb agreement. The verb in this sentence modifies subjects “*local thing and food*”. The correct form should be “*were*” which consistent with the subject of sentence. Thai learners might translate Thai sentence structure directly into English, resulting in incorrect structure. The research result of Wongranu revealed that syntactic errors had the highest frequency implying that the students usually made grammatical errors when doing translation (Wongranu, 2017).

Example 1: in the phrase “หลายวัฒนธรรม” is equivalent to “*many cultures*”, but the learners omitted the “-s”. This kind of mistake is not serious if it occurs in the small number because it does not destroy the meaning of the sentence, but if it occurs a lot, it means that the students ignore the grammar difference between L1 and L2.

In addition, the structure of Thai and English is different. Thai is an isolating language that does not have inflection on verbs for number, gender, and tense. The verbs in Thai do not express to tense. Time reference is instead inferred by using adverbs of time and guessing from context, such as “เดี๋ยวนี้” “เมื่อคืนนี้” “เมื่อวานนี้” and special markers such as the word for past time “แล้ว” “already”, and the word for future time “จะ” “will” (Iwasaki & Ingkaphirom, 2009). Therefore, when translating Thai sentences into English sentences, the translators should read the Thai text to understand the content and consider the structure of the language, then replace the text with the words and structures of English language that are most similar to Thai text in order to maintain the original meaning as possible (Suteerapongsit, 2019).

Example 2: Thai sentence “ฉันอยากให้เขาใช้เวลากับฉันมากกว่านี้” can be translated into English in many sentences as “*I wish he spend more time with me.*”, “*I wish he had spent more time with me.*”, or “*I wish he spend more time with me.*”. The time reference in Thai sentence in example can be present tense, past tense, or future tense. So, the learners should consider the context of Thai language and then translate into English with the appropriate sentence.

2. Literal Translation: This involves translating word-for-word from the L1 to the L2, disregarding idiomatic expressions and contextual nuances. The novice translator does not consider it carefully and therefore makes an incorrect translation. According to Kulsirisawad, (2014) the differences between Thai and English verb systems can be divide into two aspects. The first, there is no verb conjugation to express time in Thai language and the second is the complexities of morphological features. Takahashi, (2023) states that the learners face the misuse of tenses because verb tense in English are difference from Thai. Thai verbs do not inflect for tense as they do in English. The Thai sentence “ผมไปกรุงเทพเมื่อวานนี้” is translated into English with literal translation as “*I go Bangkok yesterday*”. From the example sentence, it illustrates that the use of adverb to express past tense as the word “*yesterday*” so, the verb “*go*” should be changed into “*went to*” with the English grammar rules. When they translate Thai into English by using literal translation method, it makes an incorrect sentence. It is in line with Kaweera, (2013) the result showed word-by-word translation as the sentence “ทำตามคำแนะนำเหล่านั้นดูสิ” (*try following this advice*) was translated as “*Try following these advices*”. The learners saw the word “เหล่านั้น” which is equivalent to the word “*these*”, so they literally translated it, overlooking that “*advice*” is an uncountable noun which does not present

the state of plural by adding suffix "-s". It confirms with Arong R. et al. (2008), they provide examples of literal translation from Malay to English, such as *"the senior will hot and angry,"* where *"hot"* is a direct translation of the Malay word *"panas"* (*hati panas*), meaning *"angry."* This approach often results in inaccurate and awkward translations.

3. Collocational Choices: Collocations are words that frequently appear together in a language. Learners' collocational errors seem to emanate from native language influence (Nesselhauf, 2003), overuse and underuse of collocations, and word creation through merging words together or bottom-up. L1 influence can lead to incorrect or unconventional collocations in the L2. (Phoocharoensil, 2012) supports the idea that L1 has a significant impact on even high-proficiency learners' use of English collocations. For instance, a Thai learner might use a collocation that is common in Thai but not in English. According to Kaweera, (2013) collocational error is the type of error interfered by L1. It occurs when the learners use literal translation to form the collocation as shown in this sentence *"เขาได้อธิบายเกี่ยวกับบ้านของเขา"*. The learners translate into English as *"He described about his house"*. The error found in the sentence is unnecessary preposition *"about"*. The learners face the problem with the use of preposition *"about"* which is the same as the word *"เกี่ยวกับ"* in Thai. This error results from L1 lexical interference when the learners employ a direct translation from Thai to English. The word *"about"* is collocated with *"talk about"* or *"think about"*. So, this sentence should be corrected as *"He described his house"*. Moreover, Thai learners made the most collocational mistakes. They confused when translating the words that always occur together. According to Chaiyaphat & Thammawong, (2024) they confirm that the students made the most errors with verb + noun combinations. It was implied that verb + noun collocation was the most challenging type for students to perform. As the sentence *"ฉันกินยาฉันจึงรู้สึกดีขึ้น"*. The learners translate the words *"กินยา"* which are the type of verb + noun collocation as *"eat medicine"*. It seems to be correct according to Thai language. When considering the use of English collocation, it can be seen that here is as error because the expression *"กินยา"* in English can be used as *"take medicine"* so this sentence should be translated as *"I took medicine, so I felt better"*.

4. Semantic and pragmatic Transfer: This refers to the transfer of meaning from L1 to L2, which can lead to inaccurate or inappropriate word choices in the target language. The translator might choose a word in the L2 that has a similar meaning to the L1 word but doesn't fit the context of the target language. According to the study of Wongranu (2017), semantic errors had the second highest frequency. Many students chose incorrect words when translating. The errors were at both the word and phrase level as following.

Example 1: Students directly translated *"กรงแคบๆ"* (small cages) with *"narrow cages"* that is incorrect. The word *"narrow"* can be used with places where length is longer than width, such as roads. But, the word *"small"* is more appropriate with a space where length and width are almost equal, such as rooms or cages. However, the word *"แคบ"*, normally equivalent to *"narrow"*, can be used in both contexts in Thai.

Example 2: The action *"กระโจนเข้าขวิด"* gives the sense of rushing towards something before butting it. The students translated this phrase as *"jump and gore"*. Nevertheless, the word *"กระโจน"* can also mean *"to leap"* or *"to jump"* forward quickly. This phrase is the part of sentence that refers to an action of the buffalo toward the lion. So, the buffalo should not leap when it is going to butt something. This phrase should be used *"charge and butt"* not *"jump and gore"*.

5. Cultural transfer: Cultural transfer of first language is the most influential element on learning second language. A successful communication not only requires a good mastery of foreign language but also the knowledge of difference of cultures. Hafdhi, (2023) said that Translators should assume with the author, source text, and the target language so that they can succeed in transferring faithfully elements of both literary and pragmatic registers in both source and target languages. When learners translate the culture-specific words in first language, they should consider whether the words have similar meaning in the second language. This is because the culture of L1 and L2 language may be the same or different. According to Wongseeree, (2021) states that learners translate the culture-specific words from Thai into English by using transliteration strategies. They translate the names related to tradition that are the Northern tradition of Thailand.

Example 1: “ตังก้วยสลาก” as “*Tan Kuai Salak*”, and “สลากกั๊ด” as “*Salakkaphat*”. The learners are also use paraphrased strategy with unrelated words.

Example 2: the learners translate the word “ข้าวคั่ว” as “*coconut balls*”. This word is for Thai traditional desert that made of rice flour, sugar and coconut. It does not have in English culture. In this case, the learners choose unrelated word to translate into English.

6. Influence of L1: Mother tongue interference or L1 interference is the impact of using first language of learners who study second language. Mother tongue affects the learners’ thought process. While trying to learn new language, they think in mother tongue then express in the second language. The transfer of mother tongue falls into two types: positive transfer and negative transfer. If the characteristics of first language and second language are similar, positive transfer will appear. But in other case it is negative transfer (Kasap, & Emamvirdi, 2022). According to Chelli (2014), interlingual errors are the result of language transfer, which is influenced by the learner’s first language. The learners make mistakes in the target language because of their mother tongue interference. The most of learners use the same set of rules in L1 and L2. These are some examples of interlanguage errors that occur when translating between languages (Tipprachaban, 2024).

Example 1: in first language (L1), “หนังสือ ของ โบบ์” the learners translate into target language (TL) or second language (L2) as “*the book of Bow*”. They translate source text by relying on the rules of the native language as a model, resulting in the meaning does not match with the target text. In line with the research result of Alfaifi & Saleem (2024) they found that Arab learners of English do not follow the correct word order in their sentence. They use grammatical rules of mother tongue with English sentence. It makes mistake in their words.

Example 2: The intended meaning “*Khalifa doesn’t come on time*”. Arab learners produce in their sentence as “*doesn’t come on time Khalifa*”. And the sentence “*What are you doing?*”, they also produce the sentence as “*What doing you*”. This because of Arabic language is a more flexibility in the movement and distribution of its components. To put it in difference word Order Can Be Altered Without Losing The Meaning.

Conclusion

The present study provides a theoretical discussion of interlanguage affecting Thai - English translation. The term interlanguage introduced by Selinger 1972 which means systematic knowledge of L2 that is independent of both the learners’ first language (L1) and second language (L2). He also adapted the norm to refer to the interim grammars constructed by second language learners on their way to the target language (TL). The discussion shows that the characteristics of interlanguage provide the examples of mistakes in translation. These errors include; 1) language transfer that means L1 syntactic transferred to the L2 during

translation. this can lead to grammatical errors or unnatural phrasing in the target language. 2) Literal translation involves translating word-for-word from the L1 to the L2, disregarding idiomatic expressions and contextual nuances. 3) Collocational choice is word that frequently appear together in a language. Learners’ collocational errors seem to emanate from native language influence. 4) Semantic transfer, this refers to the transfer of meaning from L1 to L2, which can lead to inaccurate or inappropriate word choices in the target language. The translator might choose a word in the L2 that has a similar meaning to the L1 word but doesn't fit the context of the target language. 5) Cultural transfer of first language is the most influential element on learning second language. A successful communication not only requires a good mastery of foreign language but also the knowledge of difference of cultures. 6) Mother tongue interference or L1 interference is the impact of using first language of learners who study second language. Mother tongue affects the learners’ thought process. From the discussion and example, it can serve as a guideline for translation students to develop themselves in translating Thai into English. Moreover, it also shows the correct translation that students can apply in their work.

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Session 6: Humanities, Social Science, and Innovation for Local Development

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Impact of Annoying Advertising Values and Cognitive Dissonance Theory on Gen Z Shopping Behavior

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Abstract

The increasing ubiquity of annoying advertising has significantly influenced consumer behavior, particularly among Generation Z, by shaping their decision-making processes and interactions with brands. However, the pervasive nature of such advertisements has raised concerns regarding the potential for cognitive dissonance, which can adversely affect consumer attitudes and purchasing intentions. This study aims to address these concerns by applying Cognitive Dissonance Theory to the evaluation of advertising content and consumer responses. Drawing upon core principles from Advertising Value Theory, the research identifies six distinct behavioral responses to disruptive advertisements, categorized according to perceived levels of informativeness, entertainment, and irritation. The study examines the interplay between cognitive dissonance, shifts in consumer attitudes, and subsequent behavioral changes, with particular emphasis on their effects on brand perception and purchasing decisions. Utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM) and survey data from 457 respondents in Vietnam, this research specifically investigates the reactions of Generation Z to digital advertising within the e-commerce sector. The findings offer significant insights into online consumer behavior, providing a basis for businesses to refine advertising strategies and enhance customer engagement. Moreover, the study proposes a cognitive framework aimed at mitigating dissonance, offering actionable recommendations for improving the efficacy of advertisements and fostering brand trust within the digital marketplace.

Keywords: Gen Z, shopping behavior, cognitive dissonance theory, annoying advertising.

1. Introduction

The rapid advancement of information technology, particularly in digital and social media platforms, has given rise to an array of advertising strategies that businesses employ to engage consumers. These platforms provide an increasingly complex landscape for marketing, where companies must navigate not only the effectiveness of their ads but also the potential adverse reactions from consumers. One such challenge is the growing prevalence of disruptive or "annoying" advertising, which, despite its intention to capture attention, often leads to consumer irritation, reducing the overall effectiveness of marketing efforts. This phenomenon is particularly relevant to Generation Z (Gen Z), a cohort that has grown up in a digital environment and is highly adept at filtering out unwanted content. The interaction between

consumer behavior and the pervasive nature of digital advertising has profound implications for businesses seeking to maintain positive brand perceptions and foster consumer engagement.

This study investigates the impact of annoying advertising on consumer behavior, with a particular focus on Gen Z, and incorporates Cognitive Dissonance Theory (Festinger, 1957) to understand how intrusive ads influence decision-making and purchasing intentions. Previous research, such as that by Sharma (2017), has highlighted the centrality of cognitive dissonance in consumer behavior, illustrating its significant role in shaping attitudes and behaviors in response to advertising. By addressing the psychological discomfort caused by conflicting stimuli, this research seeks to understand how businesses can better tailor their advertising strategies to mitigate dissonance and enhance consumer engagement.

Literature review and proposed model

Consumer behavior, as defined by MacInnis (2008), encompasses the processes by which individuals or groups select, use, and evaluate products, services, or ideas to satisfy their needs. This study builds upon the foundational model of consumer decision-making proposed by Kotler (2017), which outlines five key stages: need recognition, information search, evaluation of alternatives, purchase decision, and post-purchase behavior. In the context of digital advertising, these stages are often influenced by the nature of advertisements encountered by consumers, particularly in online environments such as social media platforms.

The rapid growth of e-commerce has significantly altered the dynamics of consumer behavior. Online shopping, as defined by Hasslinger (2007), refers to the process of purchasing goods or services over the internet, allowing for a more convenient and personalized shopping experience. Li (2002) and MasterCard (2008) further emphasize the growing importance of digital platforms in facilitating consumer transactions. With this shift to online shopping, understanding how digital advertising influences consumer decisions is paramount.

Advertising serves as a critical tool for introducing products, services, or brands to target audiences, with the primary goals of increasing sales, enhancing brand awareness, and shaping consumer attitudes (De-la-Vara-López, 2024). Advertisements are perceived by consumers through multiple dimensions, including informativeness, entertainment, and irritation (Abasi, 2022). Informativeness refers to the degree to which an advertisement provides useful and relevant information that aids in decision-making (Ducoffe, 1996). Entertainment, on the other hand, concerns the capacity of advertisements to engage consumers by providing enjoyment or emotional appeal (Elliot, 2015). According to Hoffman (1996), consumers often expect a certain level of entertainment from advertisements, which contributes to positive emotional responses and can strengthen brand perceptions.

However, one of the most significant challenges advertisers face is managing irritation. As described by Ducoffe (1996), irritation occurs when an advertisement is perceived as disruptive or intrusive, leading to negative emotional responses. The presence of irritating advertisements has been linked to increased consumer avoidance behavior, which can undermine the effectiveness of the advertising strategy.

Cognitive Dissonance Theory (Festinger, 1957) provides a useful framework for understanding how consumers respond to conflicting information, such as when an advertisement does not align with their expectations or preferences. Dissonance occurs when there is a perceived inconsistency between beliefs, attitudes, or behaviors, leading to psychological discomfort. In response, individuals are motivated to reduce dissonance through various mechanisms, such as altering their attitudes, changing behaviors, or seeking confirmatory information (Festinger, 1962). In the context of advertising, when consumers encounter irritating or misleading ads, the resulting dissonance may prompt them to either shift

their attitudes toward the brand or avoid the advertisement altogether. Understanding these mechanisms is crucial for developing strategies that mitigate dissonance and enhance the overall effectiveness of advertisements.

Building upon Ducoffe's (1996) Advertising Value Model, this study introduces a conceptual framework that incorporates the factors of informativeness, entertainment, and irritation, with cognitive dissonance as a central explanatory mechanism. The model posits that advertisements that are perceived as informative and entertaining tend to foster positive consumer attitudes and behavior, while advertisements that are irritating may lead to cognitive dissonance, resulting in negative shifts in attitude and purchase intentions.

The proposed model includes three key variables:

- **Informativeness (F):** The extent to which advertisements provide useful and relevant information that aids in the decision-making process.

- **Entertainment (E):** The ability of advertisements to engage consumers emotionally, enhancing their connection to the brand.

- **Irritation (I):** The degree to which advertisements disrupt the consumer experience, leading to negative emotional reactions.

Additionally, cognitive dissonance (D) acts as a mediating variable that influences consumer attitudes and behaviors. The model suggests that consumers experiencing dissonance may engage in one or more dissonance reduction mechanisms, including:

- **Attitude Change (A):** Altering beliefs or opinions about the brand in response to the ad.

- **Confirmatory Information Seeking (C):** Seeking additional information to reinforce or disprove the advertisement's claims.

- **Behavior Change (B):** Modifying purchasing intentions or behaviors based on the perceived inconsistency between the advertisement and personal beliefs.

By examining these interrelationships, the proposed model aims to offer insights into how advertising can be optimized to minimize cognitive dissonance and maximize consumer engagement, particularly within the context of Generation Z and digital advertising on social media platforms.

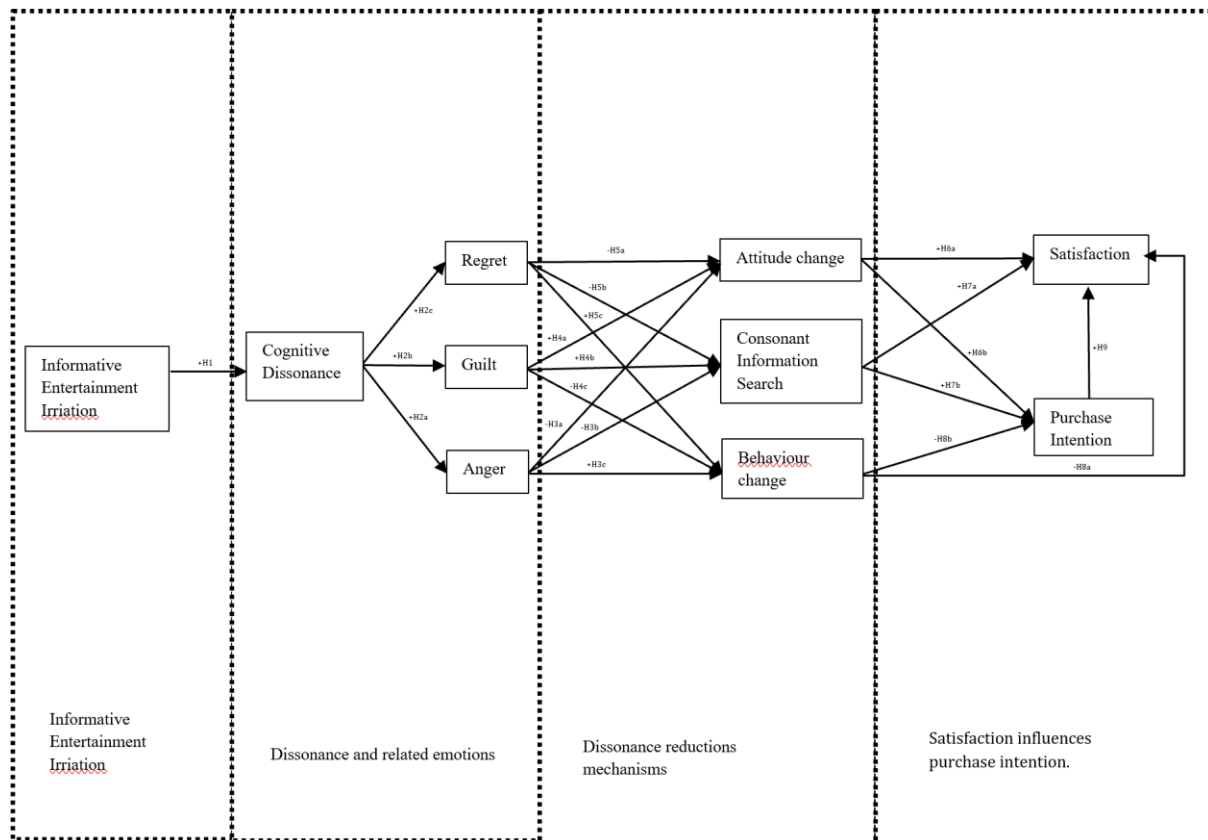


Figure 1. The proposed model

Hypothesis Development

Informativeness plays a crucial role in determining the value of advertisements. According to (Brown, 1992), this factor is strongly associated with brand attitude and serves as a key predictor of consumer behavior.

H1a: The informativeness of advertisements has a positive impact on cognitive dissonance.

Entertainment: Based on the Uses and Gratifications Theory (Schlinger, 1979), entertainment in advertising provides substantial value for both consumers and advertisers.

H1b: The entertainment value of advertisements has a positive impact on cognitive dissonance.

In (Ducoffe's, 1996) **Advertising Value Model**, irritation is often considered a negative predictor. Research indicates that excessively stimulating or intrusive advertisements may lead consumers to ignore the content or even feel that their privacy has been violated (Brehm, 1996).

H1c: The irritation value of advertisements has a positive impact on cognitive dissonance.

Anger arises when individuals perceive themselves as lacking responsibility or control over a dissonant situation (Harmon-Jones E. , 2004); (Harmon-Jones E. H.-J., 2017). It is a fundamental emotion encompassing various states such as frustration, annoyance, or resentment (Shaver, 1987)

H2a: Cognitive dissonance caused by advertising value that does not meet prior expectations positively influences anger arousal.

Guilt is often linked to disappointment or shame when behavior deviates from ethical norms or personal values (Gosling, 2006); (Davvetas, Regret in consumer choice: Cross-cultural perspectives, 2017)).

H2b: Cognitive dissonance caused by advertising value that does not meet prior expectations positively influences guilt arousal.

Regret occurs when individuals blame themselves for unsatisfactory purchasing decisions or recognize better alternatives (Dutta S. &, 2005); (Gilovich, 1995b).

H2c: Cognitive dissonance caused by advertising value that does not meet prior expectations positively influences regret arousal.

Emotions serve as mediators in stimulating and mitigating cognitive dissonance, influencing perception and decision-making (Ducoffe's, 1996) According to (Izard, 2010), emotions help individuals interpret social cues, facilitate communication, and provide a basis for cognitive evaluations. However, previous research has primarily focused on negative emotions in dissonance reduction, such as anger, fear, regret, and anxiety. This approach oversimplifies a complex emotional process, as emotions may vary depending on individuals and circumstances (Tsang, 2019); Izard, 2010). Emotions can drive individuals to commit to behavior by modifying attitudes and reinforcing decisions while considering consequences and alternatives (Roese, 1997). **Regret** is considered a strong predictor of behavior change. Studies suggest that undesirable decisions may increase the intention to disengage from advertising exposure while reducing satisfaction with the product (Davvetas V. &, 2017).

H3a: Anger negatively influences attitude change.

H3b: Anger negatively influences the search for confirmatory information.

H3c: Anger negatively influences behavior change.

H4a: Guilt negatively influences attitude change.

H4b: Guilt negatively influences the search for confirmatory information.

H4c: Guilt negatively influences behavior change.

H5a: Regret negatively influences attitude change.

H5b: Regret negatively influences the search for confirmatory information.

H5c: Regret negatively influences behavior change.

According to **Cognitive Dissonance Theory**, dissonance arises when behaviors do not align with expectations, often leading to negative emotions such as dissatisfaction. In this

context, consumer satisfaction is achieved when they minimize the gap between prior expectations and actual product value. One strategy to reduce dissonance is adjusting perceptions to reconcile expectations with actual experiences (Sharifi, 2014); (Dutta S. &, 2005)). The three main mechanisms for reducing cognitive dissonance—**attitude change, seeking confirmatory information, and behavior change**—each have varying effects on consumer satisfaction.

H6a: Attitude change positively influences perceived satisfaction.

H6b: Seeking confirmatory information positively influences satisfaction.

H6c: Behavior change negatively influences perceived satisfaction.

H7: Satisfaction with advertising value positively influences consumers' purchase intention.

2. Methodology

This study adopts a convenience sampling method, a non-probability sampling technique, to efficiently gather data within a constrained timeframe and budget. The target population for this research consists of young adults, specifically university students and young professionals, with a particular focus on individuals who are actively engaged in online shopping, especially for beauty and personal care products through e-commerce platforms. The rationale for focusing on this demographic is rooted in the fact that younger consumers, especially Generation Z, exhibit distinct behaviors and attitudes towards digital advertising, making them ideal participants for exploring the impact of annoying advertisements on consumer decision-making.

The research team developed a comprehensive questionnaire to capture relevant data on key constructs, including Cognitive Dissonance Theory, Advertising Value, Dissonance Reduction Mechanisms, Satisfaction, and Purchase Intention. In line with established guidelines for survey design, the questionnaire was initially pilot-tested with a sample of 30 university students. This pilot test aimed to identify any issues with the clarity of the questions, the comprehensibility of the scale items, and the overall structure of the survey. Following Iarossi's (2006) recommendations, the feedback gathered from the pilot participants was used to refine the questionnaire. Modifications were made to enhance the clarity of the questions and improve the overall reliability and validity of the measurement scales.

For this study, all measurement scales were adapted from established instruments in the literature, with minor adjustments to suit the specific context of the research. The constructs central to the study, including Cognitive Dissonance Theory (Festinger, 1957), Advertising Value (Ducoffe, 1996), and Dissonance Reduction Mechanisms (Festinger, 1962), were operationalized using scales previously validated in consumer behavior research. The constructs of Satisfaction and Purchase Intention were also adapted from well-established models in consumer research, ensuring their relevance to the study's objectives.

Data for the final analysis were collected via an online survey administered to 457 respondents, aged 18-29, within Vietnam. The data collection period spanned from August to December 2024. The sample comprised a mix of both students and young working professionals, with the majority being female. Participants reported a monthly income ranging from 3 to 25 million VND, which aligns with the demographic profile of active e-commerce shoppers. In terms of shopping behavior, the respondents were frequent users of popular e-commerce platforms, specifically TikTok Shop and Shopee, known for their high credibility

and widespread use in Vietnam. This sampling approach ensures that the data collected is relevant to the research objectives, as these platforms are particularly popular among young consumers for purchasing beauty and personal care products.

The data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM), with SmartPLS 4.0.9.2 software. PLS-SEM is an appropriate choice for this study, as it allows for the examination of complex relationships between latent constructs and can handle small to medium-sized samples while ensuring robust results in exploratory research. The five-point Likert scale was employed for all survey items, with responses ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). This scale provides a reliable method for capturing respondents' attitudes, perceptions, and behaviors in relation to the constructs under investigation.

Evaluation of the Measurement Model

For acceptable convergent validity, each latent variable's AVE should exceed 0.5 (Hair J. F., 2012). The AVE values, which range from 0.558 to 0.772, satisfy the criterion and provide evidence of convergent validity. Additionally, both Cronbach's alpha and composite reliability values surpass the 0.7 threshold (Nunnally, 1978), indicating satisfactory internal consistency reliability of the measures tested.

For discriminant validity, each factor's loading should exceed those of other factors within the same row (Hair J. F 2017). While a common threshold for acceptable communalities is 0.70, some scholars suggest 0.5. Our results indicate no cross-loading among variables.

Furthermore, Fornell and Larcker (1981) propose that discriminant validity is achieved when the square root of the AVE for each latent variable exceeds its correlations with other constructs. Table 1 confirms this criterion. Additionally, the structural model analysis, following (Hair J. F., An assessment of the use of partial least squares structural equation modeling in marketing research, 2014) approach, confirms the absence of multicollinearity, supporting hypothesis testing with all factors exhibiting VIF values below 5.

Table 2. Discriminant Validity – Fornell-Larcker

	Cognitive Dissonance (BH)	Satisfaction (HL)	Behavioral Change (HV)	Attitude Change (TD)	Entertainment Value (GT)	Stimulus Value (KT)	Informational Value (TT)	Purchase Intention (YD)
Cognitive Dissonance (BH)	0.908							
Satisfaction (HL)	0.130	0.866						
Behavioral Change (HV)	0.500	0.173	0.820					
Attitude Change (TD)	0.135	0.608	0.118	0.863				

	Cognitive Dissonance (BH)	Satisfaction (HL)	Behavioral Change (HV)	Attitude Change (TD)	Entertainment Value (GT)	Stimulus Value (KT)	Informational Value (TT)	Purchase Intention (YD)
Entertainment Value (GT)	0.191	0.411	0.144	0.366	0.756			
Stimulus Value (KT)	0.597	0.117	0.590	0.143	0.243	0.757		
Informational Value (TT)	0.592	0.082	0.490	0.069	0.255	0.571	0.883	
Purchase Intention (YD)	0.579	0.427	0.391	0.175	0.286	0.375	0.438	0.748

The bootstrapping procedure with 5000 samples was performed to evaluate the path coefficients (β). Table 4.7 shows the results of the path coefficients (β), associated T-values, P-values, and results. The path coefficients are considered significant when the observed t-value exceeds the critical values of 1.65, 1.96, and 2.57, corresponding to significance levels of 10%, 5%, and 1%, respectively (Hair Jr, Hult, Ringle, & Sarstedt, 2021). Regarding direct relationships, the results indicate that the T-value exceeds the critical value of 2.57 at the 1% significance level, supporting six out of the seven hypotheses, and the T-value surpasses the critical T-value of 1.96 at the 5% significance level, confirming one of the seven hypotheses.

Furthermore, the hypotheses in the model were tested through the bootstrapping procedure with 5000 resamples, using indicators such as the path coefficient β (-1;1), t-value (>1.96), and R-square (R²). The results from Table 4.7 show that all hypotheses were accepted, with the exception of the hypothesis "entertainment value \rightarrow cognitive dissonance," which was excluded due to P = 0.944.

Table 2. Results of Path Relationships in the Structural Model

Relationship	β	Std.	T values	P values	Results
Cognitive Dissonance \rightarrow Information Seeking Behavior	0.722	0.034	21.232	0.000	Accepted
Cognitive Dissonance \rightarrow Behavior Change	0.500	0.050	10.051	0.000	Accepted
Cognitive Dissonance \rightarrow Attitude Change	0.135	0.056	2.409	0.016	Accepted
Information Seeking Behavior \rightarrow Satisfaction	0.077	0.047	1.633	0.103	Accepted
Satisfaction \rightarrow Purchase Intention	0.427	0.048	8.908	0.000	Accepted
Behavior Change \rightarrow Satisfaction	0.062	0.045	1.364	0.173	Accepted
Attitude Change \rightarrow Satisfaction	0.591	0.038	15.476	0.000	Accepted

Relationship	β	Std.	T values	P values	Results
Entertainment Value \rightarrow Cognitive Dissonance	0.003	0.038	0.070	0.944	Removed
Stimulus Value \rightarrow Cognitive Dissonance	0.383	0.051	7.491	0.000	Accepted
Informational Value \rightarrow Cognitive Dissonance	0.373	0.048	7.769	0.000	Accepted

Table 2.2 presents the results of the path relationships in the structural model, showing the path coefficients (β), standard errors (Std.), t-values, p-values, and their significance levels. The findings indicate that most hypotheses were supported, as the t-values exceed the critical value of 1.96 for the 5% significance level, with p-values being less than 0.05. Specifically, the relationship between cognitive dissonance and behavior in information search ($\beta = 0.722$, t-value = 21.232) is highly significant, confirming a strong direct effect. Likewise, the path between cognitive dissonance and attitude change ($\beta = 0.135$, t-value = 2.409) is also statistically significant at the 5% level.

However, the relationship between entertainment value and cognitive dissonance ($\beta = 0.003$, t-value = 0.070) did not meet the significance threshold ($p = 0.944$), leading to the removal of this hypothesis. On the other hand, other relationships, such as the effect of information value on cognitive dissonance ($\beta = 0.373$, t-value = 7.769), showed strong positive associations, confirming the importance of information value in shaping cognitive dissonance.

The findings overall support the majority of the hypothesized paths, emphasizing the central role of cognitive dissonance in influencing consumer behavior, particularly among younger generations. Additionally, the results indicate that cognitive dissonance influences various consumer behaviors, including information search, attitude change, and purchasing intentions, which can further assist in refining marketing strategies targeting this demographic.

4. Discussion and Conclusion

Annoying advertising has become increasingly prevalent in the digital age; however, its psychological impact on consumers, particularly Generation Z, remains complex. According to **Cognitive Dissonance Theory**, when individuals experience a conflict between their beliefs and behaviors, they tend to reduce this dissonance by adjusting their thoughts or actions. In the context of annoying advertising, Gen Z—known for its strong reactions to unwanted marketing content—often perceives excessive or irrelevant advertisements as disruptive and irritating.

This negative perception can lead to two opposing behavioral outcomes. On the one hand, consumers may develop an aversion to brands that employ annoying advertising techniques, thereby reducing their motivation to purchase. On the other hand, repetitive exposure to advertisements may lead to subconscious brand recognition, which could influence purchasing decisions in the long run. However, if the perceived annoyance outweighs the perceived value of the product, cognitive dissonance may prompt consumers to actively avoid the brand, use ad-blocking tools, or seek alternative products with less aggressive marketing strategies.

To mitigate the adverse effects of annoying advertising, brands must adopt a more consumer-centric approach by personalizing content, ensuring relevance, and minimizing disruptions to user experiences. Such strategies not only reduce cognitive dissonance but also foster positive brand perception, ultimately encouraging sustainable consumer engagement and purchasing behavior.

This study provides compelling evidence that Cognitive Dissonance Theory plays a significant role in shaping the consumption behavior of Generation Z, particularly in the context of digital advertising. The findings underscore that when there is a perceived conflict between consumers' personal values and their actual consumption behaviors, a state of cognitive dissonance arises, resulting in psychological discomfort. This discomfort is rooted in the inconsistency between an individual's internal beliefs or values and the external actions they undertake, such as purchasing decisions influenced by advertising. The study highlights that cognitive dissonance is not only a prevalent psychological phenomenon but also a critical driver of behavioral change, particularly in younger consumers who are increasingly attuned to issues of ethics, environmental sustainability, and social responsibility.

The negative psychological effects associated with cognitive dissonance—such as regret, guilt, and anger—serve as powerful motivators for Generation Z to alter their consumption behavior. These emotions, which arise when individuals recognize the misalignment between their values and their actions, often prompt consumers to engage in dissonance-reducing behaviors. Such behaviors may include changing attitudes toward the product or brand, seeking additional information to reinforce their initial beliefs, or even avoiding brands or products that are perceived to conflict with their ethical or moral standards. This aligns with Festinger's (1957) assertion that individuals are motivated to resolve dissonance through attitude or behavior adjustments, and it reinforces the idea that younger consumers are more likely to exhibit these changes as a coping mechanism against discomfort.

The study's findings provide empirical support for the hypothesis that Cognitive Dissonance Theory can be used not only to explain but also to predict consumer responses to conflicts between personal values and consumption choices. In particular, Generation Z appears more sensitive to inconsistencies between their consumption habits and their ethical or social values, which suggests that they are highly motivated to seek out brands that align with their beliefs. This is especially pertinent in the context of advertising, where intrusive or misleading ads may exacerbate the dissonance between consumers' values and their purchasing behaviors. For businesses, this implies that advertising strategies must be carefully crafted to avoid generating cognitive dissonance, as such emotional discomfort can lead to negative attitudes toward the brand, reduced purchase intention, and potential consumer disengagement.

The study also highlights that the values communicated through advertisements—such as informativeness, entertainment, and perceived irritation—have a substantial and distinct impact on the consumer psychology of Generation Z. Consumers who perceive advertisements as informative or entertaining are more likely to experience positive emotional responses, which in turn reinforces favorable attitudes toward the brand. However, advertisements perceived as intrusive or irritating are more likely to trigger cognitive dissonance, especially when these ads conflict with the consumer's values or expectations. This finding further emphasizes the need for advertisers to carefully balance the informativeness and entertainment value of their ads while avoiding intrusive tactics that may alienate consumers.

In addition to the theoretical contributions, the practical implications of this study are significant for marketers and businesses. The findings suggest that advertisers targeting Generation Z must adopt strategies that resonate with the ethical and social values of this demographic. Given the heightened sensitivity of younger consumers to issues such as environmental sustainability, corporate social responsibility, and ethical practices, businesses must ensure that their advertising messages align with these values to prevent dissonance and foster positive consumer engagement. Furthermore, advertisements should prioritize delivering value in the form of relevant information and entertainment to enhance consumer satisfaction and reduce negative emotional responses, such as irritation or frustration.

In conclusion, this study reinforces the importance of Cognitive Dissonance Theory in understanding and predicting consumer behavior, particularly within the context of digital advertising aimed at Generation Z. By recognizing the psychological mechanisms that underlie consumer responses to advertising, businesses can refine their marketing strategies to minimize cognitive dissonance and optimize consumer satisfaction. Future research could further explore the nuances of dissonance reduction strategies in various consumer segments and industries, as well as investigate the long-term effects of cognitive dissonance on brand loyalty and consumer advocacy. This research contributes to a more nuanced understanding of the complex relationship between advertising, consumer values, and behavior, offering valuable insights for businesses aiming to enhance their marketing efforts in an increasingly competitive and ethically-conscious marketplace.

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The Approach to Developing the Implementation of Policies for Preventing Teenage Pregnancies in the Northeastern Region

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Abstract

This academic article aims to present guidelines for developing the implementation of adolescent pregnancy prevention policies in Northeastern Thailand. It covers the challenges and obstacles in policy implementation, proposed developmental strategies, conclusions, and recommendations.

Keywords: Development Guidelines, Policy, Adolescent Pregnancy, Northeastern Thailand

Introduction

The Northeastern region of Thailand faces issues related to teenagers, particularly teenage pregnancies. Teenage pregnancy is a social problem that affects health, families, and the economy of the country. The Thai government has prioritized this issue by developing policies and strategies to prevent and address the problem among teenagers. These policies focus on promoting knowledge, understanding, and access to appropriate health services. Kalasin Province is one of the areas experiencing a high level of this issue. Evaluating the implementation of these policies in the region is crucial to improving strategies and enhancing the effectiveness of the measures used (Ministry of Public Health, 2021).

Teenage pregnancy is a problem with social and economic impacts on various dimensions, especially in the Northeastern region of Thailand, which has the highest teenage pregnancy rate in the country. The Thai government places great importance on policies to prevent teenage pregnancies. However, the implementation of these policies in the region still faces several challenges. This article aims to propose approaches for developing the effective implementation of these policies in the Northeastern region (UNFPA Thailand, 2019).

Objective

To present The approach to developing the implementation of policies for preventing teenage pregnancies in the Northeastern region.

Content

The importance of the problem: Data from health agencies indicate that the teenage pregnancy rate in the Northeastern region continues to rise. Factors contributing to this issue include a lack of sexual education, cultural attitudes that do not promote prevention, and limited

access to healthcare services. Addressing this problem requires an approach that is tailored to the specific context of the region

The Prevention and Resolution of Teenage Pregnancy Act, B.E. 2559, was enacted to promote the integration of efforts and ensure that all parties work together effectively. The National Strategy Plan for the Prevention and Resolution of Teenage Pregnancy for the fiscal years 2015-2024 includes Strategy 1: Develop an education system that promotes comprehensive sexual education and life skills with appropriate support services. The first objective is to ensure that teenagers receive education in sexual health and life skills. To achieve this goal, it is necessary to establish a comprehensive sex education curriculum that covers sexual health, reproductive health, and essential life skills (Nittaya Pensirinpah, 2021).

The **Prevention and Resolution of Teenage Pregnancy Act, B.E. 2559** addresses the issue of teenage pregnancy in Thailand, which affects all levels of society. The problem is complex and cannot be solved by the authority of a single agency alone, making it necessary to establish a mechanism for policy-making, strategy development, and joint action by all relevant agencies, including government bodies, private sector organizations, and civil society. Section 5 of this Act states that "Teenagers have the right to make decisions for themselves and the right to receive information and knowledge, reproductive health services, confidentiality, privacy, social welfare on an equal basis, without discrimination, and other rights as provided under this Act, in a correct, complete, and adequate manner." The Act also outlines the roles and responsibilities of various agencies, with one of the key roles being that of "educational institutions," which are tasked with preventing and addressing teenage pregnancy by:

1. Providing age-appropriate sexual education for students.
2. Ensuring the availability of trained educators to teach sexual education and provide counseling.
3. Implementing systems for the care, assistance, and protection of pregnant students, ensuring they continue their education in a suitable and uninterrupted manner, while also facilitating their access to reproductive health services and social welfare as needed.

Meanwhile, "healthcare services" are also required to take action as outlined in the Act. 1) 1) Provide accurate, complete, and sufficient information and knowledge about the prevention and resolution of teenage pregnancy to teenage clients. 2) Ensure the provision of counseling services and reproductive health services that meet standards and align with the rights outlined in Section 5, including establishing a referral system for appropriate social welfare support.

"Employers" with teenage employees are required to prevent and resolve teenage pregnancy by providing information and knowledge, or supporting teenage employees in accessing counseling and reproductive health services. Additionally, a referral system should be in place to ensure they receive appropriate social welfare services. "Local governments" have the authority and responsibility to ensure that teenagers within their jurisdiction receive the rights outlined in Section 5. It is clear that the **Prevention and Resolution of Teenage Pregnancy Act, B.E. 2559** defines the rights of teenagers regarding access to information, knowledge, and reproductive health services, which all relevant sectors must follow (Nittaya Pensirinpah, 2021).

The problems of teenage pregnancy in the Northeastern region are as follows: 1) The highest pregnancy rate in the country: According to data from the Ministry of Public Health, the Northeastern region has the highest teenage pregnancy rate in Thailand. Contributing factors include economic, social, and educational factors. 2) Cultural and social factors: Teenagers in rural areas often face limitations in sexual education knowledge, as well as community attitudes that do not encourage proper use of contraceptive methods. 3) Limited

access to healthcare services: Rural areas in the Northeastern region face challenges due to a lack of adolescent health clinics, specialized personnel, and health resources. 4) Economic and social impacts: Teenage pregnancy directly impacts youth education, the economic stability of families, and the overall development of communities (National Economic and Social Development Board, 2020). **Problems and obstacles in the implementation of policies.**

1. Inconsistency between policies and local context: National-level policies are often not adapted to the economic, social, and cultural conditions of the Northeastern region.

2. Lack of cooperation between agencies: Fragmented implementation and insufficient communication between government agencies and communities. 3

3. Lack of resources: Limited personnel, budget, and educational materials (Adolescent Health Promotion Program, 2020).

Approaches for development

1. **Adapt policies to the local context:** Conduct local-level data surveys to design policies that are appropriate for the area, and promote community participation in planning and decision-making.

2. **Enhance sexual education and knowledge:** Provide training for teachers and healthcare personnel to deliver accurate information, and create easy-to-access educational materials that are suitable for teenagers.

3. **Build a network of cooperation:** Encourage collaboration between the government, private sector, and non-governmental organizations, and promote the role of community leaders and religious organizations in supporting teenage pregnancy prevention.

4. **Improve access to healthcare services:** Increase the number of adolescent health clinics in rural areas and reduce economic and social barriers to accessing healthcare service

Conclusion

Preventing teenage pregnancy in the Northeastern region requires integrated actions that are tailored to the specific context of the area. The approach proposed in this article focuses on improving policies, enhancing education, building a network of cooperation, and developing access to healthcare services (Smith, R., & Johnson, K., 2021). If these approaches are implemented effectively, they will help reduce teenage pregnancy and improve the quality of life for youth in the Northeastern region in a sustainable manner.

To successfully implement teenage pregnancy prevention strategies in the Northeastern region, it is essential to focus on integrated efforts at all levels, from comprehensive policy planning to practices that address the needs of the community. Particularly, the involvement of youth in the process of developing solutions will help foster understanding and acceptance of the proposed measures (World Health Organization, 2020). Additionally, modern technologies and media should be used to enhance learning and improve access to information for teenagers effectively. When these approaches are implemented together, they will help reduce the teenage pregnancy rate and create a secure future for the youth in this region.

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Cultural Identity Preservation in Association with Tourism Development of the H’Mong People in Si Ma Cai District and Bac Ha, Lao Cai Province, Vietnam

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Abstract

The H’Mong people in Si Ma Cai and Bac Ha districts, located in Lao Cai Province, Vietnam, possess a rich cultural heritage and profound humanistic values. This heritage serves as a distinctive tourism resource that draws numerous visitors. Through a SWOT analysis and an evaluation of achievements, challenges, and their underlying causes, this article presents ten solutions to strengthen cultural preservation while promoting sustainable tourism development. These proposed solutions aim to assist local communities and authorities in advancing economic, cultural, and social progress.

Keywords: Cultural preservation, H’Mong culture, tourism, Si Ma Cai, Bac Ha

1. General Introduction to H’Mong Culture in Si Ma Cai and Bac Ha Districts

Si Ma Cai and Bac Ha are mountainous districts in the Northwest Region of Vietnam. These districts boast diverse cultural landscapes and a rich heritage, contributing significantly to Lao Cai Province's economic growth and playing a vital role in safeguarding the unique cultural values of ethnic minorities. Among these, the H’Mong culture stands out as particularly remarkable.

The H’Mong people in Si Ma Cai and Bac Ha districts primarily engage in mountainous agricultural activities. They hold a rich and distinctive cultural heritage that encompasses their language, traditional costumes, customs, festivals, and community practices, reflecting the lifestyle of highland agricultural societies. Their primary livelihoods revolve around cultivating rice, corn, and potatoes, alongside livestock and poultry farming.

Comprising over 90% of the population, the H’Mong people exert a profound influence on the cultural traditions of other ethnic groups in the region.

1.1. The H’Mong People’s Housing

The housing of the H’Mong people in Si Ma Cai and Bac Ha is characterized by remarkable diversity, reflecting their adaptation to the harsh climates and rugged terrains of the region. Traditionally, their homes are built using rammed-earth and wooden materials, designed to endure severe weather conditions. These structures are typically constructed on elevated ground to prevent dampness during the rainy season, combining simplicity with functionality to optimize space for living and storage.

Furthermore, the H'Mong people place significant emphasis on building barns for livestock and poultry, such as cows, goats, and pigs. These barns are usually located close to the house to facilitate care and protect the animals effectively.

1.2. Traditional Handicrafts and Costumes of the H'Mong People

The H'Mong people in Si Ma Cai and Bac Ha are renowned for their traditional handicrafts, particularly brocade weaving. H'Mong brocade is crafted from natural fibers such as cotton or linen and features intricate geometric designs and unique hand-embroidered patterns. These brocade products serve various purposes, including costumes, handbags, blankets, and household decorations.

H'Mong women's traditional costumes are especially striking, characterized by vibrant colors and meticulous designs. Their shirts and skirts are carefully tailored, featuring elaborate embroidery and seams. Women's shirts are form-fitting with slits on both sides, complemented by brocade belts. Bright colors such as red, blue, and yellow, combined with geometric patterns, enhance the visual appeal of their attire. Additionally, H'Mong women often wear distinctive headscarves adorned with embroidered motifs.

H'Mong men typically wear brocade shirts, long pants, and hats, which, like women's clothing, reflect their cultural identity. Beyond their aesthetic value, these traditional garments convey important social meanings, signifying age, family roles, and social status within the community. While such garments are now mostly worn during festivals, weddings, and other cultural events, their significance remains integral to H'Mong identity.

In addition to brocade weaving, the H'Mong people excel in crafting household items and silver jewelry. Silverware, often elaborately carved, holds both decorative and symbolic importance, especially during festivals and weddings, where it represents power and social prestige.

1.3. Language

The H'Mong people in Si Ma Cai and Bac Ha communicate using the Mong-Dao language group, which encompasses a rich array of dialects. While variations in pronunciation, vocabulary, and grammar exist among different regions, these dialects share common linguistic features that enable mutual understanding within the community.

Additionally, many H'Mong individuals have developed proficiency in their traditional writing system, preserving their linguistic heritage. This writing system plays a significant role in documenting cultural practices, oral traditions, and community knowledge, contributing to the transmission of cultural identity across generations.

1.4. Beliefs and Religions

The beliefs of the H'Mong people in Si Ma Cai and Bac Ha are deeply rooted in polytheism, with a strong focus on ancestor worship, nature spirits, and guardian deities. Guardian deities are often honored in private homes or at community temples located in sacred areas. The H'Mong people also maintain a profound connection to supernatural forces, believing in their ability to bring prosperity, ensure good harvests, and protect families from misfortunes. To express their gratitude and seek blessings, the H'Mong people frequently organize ceremonies that involve offerings and rituals. These ceremonies reflect their close relationship with nature and their efforts to maintain harmony between the physical and spiritual realms. In recent years, some H'Mong communities in these districts have adopted

Protestantism, integrating new religious practices while still preserving aspects of their traditional beliefs.

1.5. Festivals and Rituals

Festivals and rituals hold a central place in the spiritual and cultural life of the H'Mong people in Si Ma Cai and Bac Ha. Key rituals include ancestor worship ceremonies and nature deity worship, which are performed during important occasions such as the New Year, crop festivals, and weddings. One of the most prominent festivals is the Gau Tao Festival, celebrated to pray for health, prosperity, and good fortune. These festivals and rituals are not only opportunities for the H'Mong people to honor their ancestors and deities but also serve as vital social events. They strengthen community bonds, promote solidarity, and allow for the exchange of cultural practices. Through vibrant dances, traditional music, and ceremonial activities, the H'Mong people express their gratitude, joy, and unity, showcasing their rich cultural heritage.

2. Assessment of the Current Status of H'Mong Cultural Preservation in Association with Tourism Development in Si Ma Cai and Bac Ha

2.1. SWOT Assessment

Strengths (S):

- S1: The diverse and uniquely distinctive H'Mong culture in Si Ma Cai and Bac Ha serves as a valuable tourism resource. Key attractions include rammed-earth houses, traditional handicrafts (sewing and embroidering costumes), H'Mong cuisine (e.g., Sin Cheng duck and duck eggs, seven-color sticky rice, Chung cake, and corn wine with special yeast), vibrant festivals, worship ceremonies, and folk arts.
- S2: The majority of H'Mong people in Si Ma Cai and Bac Ha possess a strong awareness of their cultural values. They express pride and affection for their ethnic identity, coupled with a strong commitment to preserving and protecting their cultural heritage.
- S3: Within the H'Mong community, artists, shamans, and cultural custodians play an essential role in safeguarding traditional culture. These individuals hold in-depth knowledge of cultural traditions and actively pass them down to younger generations.
- S4: Sacred cultural rituals, such as ancestor worship and forest-worship ceremonies, remain integral to the H'Mong worldview. These practices contribute significantly to preserving and perpetuating ritualistic cultural elements within the community.
- S5: Many traditional cultural practices continue to hold relevance in modern life. These include cultural expressions in education, labor practices, entertainment, and social customs, which remain deeply ingrained in daily activities.
- S6: Most H'Mong households express interest in utilizing their cultural heritage as a foundation for developing tourism products. This interest fosters job creation, household economic development, and the broader integration of culture with economic opportunities.

Weaknesses (W):

- W1: The promotion of H'Mong cultural values and tourism in Si Ma Cai and Bac Ha remains limited due to inadequate infrastructure, including transportation, accommodation, and other essential services, which fail to meet the needs of tourists effectively.

- W2: The lack of systematic documentation and preservation of H’Mong cultural practices has resulted in some traditional values and practices being lost or distorted over time.
- W3: While the majority of H’Mong people express pride in their culture, a portion of the younger generation shows diminishing interest in traditional customs, influenced by external cultural trends and modernization.
- W4: Tourism activities in the area often focus heavily on economic development without adequate emphasis on cultural preservation, leading to the commercialization and potential loss of authenticity in certain cultural practices.
- W5: Limited access to financial resources and training for local people hinders the development of community-based tourism initiatives, which could otherwise strengthen cultural preservation efforts and improve economic conditions.

Opportunities (O):

- O1: Increasing global and domestic interest in cultural tourism provides a significant opportunity for the H’Mong people in Si Ma Cai and Bac Ha to showcase their unique cultural heritage to a wider audience.
- O2: Support from local authorities and non-governmental organizations for cultural preservation and sustainable tourism development has created favorable conditions for promoting H’Mong culture.
- O3: The growing trend of ecotourism and community-based tourism aligns well with the cultural and natural assets of Si Ma Cai and Bac Ha, offering potential for integrating tourism with cultural preservation.
- O4: Advances in technology and digital platforms enable the H’Mong community to document, promote, and market their cultural heritage more effectively to tourists and researchers.
- O5: Collaboration with neighboring regions and ethnic groups in Lao Cai Province offers opportunities to develop comprehensive cultural and tourism networks, enhancing the overall appeal of the area.

Threats (T):

- T1: The rapid development of tourism in Si Ma Cai and Bac Ha, if not properly managed, risks leading to over-commercialization and the degradation of authentic cultural values.
- T2: Environmental challenges such as deforestation, land erosion, and climate change pose significant threats to the sustainability of agricultural and cultural practices in the region.
- T3: External cultural influences, driven by globalization and modern lifestyles, could erode the traditional values and identity of the H’Mong community.
- T4: Competition from other ethnic minority groups and tourist destinations in Vietnam presents challenges in attracting and retaining visitor interest.
- T5: A lack of comprehensive policies and long-term planning for cultural preservation and tourism development may result in fragmented and ineffective efforts to address the region’s challenges.

2.2. General Assessment Achievements:

The cultural heritage of the H’Mong people in Si Ma Cai and Bac Ha is remarkably rich, diverse, and unique, embodying profound humanistic values. This heritage has become a distinctive tourism resource capable of attracting visitors.

The H’Mong people in these areas demonstrate strong awareness of the importance of their cultural heritage and actively engage in its preservation. Many cultural elements remain well-conserved and are seamlessly integrated into their daily lives.

Local authorities have prioritized the preservation and promotion of H’Mong cultural heritage through supportive policies, infrastructure development, and financial assistance. Various programs and projects have been implemented, yielding significant and encouraging outcomes.

Numerous cultural heritages have been restored and preserved through collaboration between the H’Mong people and local authorities. Some of these heritages have been developed into tourism products, contributing to job creation, income generation, and improved household economies.

Additionally, certain cultural heritages have been digitized to ensure their long-term preservation and broader promotion.

Existing Limitations:

A large proportion of H’Mong people, particularly among the younger generation, possess only a superficial understanding of their cultural heritage. The knowledge of origins and meanings behind cultural elements is largely confined to a few elders, artists, and shamans, putting the heritage at risk of being lost.

Cultural heritages restored through state-supported projects are often neglected or abandoned once the projects conclude.

Some restored cultural heritages have become overly formalized, disregarding their core values or the environmental contexts in which they originated. This has resulted in hybridization and a loss of authenticity.

Traditional practices, such as brocade weaving, are increasingly replaced by foreign products like Chinese and Thai brocade, as well as modern cultural practices.

Certain cultural heritages leveraged for tourism lack effective marketing strategies or fail to attract sufficient visitors, resulting in underutilized local tourism resources.

Tourism infrastructure in H’Mong areas remains underdeveloped, hindering sustainable tourism growth.

Efforts to digitize cultural heritage face significant challenges due to limited budgets, insufficient equipment, and technical difficulties.

Causes of Shortcomings and Limitations:

Objective Causes:

- Policies aimed at preserving cultural heritage are not always well-adapted to local realities, leaving many issues unresolved.
- The mountainous terrain of Si Ma Cai and Bac Ha poses challenges for infrastructure development, particularly in transportation and tourism facilities.
- The H’Mong economy, predominantly reliant on agriculture and livestock farming, is characterized by high poverty rates. Many households lack the financial resources to invest in tourism services.
- Difficult living conditions force families to focus on immediate survival, often at the expense of preserving cultural traditions.
- Cultural heritage preservation is inherently complex, as it involves interrelated elements that evolve alongside societal and historical trends.

Subjective Causes:

- Some local officials lack the necessary experience and expertise in managing cultural heritage preservation, resulting in ineffective guidance and strategies.

- Dependence on state support has discouraged proactive efforts among the H’Mong people to independently preserve their cultural heritage.
- A lack of awareness regarding the long-term value of cultural heritage has led to improper exploitation and distortion of traditions.
- Insufficient training in heritage preservation for tourism development has limited the effectiveness of local initiatives.
- Unsuccessful attempts to monetize cultural heritage have discouraged further preservation efforts.
- Younger generations often show a preference for foreign cultures, which undermines traditional practices.
- Some H’Mong individuals are reluctant to digitize their cultural heritage due to sacred beliefs surrounding its preservation.

3. Solutions for Preserving the Cultural Heritage of the Mong People in Si Ma Cai, Bac Ha, in Association with Tourism Development

	Solution Group	Key Points
1	Policies and Mechanisms	Develop regulations, preferential policies for investment, and low-interest loans for communities.
2	Digitizing Cultural Heritage	Record and store H’Mong cultural elements; use VR/AR technologies; develop digital platforms.
3	Environmental Protection	Preserve ecosystems, construct green infrastructure, and manage waste at tourist sites.
4	Human Resource Training	Train locals in tourism services, including guiding, hospitality, and cultural product development.
5	Tourism Promotion	Use social media, organize events, and hold press conferences to market H’Mong culture effectively.
6	Infrastructure Development	Attract ODA, local budgets, and other resources to improve transportation and tourism facilities.
7	Regional Connectivity	Strengthen connections with major tourist hubs like Hanoi, Quang Ninh, and Sa Pa.
8	Exploiting Cultural Heritage	Develop unique tourism products based on H’Mong cultural heritage; create commercialized items like brocade handbags, wallets, or eco-friendly souvenirs
9	Investment Mobilization	Mobilize state capital, enterprise capital, and cultural resources from the community to develop tourism infrastructure and services
10	Propaganda and Education	Use traditional and modern communication channels to raise awareness about H’Mong cultural preservation and tourism development; build a team of influencers to support digital campaigns

3.1. Group of Solutions on Specific Institutions and Policies

3.1.1. Institutions

Institutions play a pivotal role in disseminating laws and regulations related to culture, sports, and tourism. Both formal institutions—such as laws, policies, and regulations—and informal institutions significantly contribute to preserving the cultural heritage of the H’Mong people in Bac Ha and Si Ma Cai. Among informal institutions, the village covenant serves as

a critical tool; however, its application has not been fully leveraged in the daily lives of the H'Mong people in these districts.

To enhance its effectiveness, the village covenant should be revised and supplemented to function as a guiding framework for the community. It establishes community standards and sanctions, formulated with input from village elders and household heads. Key issues addressed in village covenants include dispute resolution, ensuring public security, forest conservation, and managing other communal matters.

These covenants are traditionally established through oral agreements during sacred ceremonies, where the entire village pledges adherence in the presence of witnesses, including the village gods. The sacred nature of these covenants ensures strict compliance, as they represent the collective commitment and unified voice of the community. Sanctions for violations reinforce the authority of these covenants, but their true strength lies in the unity and collective agreement they foster among community members.

3.1.2. Policies and Mechanisms

The proposed solutions for policies and mechanisms include:

Develop and implement policies for the digitalization of cultural heritage conservation. Focus on establishing projects and community-based models for cultural heritage preservation, with particular attention to support from ministries and provincial resources. Additionally, policies should be created to support artists and cultural practitioners.

Introduce banking policies for low-interest loans to households. These loans should enable families and villages to establish experimental models for cultural heritage preservation and tourism development.

Provide preferential tax and credit policies to encourage businesses to bring tourists to community tourism areas. This includes tax reductions and preferential loan options.

Create policies to attract direct investment (FDI), joint ventures with foreign countries, and sponsorship capital for tourism development. Prioritize the upgrading of transportation systems, electricity supply, clean water systems, waste treatment, sanitation, and communication infrastructure.

Encourage domestic investment through increased joint ventures and incentives under investment law to develop hotels, restaurants, eco-tourism areas, and other facilities.

Permit diverse investment types, including 100% foreign-owned projects, particularly for infrastructure development.

Offer time-limited tax exemptions or reductions for investment projects focused on high-quality tourism products with on-site export potential.

Establish mechanisms to support training and coaching in tourism skills, information dissemination, and promotion. Develop a comprehensive tourism development strategy to attract businesses to invest in Bac Ha and Si Ma Cai districts.

3.2. Group of Solutions for Mobilizing Resources from Stakeholders in Preserving Cultural Heritage Associated with Tourism Development

3.2.1. State Capital

The People's Committees of Si Ma Cai and Bac Ha districts should lead efforts to integrate various projects into a comprehensive tourism development program. This program should aim for diverse goals with a unified objective: improving the livelihoods of the H'Mong people. State capital allocation should adhere to the principle of "teaching people to fish, not giving them fish," prioritizing areas such as infrastructure development, planning, tourism product design, brand building, promotion, implementation of tourism models, and evaluation of their effectiveness.

Experience from other localities highlights the risks of dependency when funds are allocated to communities without proper guidance. Communities often abandon tourism models once projects conclude, undermining long-term sustainability.

3.2.2. Enterprise Capital

Enterprise investment is critical; however, the involvement of businesses in community tourism should be limited to roles such as guest reception and tourism promotion. Over-involvement risks diminishing local income, as it may turn the H'Mong people, who are the rightful stewards of cultural resources, into mere employees for external entities.

Effective land management is crucial to prevent unchecked land sales that might lead to the H'Mong people losing their land and homes. Such practices could trigger social conflicts and force community members into dependency on external businesses, jeopardizing the long-term sustainability of tourism development.

3.2.3. Cultural Resources of the Community

Cultural resources are the most valuable assets of the H'Mong people, possessing both functional and intrinsic value. These resources form the foundation for sustainable tourism development. Recognizing the H'Mong community as both the rightful owners and stewards of these cultural assets is essential.

In addition to cultural heritage, the community can contribute other valuable resources, such as human capital and land, to effectively support tourism development while maintaining their ownership and control.

3.2.4. Consulting Knowledge Capital of Scientists

Preserving cultural identity while utilizing it for tourism development in Si Ma Cai and Bac Ha requires innovative, market-oriented strategies. These include effective planning, product development, promotion, brand positioning, and sales. Expert consultations are essential for successfully implementing these stages, as demonstrated by other successful community tourism models in Vietnam.

3.2.5. Scientific and Technological Resources, Especially Digital Technology

The mobilization of scientific and technological resources, particularly green and clean technologies, is increasingly vital for sustainable tourism development. The application of digital technology in marketing and tourism promotion has grown significantly in Vietnam, utilizing online platforms, electronic information pages, and digital tourism publications.

Many businesses now employ e-marketing strategies to streamline operations, enhancing efficiency and expanding reach in the tourism sector. This approach is widely adopted in Vietnam and has proven effective in boosting the visibility and appeal of tourism destinations.

3.3. Group of Solutions to Protect the Environment in Preserving H'Mong Cultural Heritage Associated with Tourism Development

3.3.1. Protecting the Ecological Environment

Protecting the ecological environment of H'Mong villages involves preserving the natural landscape, maintaining ecological systems, and minimizing the negative impacts of economic and tourism development. Efforts should focus on:

Developing tourist landscapes that highlight typical regional flora, such as Tam Hoa plum, Tai Nung pear, peach blossoms, and buckwheat flowers.

Ensuring that construction projects (e.g., roads, civil works, houses) respect the traditional landscape of H'Mong villages by establishing strict regulations and reward-punishment mechanisms.

Promoting hygiene and landscape improvements in families, villages, and along village pathways. Integrating national rural development programs to build septic tanks, biogas

pits, and implement composting processes for organic fertilizer production, thus utilizing livestock waste effectively.

It is essential to plan and designate areas that retain the traditional cultural features of the H'Mong people, with specific policies to support environmental and biodiversity protection. Investments should be made to establish waste and wastewater collection and treatment facilities at tourist sites within H'Mong villages.

Additionally, attention should be given to forest, land, and water protection, preserving local natural resources for tourism. Environmental protection tasks must be integrated into tourism development planning, including conducting environmental impact assessments for new projects.

3.3.2. Protecting the Social and Tourism Environment

Efforts to protect the social and tourism environment should include:

Establishing stations and wharves equipped with modern, safe, and suitable facilities; developing safety plans and first-aid measures for emergencies.

Strengthening inspection and supervision to maintain security and sanitation at tourist attractions in H'Mong villages. This includes ensuring order, combating social evils, and strictly addressing activities that endanger tourists.

Coordinating with local military agencies when organizing tours, especially for foreign tourists, to prevent issues related to political security, social order, and national defense in border areas.

Creating a department dedicated to monitoring tourism safety and security, operating either full-time or part-time.

Key Investments:

Prioritize programs to preserve the cultural heritage of H'Mong villages in Si Ma Cai and Bac Ha. This includes upgrading infrastructure, building a H'Mong cultural center associated with a tourism information hub, and improving access to villages through clean water systems, roads, and landscaping.

Organize training programs to enhance the professional skills of guides, coaches, and technical staff for adventure tourism activities such as caving, waterfall exploration, and mountain climbing. Implement a comprehensive warning and guidance system for tourists engaging in adventure activities, ensuring 100% of adventure tours include safety training.

Community Support and Incentives:

Develop policies to support local residents in creating and running community and cultural tourism training courses, focusing on skills for integrating ecological and agricultural tourism.

Establish initial funding to create foundational tourism models. Once tourism products attract visitors, residents can collect fees to maintain the heritage and contribute to family economic growth.

Implement reward and punishment mechanisms to encourage activities that protect the ecological environment and biodiversity.

3.4. Group of Solutions to Exploit the Cultural Heritage of the H'Mong People in SMC&BH to Build Tourism Products

3.4.1. Choosing the Cultural Heritage of the H'Mong People to Build Tourism Products Suitable for the Needs of Tourists

Designing and building cultural tourism products for the H'Mong people requires a specific process. First, it is essential to study the cultural tourism resources and natural conditions of Bac Ha and Si Ma Cai districts. Research tourist attractions and develop ideas

based on tourists' needs. These ideas should be transformed into tourism products that highlight H'Mong cultural tourism.

The products must meet modern requirements, attract tourists, and, most importantly, be unique. Their distinctiveness should stem from the tourism resources and the "soul" of H'Mong culture. The process includes trial productions, tourist surveys, and collaboration with consultants, artists, and tourism businesses.

Products must target specific markets to cater to different tourist segments, such as domestic visitors, Chinese tourists, or European tourists.

They should adhere to principles of environmental protection, cultural preservation, and community benefit.

3.4.2. Expanding the Space for Experiencing the Cultural Heritage of Local Ethnic Groups

H'Mong cultural tourism products in Si Ma Cai and Bac Ha can be connected to cultural heritages in neighboring areas, such as Ha Giang, Sa Pa, and Mu Cang Chai, to create appealing tourist routes.

The role of travel agencies in building and promoting these routes is crucial. Collaboration with agencies specializing in tours to the Northern regions can enhance the visibility and attractiveness of H'Mong cultural tourism.

3.4.3. Creating H'Mong Cultural Tourism Products with High Commercial Value

Diversifying H'Mong cultural tourism products is essential. For instance, in brocade making:

Move beyond traditional items like dresses, shirts, or scarves to create handbags, wallets, laptop covers, home decor, and souvenirs.

Combine traditional weaving techniques with modern designs to appeal to broader audiences.

Use natural materials (linen, cotton) and eco-friendly dyeing methods to align with global “green” consumption trends.

3.4.4. Building Community Cultural Tourism Spots in H'Mong Villages/Hamlets

Planning H'Mong villages as community cultural tourism spots is an effective way to preserve cultural heritage and stimulate local economic development.

These villages can offer visitors an authentic experience of H'Mong cultural life, customs, and practices. Highlights include:

Traditional rammed-earth houses.

Handicrafts and artists' working spaces.

Additional services such as homestays, local cuisine, and folk art performances, providing visitors with a more comprehensive understanding of H'Mong culture.

Training residents in tourism service skills is essential to ensure they can confidently serve as hosts and promote their culture to international visitors.

3.5. Group of Solutions to Promote and Advertise Tourism

Tourism promotion involves market research, understanding tourist needs, and forecasting the potential for visits to villages and hamlets. It also includes analyzing customer behavior, competitor strategies, and implementing effective propaganda, promotion, and mobilization to attract tourists and encourage businesses to invest in local tourism activities.

3.5.1. Planning for Digitalization, Promotion, and Advertising of Tourism

Digitalization Plan: Digitalization is a complex task requiring significant investment. Therefore, the district should develop a comprehensive project for digitizing H'Mong culture to support tourism development.

Promotion and Advertising: These are essential measures to attract tourists to villages and hamlets and support tourism activities.

Survey and Evaluation: Conduct surveys to assess the strengths and weaknesses of tourism activities. Use this information to highlight strengths, address limitations, and improve the quality of tourism products for both residents and tourists.

Developing Promotion Goals: Set objectives based on service capabilities, facilities, tourist capacities, and the needs of both domestic and international tourists. Define expected visitor numbers and establish appropriate promotional strategies.

Choosing Promotion Channels: Identify suitable channels for promotion, such as television, social networks, and other media platforms.

3.5.2. Promoting H'Mong Cultural Tourism

Develop Marketing Slogans: Create a slogan based on survey results that highlights the strengths and uniqueness of tourism activities.

Building Promotional Tools: Leverage both traditional and modern information channels, including newspapers, magazines, television, radio, websites, and social media platforms.

Organize press conferences 15–30 days before major tourism events. These conferences can provide journalists and businesses with the necessary information to attract tourists. For example, Bac Ha and Si Ma Cai districts could hold annual press conferences in Hanoi or online at the start of the tourism season.

Event-Based Promotion: Use local cultural festivals and fairs as key opportunities to showcase and promote H'Mong cultural tourism products.

Expanding Online Presence: Promote H'Mong cultural tourism products through online platforms, combining traditional methods with modern technology to reach wider markets, both domestically and internationally.

International Outreach: Invite H'Mong artists to participate in international handicraft fairs or cultural exhibitions to introduce products to global audiences.

E-Commerce Platforms: Utilize e-commerce platforms to sell tourism products derived from H'Mong cultural heritage. These could include platforms such as Shopee, Lazada, Etsy, or Amazon to access broader markets.

3.6. Solutions for Training and Managing Human Resources

3.6.1. Solutions for Training and Fostering Human Resources

Training Objectives:

The goal is to train farmers to become proficient in tourism services. This includes developing skills in visitor reception, room arrangement, tourism service execution, culinary preparation, and souvenir and gift production.

Training Methods:

Organizing training classes with practical, hands-on content linked directly to tourism activities.

Facilitating visits and experiential learning programs, which are highly effective and easy for participants to absorb.

Collaborating with universities and colleges in Lao Cai province, non-governmental organizations, and consulting firms to offer specialized training courses for the community.

3.6.2. Group of Solutions to Strengthen the Management System

Establishing a robust tourism management board capable of coordinating tourism activities at the local level.

This board should play a pivotal role, especially in areas with adventure tourism, to: Provide direction and orientation for sustainable tourism development.

Act as a bridge connecting local communities, government agencies, businesses, and tourists.

3.7. Group of Solutions on Investment for Tourism Infrastructure Development

Continue implementing tourism development projects, programs, and plans aligned with the orientation outlined in the Party Congress resolutions of the districts.

Attract high-quality tourism investment projects, including entertainment areas, restaurants, luxury hotels, and innovative tourism types such as adventure tourism and ecological research tourism.

Promote socialization to develop infrastructure in tourist areas and attractions, prioritizing public facilities such as toilets, electricity systems, clean water, food and beverage services, and shopping centers.

Focus on preparing and submitting documents to authorities to recognize local tourist areas, routes, and attractions once all conditions are met.

Increase state capital allocation for tourism infrastructure development based on priority.

Regularly review and monitor the progress of tourism investment projects, addressing obstacles, and expediting implementation.

Propose the withdrawal or transfer of tourism projects that fail to meet progress requirements.

Strengthen the socialization of tourism investment by implementing policies and mechanisms that encourage high-end and innovative tourism product development.

Mobilize investment capital from various sources, including:

State budget allocations for tourism infrastructure.

ODA funding.

Provincial budgets.

Other legally mobilized resources to finance traffic works, cultural and sports facilities, and the restoration of cultural and historical relics.

Effectively implement state policies and provincial resolutions that support tourism development for ethnic minorities, enabling them to participate in tourism services.

Encourage businesses and households to access bank loans and state credit capital to upgrade and expand tourism projects and infrastructure.

Promote contributions from tourism income toward preserving and restoring ecological and cultural values, as well as fostering "green" tourism initiatives that adapt to climate change.

3.8. Solutions for Local, Regional, and Inter-Regional Connection

3.8.1. Raising Awareness of Connection and Tourism Development in Si Ma Cai, Bac Ha

Local authorities in Si Ma Cai and Bac Ha should establish close cooperation and clearly define the scope of tourism connection within the region and subregion. Key areas for cooperation include:

Developing regional tourism planning.

Unifying mechanisms and policies for managing tourism development.

Creating specific tourism products at both regional and local levels.

Developing new tourism products and exploring tourism markets.

Establishing programs for human resource development in tourism.

Promoting tourism through advertising and marketing.

Attracting investment for building tourism infrastructure.

3.8.2. Connection Content

Strengthening cooperation with major tourist centers across the country, such as Hanoi, Quang Ninh, Da Nang, and Ho Chi Minh City, as well as key tourist hubs in the Northwest region, including Sa Pa, Moc Chau, Dien Bien Phu, and neighboring localities like Mu Cang Chai, Lai Chau, and Ha Giang. Collaboration should also align with the model of the 8 Northwest provinces to enhance tourism competitiveness and sustainability. Particular attention should be paid to connections that highlight the cultural heritage of the H'Mong people.

Enhancing connections with the tourist route linking Sa Pa, Bac Ha, Si Ma Cai, and Muong Khuong.

Building and promoting tours and tourist routes based on the unique roles and responsibilities of each locality while creating recognizable brands for destinations.

Ensuring high levels of consensus and practicality in cooperation. This requires moving beyond formal agreements to establish tangible models, specific programs, and a clear roadmap for tourism connectivity.

3.9. Group of Solutions for Propaganda and Education

3.9.1. Research on the Specific Characteristics of Traditional Communication in the H'Mong Ethnic Group in Si Ma Cai, Bac Ha

Direct communication through village chiefs, elders, and other respected community members plays a vital role in quickly shaping public opinion and influencing collective decision-making.

3.9.2. Research on Communication Channels via Social Networks

Innovating communication methods in Si Ma Cai and Bac Ha involves the following approaches:

Shifting Communication Methods: Transition from direct tourism propaganda and mass media channels to indirect communication, with a primary focus on social networks.

Building a Team of Influencers: Identify and cultivate a team of bloggers from Si Ma Cai and Bac Ha. Each ethnic community or district should establish influential bloggers who can serve as collaborators for district and city cultural centers and cultural offices.

Transforming Cultural Office Functions: Redefine the roles of cultural offices and centers in Si Ma Cai and Bac Ha. The Cultural Center-District Radio Station should transition from being a direct propaganda unit to functioning as a service provider that supports communication and tourism promotion.

3.10. Digitizing the Cultural Heritage of the H'Mong People in Si Ma Cai, Bac Ha

3.10.1. Helping the H'Mong People Understand the Role of Digitizing Cultural Heritage

The entire collection of tangible and intangible cultural heritage of the H'Mong people should be photographed, recorded, and archived by specific topics, including houses, villages, costumes, music, dance, customs, folk songs, cuisine, and handicrafts. This digitization enables long-term storage and facilitates its use in promotion, propaganda, and the commercialization of tourism products.

3.10.2. Steps in Digitizing H'Mong Cultural Heritage for Preservation and Tourism Development

Digitizing cultural heritage involves recording and storing documentation on H'Mong culture in Si Ma Cai and Bac Ha. This includes high-resolution photographs, detailed videos, and written records of traditional practices. Furthermore, employing technologies such as virtual reality (VR) and augmented reality (AR) can enhance interactive experiences for both preservation and tourism. Developing a comprehensive digital platform to archive and

showcase H'Mong cultural heritage will facilitate access for researchers, tourists, and educators. Lastly, tourism products derived from these digital archives can be created, aligning with modern trends in cultural tourism.

3.10.3. Addressing Difficulties and Challenges in Digitizing Cultural Heritage

The digitization process faces numerous challenges, such as high investment costs, limited resources, and a shortage of experts in cultural heritage digitization.

To overcome these obstacles, particularly in remote areas like Bac Ha and Si Ma Cai, it is necessary to:

Establish a team of highly qualified experts in information technology, heritage conservation, and data management.

Provide training programs to develop expertise in these areas, despite the logistical and financial obstacles involved.

Address community resistance to change by raising awareness of the benefits of digitization. While digitizing cultural heritage is an effective solution for preservation and tourism development, not all communities readily accept these transformations.

Conclusion

H'Mong culture serves as a crucial resource for tourism development, playing a key role in establishing destination branding. The revenue generated from tourism not only supports the restoration and promotion of cultural heritage but also fosters sustainable practices. Proper utilization of cultural heritage mitigates adverse effects and maximizes positive impacts, thereby driving economic development, preserving cultural identity, improving social security, and safeguarding the environment.

The 10 groups of proposed solutions encompass mechanisms and policies, product development, heritage and environmental protection, resource coordination, capacity-building for cultural managers and the H'Mong people, propaganda and education, infrastructure improvement, and the application of digitization. If these solutions are implemented synchronously and comprehensively, they will be practical, feasible, and significantly enhance the effectiveness of heritage preservation and tourism development.

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Application of Digital Technology in Sustainable Tourism Management in Lao Cai Province

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Abstract

Lao Cai, located in the mountainous northwest region of Vietnam, is one of the country's top potential tourist destinations. Its highlights include renowned attractions such as Sa Pa, Y Ty, Bac Ha, and the summit of Fansipan. Lao Cai captivates visitors not only with its majestic natural landscapes but also with the rich cultural diversity of 25 ethnic groups. Ethnic minority villages have become appealing destinations, drawing millions of international and domestic tourists annually. However, rapid tourism growth has placed significant pressure on local natural resources and cultural heritage. This article explores how digital technologies, including Big Data, Artificial Intelligence, the Internet of Things, and mobile applications, can be leveraged for effective sustainable tourism management in Lao Cai. These technologies not only enhance management capabilities but also optimize customer experiences, minimize environmental impacts, and safeguard traditional cultural values. In addition to analyzing the potential benefits, the article proposes specific solutions such as building a centralized tourism database, developing smart applications integrating maps and online booking services, enhancing digital skills for management personnel and local communities, and fostering public-private partnerships in technological development. The adoption of digital technologies is not merely a trend but an imperative to ensure sustainable development, harmonizing economic growth with resource protection and cultural preservation in Lao Cai. This is an opportunity for the province to become a model for smart tourism in Vietnam.

Keywords: Lao Cai, digital technology applications, smart tourism, sustainability

1. Introduction

Lao Cai Province, located in the mountainous northwest region of Vietnam, boasts a unique geographic position that encompasses majestic natural landscapes and the vibrant cultural heritage of ethnic minorities. Renowned destinations such as Sa Pa, Y Ty, and villages of the H'Mong, Dao, and Tay ethnic groups have become familiar attractions for both domestic and international tourists. However, the rapid growth of the tourism sector has posed significant challenges, including environmental degradation, infrastructure overload at popular sites, and encroachment upon indigenous cultural values.

In this context, sustainable tourism management emerges as a critical factor to ensure economic development while protecting natural resources and preserving local cultural identity. Sustainable tourism management goes beyond regulating visitor numbers or planning infrastructure; it requires leveraging modern tools to monitor, manage, and optimize tourism activities more effectively.

Digital technology has demonstrated its importance across various fields, from industry and agriculture to education. In tourism, digital technology applications such as Big Data systems, Artificial Intelligence (AI), and mobile applications not only enhance management efficiency but also improve tourist experiences and minimize negative environmental impacts. When deployed effectively, these tools can address the current challenges in Lao Cai and pave the way for sustainable development in the local tourism sector.

With the aim of harnessing the potential of digital technology in tourism management, this article focuses on analyzing digital technology applications that can be implemented in Lao Cai, including data collection, environmental monitoring, and optimizing visitor experiences. It also proposes specific solutions to leverage digital technology effectively to achieve sustainable tourism development, contributing to the preservation of natural resources and the unique cultural values of the province.

2. Content

2.1. Overview of Digital Technology in Tourism Management

2.1.1. Concept of Digital Technology in Tourism

Digital technology in tourism, commonly referred to as “Smart Tourism,” is the integration of advanced technologies to enhance management efficiency, optimize customer experiences, and support sustainable development. According to Buhalis and Amaranggana (2015), smart tourism is built on a foundation of Big Data, Artificial Intelligence (AI), the Internet of Things (IoT), and Cloud Computing. These technologies not only facilitate management activities but also enable the prediction and analysis of tourism trends, creating personalized services and products tailored to the diverse needs of tourists.

The concept of “smart tourism” arises from the intersection of digital technologies and the increasing demand for improved services in the tourism industry. Xiang et al. (2015) suggest that smart tourism is not merely about the application of digital tools but represents a digitized ecosystem in which stakeholders—ranging from governments and businesses to tourists—are interconnected through digital platforms. This interconnectedness enables information to be shared quickly, transparently, and efficiently, improving decision-making processes and optimizing resource management.

One of the most notable features of digital technology in tourism is its ability to integrate data from various sources to provide real-time information. This capability is a core element enabling smart tourism destinations to respond flexibly to the rapidly changing market. Moreover, data integration facilitates the development of smart services, such as virtual tour guides, personalized itinerary recommendations, and alerts about overcrowding at tourist sites.

Additionally, digital technology expands the concept of “tourism services” from physical spaces to virtual realms. With the support of Virtual Reality (VR) and Augmented Reality (AR), tourists can pre-experience destinations through 3D simulations, helping them make choices that better align with their preferences and budgets.

The concept of digital technology in tourism not only reflects the application of modern technologies but is also closely linked to the philosophy of sustainable development. According to UNWTO (2018), smart tourism not only optimizes economic benefits but also minimizes negative impacts on the environment and culture. This is achieved through smart monitoring systems, such as environmental sensors, to track and manage pollution levels or the exploitation of natural resources at tourist destinations.

Thus, digital technology in tourism is a comprehensive concept encompassing technologies, methods, and modern management philosophies aimed at enhancing the value of tourist experiences, optimizing the efficiency of the tourism sector, and supporting sustainable

development. Understanding and implementing digital technology in tourism is not merely a trend but a necessity to address challenges and seize opportunities in the context of globalization and digitalization today.

2.1.2. The Role of Digital Technology in Tourism

Digital technology is reshaping the tourism industry, improving management efficiency, enhancing tourist experiences, optimizing business operations, and promoting sustainable development. Below are the key roles of digital technology in tourism, analyzed scientifically and in detail:

Enhancing Destination Management and Operations Efficiency: Digital technology enables tourism authorities to monitor and optimize operations effectively. The use of Big Data supports the collection and analysis of vast amounts of information related to tourist behavior, market demand, and tourism resources. This data provides critical insights for strategic planning and policy adjustments. For instance, major tourist cities like Amsterdam use IoT technology to monitor visitor density at attractions, allowing for better distribution of tourists and minimizing overcrowding (Gretzel, Sigala, Xiang, & Koo, 2015). Moreover, tools such as Customer Relationship Management (CRM) systems help tourism businesses maintain relationships with customers, enhancing efficiency in managing customer information and providing personalized care.

Personalizing Tourist Experiences: Artificial Intelligence (AI) and data analytics tools enable the delivery of personalized services tailored to the preferences and needs of individual tourists. This capability provides superior experiences, increasing customer satisfaction and loyalty. Online platforms like TripAdvisor and Airbnb use AI algorithms to recommend attractions, restaurants, or accommodations based on users' search behavior and reviews (Neuhofer, Buhalis, & Ladkin, 2015). Additionally, mobile applications offer real-time travel guidance, smart maps, and personalized support services, helping tourists save time and enjoy their trips more efficiently.

Supporting Tourism Promotion and Marketing: Digital technology has revolutionized tourism marketing, utilizing tools such as search engines, social media advertising, and content marketing. Personalized online advertising campaigns based on Big Data can target the right audience, reduce promotional costs, and enhance communication effectiveness. According to Xiang, Magnini, and Fesenmaier (2015), social media platforms like Facebook, Instagram, and TikTok have become powerful tools for building brands and increasing destination recognition. Visual content, such as videos and images, not only captures attention but also serves as a compelling motivator in destination selection.

Enhancing Conservation and Sustainable Development: A critical role of digital technology is its contribution to the conservation of natural and cultural resources, fostering sustainable tourism development. IoT sensor systems monitor environmental conditions at tourist destinations, providing data for effective resource management. In natural reserves, IoT sensors track visitor numbers and assess the impact of tourism activities on ecosystems, enabling timely measures to mitigate negative effects (UNWTO, 2018). Additionally, digital technology preserves and showcases cultural values through digitization platforms and virtual reality applications.

Strengthening Connectivity and Collaboration in Tourism: Digital technology facilitates connections among stakeholders in the tourism industry, including managers, businesses, and tourists. This digitized ecosystem enables quick, transparent, and efficient information sharing, improving coordination among participants. Online Travel Agencies (OTAs) such as Booking.com and Expedia directly link customers with service providers,

reducing the role of traditional intermediaries. This not only lowers costs but also increases competitiveness in the tourism market (Gretzel et al., 2015).

Driving Innovation in Tourism Products and Services: Digital technology acts as a catalyst for innovation in designing and delivering tourism products. Developments in Augmented Reality (AR) and Virtual Reality (VR) have introduced new forms of experiences. Tourists can participate in virtual tours, exploring historical sites or natural wonders without leaving their homes. Furthermore, tools such as digital maps or virtual tour guides enhance interactivity and engagement in tourism products. This has proven especially valuable during the COVID-19 pandemic, when traditional forms of tourism faced significant limitations. Digital technology plays a pivotal role in transforming the tourism industry, from destination management and personalized experiences to effective promotion, resource conservation, and sustainable development. These applications benefit stakeholders and enable the tourism industry to adapt and thrive in the context of increasing globalization and digitalization. Strategic adoption of digital technology will be key to building a modern and sustainable tourism industry in the future.

2.2. Current State of the Tourism Industry in Lao Cai

2.2.1. Achievements in Tourism Development in Lao Cai

Development of Tourism Infrastructure

In recent years, Lao Cai has made significant progress in building tourism-supporting infrastructure. The completion of the Noi Bai – Lao Cai Expressway in 2014 substantially reduced travel time from Hanoi to Sa Pa, cutting the journey from 8 hours to just 4 hours. This milestone has enhanced connectivity between Lao Cai and major economic hubs, creating favorable conditions for tourism development. It has also facilitated easier access for both domestic and international tourists, positioning Lao Cai as a central hub for tourism in the Northwest region of Vietnam.

Additionally, the Fansipan Legend cable car system, completed in 2016, now takes visitors from the Muong Hoa Valley to the summit of Fansipan – the “Roof of Indochina” – in just 15 minutes. This project not only makes the summit more accessible to tourists but has also become a symbol of modern tourism in Lao Cai.

Moreover, Lao Cai has seen substantial investments in its accommodation system. International standard hotels such as Victoria Sa Pa Resort & Spa and Hotel de la Coupole – MGallery, along with a network of homestays in local villages, cater to the diverse needs of tourists. These range from luxurious retreats to immersive cultural experiences, showcasing the province's versatility in meeting the expectations of various types of travelers.

Diversification of Tourism Products

Lao Cai has transformed from a traditional natural tourism destination into a hub offering a variety of tourism experiences, catering to the diverse preferences of visitors. Ethnic minority villages such as Cat Cat, Ta Phin, and Ta Van have become highlights with distinctive products like stilt house homestays, local guide services, and experiential tours such as weaving, farming, and upland cultivation.

Innovative tourism models have been developed, including agritourism combined with wellness retreats, orchid cultivation integrated with eco-tourism, and specialized farming experiences. Examples include the cultivation of ancient roses, strawberry farms in Sa Pa, pear (Tai nung) and plum orchards in Bac Ha, and Linh Duong tea hills in Lao Cai City. Visitors can not only enjoy the picturesque landscapes of flowers, strawberries, tea, and plums but also engage in hands-on activities like planting, tending, and harvesting. Tourism tied to the cultural heritage of Lao Cai's terraced fields is also a centerpiece of the "Journey to Discover the Northwest Heritage Terraced Fields" program.

Additionally, cultural festivals have become significant attractions, including the Gau Tao Festival (H'Mong ethnic group), the Xuong Dong Festival (Tay ethnic group), and events such as the Sa Pa Flower Festival, Sa Pa in the Clouds Festival, Bac Ha's traditional horse racing, and Vo Ngua Tren May – Sa Pa. Reenactments of the Sa Pa Love Market, the Northwest Quintessence Festival – Lao Cai's Fragrance, and other festivals like the Red Dao's Tet Dance, the H'Mong ethnic group's Gau Tao Festival, and the Water and Land Procession Festival of the Tay ethnic group in Bac Ha enrich the cultural fabric. Other notable events include the Roong Poo Festival of the Giay ethnic group, the Ga Ma Do Forest Worship Ceremony in Bat Xat, and the Kho Gia Festival of the Ha Nhi ethnic group (Bat Xat). These activities not only preserve traditional cultural values but also attract domestic and international tourists. Furthermore, they promote tourism while encouraging local communities to participate in economic development (Trong Bao, 2022).

Enhancing Tourism Promotion and Marketing

Lao Cai has implemented numerous successful tourism promotion campaigns, combining traditional media with digital platforms. Highlight events such as the Sa Pa Flower Festival, Bac Ha Horse Racing Festival, and Sa Pa Winter Festival not only preserve local culture but also create opportunities to attract visitors to the region.

Promotion campaigns on social media and online tourism platforms like TripAdvisor and Booking.com have enabled Lao Cai to effectively reach international markets. Iconic images of Sa Pa's terraced fields, highland markets, and traditional festivals frequently appear in international media, contributing to the unique tourism branding of the province. The image of Sa Pa as the “City in the Mist” has become a symbol of Lao Cai's tourism, widely promoted through media campaigns and experiential travel programs. According to the Vietnam National Administration of Tourism (2020), branding strategies that emphasize the province's unique cultural and natural features have significantly increased the number of international tourists visiting Lao Cai.

Developing Tourism Workforce

Recognizing the importance of human resources, Lao Cai has invested in training and developing its tourism workforce. Training programs for hospitality services, tour guides, and management skills are regularly organized through collaboration between training institutions and the Department of Tourism.

International cooperation projects have also been implemented to improve workforce quality. For instance, the sustainable tourism skills development project in partnership with SNV Netherlands focuses on equipping local communities—particularly women and ethnic minority youth—with marketing and management skills. These efforts aim to strengthen the capacity of the local tourism workforce and enhance the overall quality of tourism services in the province.

Preserving and Promoting Cultural and Natural Values

Lao Cai is one of the pioneering provinces in integrating tourism development with cultural and natural resource conservation. The traditional cultural values of the H'Mong, Dao, Tay, and Giay ethnic groups have been preserved and showcased through community-based tourism activities. Natural reserves such as Hoang Lien Son and Hoang Lien National Park are strictly managed to maintain a balance between tourism development and ecosystem protection. According to WWF Vietnam (2022), monitoring and mitigation measures have successfully reduced pollution and environmental degradation at popular trekking destinations like Fansipan Mountain and Muong Hoa Valley.

Supporting Local Communities in the Tourism Value Chain

One of Lao Cai's most significant achievements is the development of community-based tourism models. Local authorities have encouraged ethnic minority communities to participate in tourism services, including running homestays, providing guided tours, and producing and selling traditional handicrafts. Community-based tourism in Lao Cai not only provides a stable income for households but also raises awareness about cultural and environmental preservation. For instance, villages such as Cat Cat and Ta Phin have become exemplary community tourism destinations, where visitors can immerse themselves in local culture, cuisine, and daily life.

Applying Digital Technology in Tourism Management

Lao Cai has effectively leveraged digital technology to enhance management capabilities and improve the tourist experience. Mobile applications offering real-time information on weather, traffic conditions, and visitor density at attractions have been piloted in Sa Pa. Additionally, a tourist data management system has been implemented to help authorities monitor tourist behavior and predict trends. These initiatives serve as a foundation for Lao Cai's transition toward a “smart tourism” model in the near future (Lao Cai Department of Tourism, 2021).

2.2.2. Limitations in Tourism Management in Lao Cai

Infrastructure Falling Behind Growth and Environmental Impact

Despite significant improvements, Lao Cai's transportation and tourism infrastructure still lag behind the rapid growth of the tourism sector. Popular destinations like Sa Pa and Bac Ha face overcrowding, especially during peak seasons. Intra-provincial transportation infrastructure, such as roads to major tourist hotspots, struggles to keep pace with growth, leading to traffic congestion and deterioration.

Additionally, the influx of tourists generates substantial waste and environmental pollution. According to WWF Vietnam (2022), well-known tourist areas such as Muong Hoa Valley and Fansipan Mountain are experiencing ecosystem degradation due to the pressure of tourism activities. Damage to native plant species along popular trekking routes has also been reported, impacting the region's unique ecosystems

Low Quality of Tourism Workforce

Although Lao Cai's tourism industry is growing rapidly, the local workforce has not yet met the demands of an international destination. Most workers in the tourism sector are locals, but many lack professional skills and foreign language proficiency, resulting in inconsistent service quality and, at times, diminished visitor experiences.

Moreover, tourism training facilities in Lao Cai are limited in scale and quality. Training programs are often short-term, insufficient for building a professional workforce capable of competing with other major tourism destinations. This skill gap continues to hinder the province's ability to fully capitalize on its tourism potential.

Lack of Tourism Product Diversification

Despite Lao Cai's rich tourism potential, its offerings remain concentrated on a few well-known destinations such as Sa Pa, Fansipan, and Bac Ha. These destinations have become overly popular, leading to saturation and leaving returning tourists feeling uninspired. While community-based tourism is encouraged, products in ethnic villages like Cat Cat and Ta Phin primarily rely on traditional activities without significant innovation or creativity. This lack of unique and differentiated products prevents Lao Cai from fully tapping into the diverse needs of its potential customer base.

Ineffective Cultural Management and Preservation

Tourism development in Lao Cai has sometimes led to the commercialization of traditional cultural values, reducing their authenticity and uniqueness. Events such as the Gau

Tao Festival and Bac Ha Market, which hold deep cultural significance, have been transformed into profit-driven commercial events, prioritizing revenue over cultural preservation. Furthermore, inconsistent management of cultural tourism products has resulted in unhealthy competition among businesses, diminishing the overall value of the destination.

Inefficient Application of Digital Technology in Tourism Management

While digital technology is an indispensable trend in tourism management, its application in Lao Cai remains limited. Currently, only basic tools such as informational websites and online booking systems have been implemented, with no integrated data management system in place. Advanced technologies like Artificial Intelligence (AI), Big Data, and the Internet of Things (IoT) have not been widely adopted, leaving the province unable to fully exploit the potential of technology for sustainable tourism development (Lao Cai Department of Tourism, 2021).

The limitations in Lao Cai's tourism management affect not only the quality of visitor experiences but also threaten the sustainable development of the local tourism industry. Addressing these challenges requires strategic investments and close collaboration among stakeholders, along with a strong push for digital technology adoption to enhance management efficiency and unlock the province's potential.

2.3. Application of Digital Technology in Sustainable Tourism Management in Lao Cai

The application of digital technology in sustainable tourism management not only improves management efficiency but also helps protect resources, preserve culture, and enhance the visitor experience. In Lao Cai, which boasts abundant natural and cultural resources, the implementation of digital technology can play a strategic role in sustainable tourism development. Below are specific aspects:

2.3.1. Management of Natural Resources and the Environment

Digital technology enables the monitoring, tracking, and optimization of natural resource usage at tourist sites, thereby minimizing negative environmental impacts. Tools such as Geographic Information Systems (GIS) and the Internet of Things (IoT) have been applied to monitor environmental quality and analyze the effects of tourism activities. GIS allows for the mapping of natural resources, monitoring vulnerable areas, and supporting environmental protection planning. According to Gössling et al. (2019), GIS has proven effective in monitoring and managing nature reserves, particularly in sensitive areas like Hoang Lien National Park. IoT sensors are used to monitor air quality, water quality, and noise levels at tourist sites. In locations such as Muong Hoa Valley and Fansipan Mountain, the installation of sensors can provide timely alerts on pollution levels or overcrowding, enabling the implementation of mitigation measures.

Through the integration of GIS and IoT, Lao Cai can adopt a proactive approach to environmental management, ensuring sustainable tourism practices while maintaining the ecological integrity of its key attractions.

2.3.2. Building a Centralized Tourism Database

A centralized tourism database acts as the "core digital infrastructure" for a smart tourism management system. Tourist attractions like Fansipan, Bac Ha Market, and Ta Van Village need to be digitized, continuously updated, and stored with relevant data, including geographic location, infrastructure status, ticket prices, and available amenities. Data on visitor traffic by day, week, and month would provide valuable insights for planning and forecasting. The system can update visitor flow data, facilitating effective management of these destinations.

Additionally, integrating feedback from online platforms such as TripAdvisor or Google Reviews can help capture customer expectations and identify areas for service

improvement. Analyzing these reviews using AI technology will help detect potential issues and opportunities for enhancement.

This database should leverage **Big Data** to aggregate information from various sources, including social media, booking systems, and online feedback. Collaboration between the Lao Cai Department of Tourism and technology companies like FPT, VNPT, and Viettel is essential for the implementation of this digital infrastructure.

Big Data offers the capability to deeply analyze diverse information related to tourist behavior, needs, and visitor flow, thus creating a comprehensive database for management. It collects data from sources such as social media, booking systems, search engines, and destination sensors. This data helps visualize travel trends, such as peak seasons in Sa Pa, popular trekking routes, or foreign tourists' dining preferences. Big Data also analyzes spending habits, booking frequency, and online reviews to predict demand.

According to Xiang et al. (2015), this data not only aids in personalizing tourist experiences but also informs management policies, particularly in resource allocation for popular destinations. Big Data can be used to assess peak times for trekking routes like Fansipan, allowing for measures to reduce overcrowding and distribute tourists to alternative routes, such as Y Ty.

Big Data is not only a tool for managing tourist flows but also a critical asset for long-term planning, ensuring the sustainable use of tourism resources. By analyzing data from trekking routes or resorts, managers can determine the carrying capacity of each area, thereby reducing pressure on natural resources.

Big Data provides real-time data that allows for destination planning based on tourist density, environmental conditions, and available resources. For instance, it enables the prediction of seasonal tourist volumes, helping managers adjust policies to prevent overcrowding at popular destinations like Sa Pa.

According to Xiang et al. (2015), using Big Data optimizes operational efficiency and alleviates stress on infrastructure. Detailed insights from Big Data support zoning plans, easing the burden on sensitive areas and encouraging tourism to less-explored regions.

By offering precise, actionable insights, Big Data facilitates smarter allocation of resources, strategic visitor distribution, and the promotion of sustainable tourism development across Lao Cai Province.

2.3.3. Application of Artificial Intelligence (AI)

Personalized and Interactive Tourist Guidance

AI enables the creation of automated systems that provide interactive and personalized experiences based on tourists' behavior data. Smart chatbots can deliver real-time information about itineraries, attractions, or respond to customer inquiries in multiple languages. According to Buhalis et al. (2019), such systems not only enhance management efficiency but also improve visitor satisfaction.

AI utilizes search history, booked travel routes, and feedback to offer personalized recommendations, thereby elevating the overall experience. A tourism-support chatbot integrated into Lao Cai's system could guide visitors to lesser-known areas like Bac Ha or suggest homestays in ethnic villages, tailoring recommendations to individual preferences.

Trend Prediction and Risk Management

AI has the ability to forecast tourism trends by analyzing Big Data, helping mitigate risks and optimize resources. It can analyze past and current data to predict expected tourist numbers during holidays based on booking and traffic data.

Moreover, AI can create predictive models to assess the impact of new policies, such as increasing entrance fees, on tourist flow. This capability enables managers to proactively

By adopting these advanced technologies and focusing on sustainable marketing, Lao Cai can create captivating campaigns that attract tourists while minimizing environmental impacts and promoting the sustainable development of its tourism sector.

2.3.6. Strengthening Investment, Workforce Training, and Awareness

Training for Managers and Local Communities

Tourism managers need training on using and leveraging digital technology. This includes utilizing Big Data to predict trends and assess operational effectiveness, as well as managing smart tourism systems to handle platforms for accommodation management, environmental monitoring, and smart applications.

For local communities involved in the tourism supply chain, raising awareness about digital technology is crucial for their participation in the digital economy. Training programs should focus on: Operating services on online platforms. Registering services on tourism applications. Handling online transactions.

Additionally, introducing environmentally friendly technologies can help communities understand how environmental monitoring systems contribute to sustainability. Technology can also be used to preserve culture by encouraging residents to document and digitize customs and traditions, creating engaging content for tourism platforms.

Attracting Technology Companies

Encouraging technology companies to participate in developing smart tourism management systems is essential. Collaboration between the government and technology enterprises is a key success factor. The government should provide a transparent legal framework, initial financial support, and foundational data. Technology companies can offer solutions such as tourism data platforms, mobile applications, IoT infrastructure, Big Data analytics, and environmental monitoring systems.

For instance, VNPT has experience in implementing Smart City solutions in various provinces. A well-coordinated investment in digital technology infrastructure is critical, including: **Data Centers:** To store and process information. **IoT Networks:** For real-time monitoring at tourist sites. **Centralized Data Analytics Platforms:** To streamline insights for decision-making.

Private Sector Involvement

Private enterprises play a vital role in reducing the burden on state budgets and accelerating the development of digital infrastructure. Their contributions can range from IoT networks to data center systems, fostering the rapid growth of digital capabilities in Lao Cai's tourism sector.

By integrating training, investment, and partnerships, Lao Cai can ensure that both the workforce and infrastructure are well-equipped to handle the demands of smart and sustainable tourism management.

3. Conclusion

Digital technology has proven to be a vital force in transforming and enhancing the efficiency of tourism management globally. For Lao Cai, a destination with diverse and abundant tourism potential, adopting digital technology is not just an inevitable trend but also a strategic solution to achieve sustainable tourism development.

Key Benefits of Digital Technology

Tools such as Big Data, Artificial Intelligence (AI), and mobile applications enable the collection, analysis, and optimization of data, empowering managers to make precise and timely decisions. These technologies allow Lao Cai to manage tourist flows, protect natural resources, and create unique, personalized travel experiences for each visitor.

Digital technology also contributes to environmental protection. IoT-based monitoring systems and smart sensors help track air and water quality, as well as resource conditions at destinations like Hoang Lien National Park and Fansipan. This ensures that economic growth from tourism does not come at the expense of environmental degradation.

Strategic Investments and Collaboration

To successfully implement digital technology, strategic investments in technical infrastructure are essential, from IoT networks to centralized tourism databases. Equally important is close collaboration among stakeholders. Local authorities should take the lead in guiding and coordinating efforts, technology enterprises should provide technical solutions, and local communities should actively participate in the tourism value chain.

Opportunities for Sustainable Development

The adoption of digital technology opens up opportunities for Lao Cai to become a model of sustainable tourism development. This approach not only addresses current tourism challenges but also serves as the key to preserving natural and cultural values for future generations.

By integrating innovative technologies, strategic planning, and stakeholder engagement, Lao Cai can position itself as a leader in sustainable tourism while setting a precedent for other destinations to follow.

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Solutions to Promote Innovative Start-Up Among Ethnic Minority Youth in Lao Cai Province

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Abstract

Startup is a topic that has received a lot of attention in the world and in Vietnam. In Lao Cai province, innovative startups are currently expected to contribute to local economic growth, increase job creation and improve sustainable livelihoods for ethnic minority and mountainous people. A survey of over 450 ethnic minority youths in Lao Cai province shows that start-ups mainly take place in the form of individual business households such as green agricultural products, tourism and services. However, the startup model is still at small-scale, facing limitations in capital and support from informal financial sources. The study suggests synchronous solutions such as: raising awareness about innovative startup for ethnic minority youths, supporting infrastructure, encouraging creativity and investing in education and training. In addition, strengthen the role of start-up support organizations such as incubators and start-up clubs to create a favorable environment for the youths to promote local economy.

Keywords: Entrepreneurship, Innovative Startups, Ethnic Minority Youth, Lao Cai province.

1. Introduction

In the context of world economic integration, startups are expected to create economic growth, contribute positively to socio-economic development, and contribute to creating many jobs for the community and society. The political report at the 12th Congress of Vietnam Communist Party has set out the direction “Encouraging and promoting the process of starting a business. There are policies to promote the development of Vietnamese enterprises in both quantity and quality, truly becoming the core force, leading the cause of industrialization and modernization”. On May 18, 2016, the Prime Minister signed Decision No. 844/QĐ-TTg approving the Scheme of “Supporting the National Innovation Start-up Ecosystem by 2025” to “create a favorable environment to promote and support the formation and development of fast-growing enterprises based on the exploitation of intellectual property, new technologies, and new business models. Urgently complete the legal system to support innovative start-ups”.

Lao Cai is the central province of the northern midlands and mountains region, with an essential geographical location on the Kunming (China) - Lao Cai - Hanoi - Hai Phong economic corridor. Lao Cai border-gate economic zone is considered one of the most dynamically developed border-gate economic zones in the Northern provinces, the province

has many beautiful natural landscapes, unique national culture, with many rare animals, potential for tourism development and many types of agricultural products with high economic value.

The average population in 2022 of Lao Cai province is 770.59 thousand people, including the urban population of 206.5 thousand people, accounting for 26.80%; the rural population is 546.09 thousand people, accounting for 73.20%. In which, young people are about over 147,000 people, accounting for 19.08% of the total population of the province, with 25 different ethnic groups. Therefore, Lao Cai province has been paying attention to job creation for workers, especially the youth force who are ethnic minorities. At the Fifth Congress of Delegates of the Vietnam Youth Union of Lao Cai Province, one of the important tasks was identified as the effective implementation of the program “Accompanying young people to establish themselves and establish a career”, which focuses on organizing activities to support ethnic minority youth, young religious believers.

In recent years, Lao Cai Provincial Youth Union has had many policies and programs to accompany with young people in start-up and career movements. As a result, The Union annually organizes more than 20 training activities, forums, and sharing start-up experiences for more than 1,000 youth union members. Many activities encourage youth union members to actively participate in economic development activities, support innovative startups, and establish economic models as examples for youth union members. Up to now, the province has 439 models of youth economic development which yields an income of 50 million VND and above.

At the same time, the Union has maintained 9 district-level economic development youth clubs with 120 members, newly established and maintained 85 commune-level economic development youth clubs; effectively maintain 581 youth cooperative groups including 552 saving and lending groups of the Social Policy Bank; 16 youth cooperatives. The district-level Youth Union continues to maintain 9 pioneered youth teams specializing in delivering scientific and technical advances in 9 districts/cities, thereby creating favorable conditions and environment to help young people develop economically, get out of poverty, and at the same time provide the market with high-quality products and create jobs for young people in the province.

Despite many achievements in the past period, the movement to start a business among young people in Lao Cai province still faces many difficulties and limitations. For example, youth startup models are still at small-scale, many models have not been implemented in practice. Currently, the Provincial Youth Union is still facing difficulties in building a fund to support youth start-ups. Most of the support for start-up models and projects comes from traditional capital sources, only a small source of capital comes from organizations, coordination units, and member clubs.

Stemming from the above situation, a study was carried out to clarify the limitations and causes which led to the business start-up movement among the youth in Lao Cai province has not met the potential, thereby proposing policy recommendations for the Provincial Youth Union to improve the quality of business start-ups among the youth in Lao Cai province in the upcoming time.

2. Theoretical Framework

2.1. Theoretical basis on innovative startup for ethnic minority youth

2.1.1. Concept of Startup

There have been many studies on startup, however depending on different approaches, the concept of startup is understood in different meanings.

The first view: startup is starting a new one, which includes the activities necessary to create or form a new business (Aldrich, 1980) or create a new organization (Gartner, 1989). Stenholm et al. (2013) argue that a start-up enterprise is an institution or organization designed to create new products and services under extremely uncertain conditions.

Second view: From the perspective of exploiting business opportunities, entrepreneurship is a process in which an individual recognizes and evaluates business opportunities, gathers the necessary resources, and initiates appropriate actions to effectively exploit business opportunities (Nwachukwu, 1990). Entrepreneurship can also be understood as the discovery of opportunities and the creation of new economic activities, usually through the establishment of a new organization (Reynolds et al., 1995).

Third view: Entrepreneurship is a term that refers to the initial stage of a company's operational process. Companies that are in this stage are often funded by the founders themselves to develop products and services that they believe are in supply. This definition also coincides with the definition of Aswath Damodaran (2009). Due to limited revenue sources and high costs, most small-scale startups are often unstable in the long term without capital support from investment funds.

According to the research team's approach: Starting a business is taking advantage of market opportunities to start a new business, to own - run the business yourself or hire a manager, with the aim of bringing value to yourself and to society. Thus, ordinary entrepreneurship is understood in the sense of creating jobs on their own, entrepreneurs are self-employed, do not work for anyone.

2.1.2. Concept of Innovative Startup

According to Blank (2013), innovative startup includes two contents: (i) a disruptive business idea, i.e. creating something that has never been on the market or creating a better value than what is already available, such as being able to create a new segment in manufacturing (such as a smart device that measures personal health), a completely new business model, or a unique, never-before-seen type of technology (like 3D printing technology); (ii) Growth value is superior to traditional, a startup called innovative will not set a limit to growth, and they have the ambition to grow to the greatest extent possible. They create a huge influence, can be considered market makers. It means making a difference not only in the country but with all companies in the world.

According to the Vietnamese National Law (2017), innovative startup is defined as a small and medium-sized enterprise (SME) established to implement ideas based on exploiting intellectual property, technology, new business models and capable of rapid growth. Thus, the three basic criteria for determining innovative startup enterprises are: (i) Legal status: must be an enterprise, (ii) Activities: Must be based on the exploitation of intellectual property, technology or new business model, and (iii) Prospects: Have the ability to grow rapidly. This definition is relatively consistent with the common definitions of startups in many countries around the world, especially in terms of factors related to creative activities and development prospects.

In addition, according to Decision 844/QD-TTg (2016), innovative startup enterprises are understood as enterprises with the ability to grow rapidly based on the exploitation of intellectual property, technology, and new business models. innovative startup enterprises have an operation period of not more than 5 years from the date of issuance of the first business registration certificate.

Thus, from the point of view of innovative startup, it is understood that an enterprise is established based on exploiting intellectual property, technology, new business model and

capable of rapid growth, with an operating period of not more than 5 years from the date of issuance of the first business registration certificate.

However, according to the approach of the research team, innovative startup is a startup based on the exploitation of intellectual property, the application of science and technology to the production and business process to improve products, services or processes, thereby helping the organization develop rapidly.

2.1.3. Concept of Startup Ecosystem

According to the Organization for Economic Cooperation and Development (OECD), the Startup Ecosystem is “a synthesis of formal and informal links between: start-up actors (potential or current); start-up organizations (companies, venture capitalists, angel investors, banking systems,...); and relevant agencies (universities, state agencies, public investment funds,...) and the startup process (business establishment rate, number of enterprises with good growth rate, number of entrepreneurs,...) directly impacts the local startup environment” (Mason, 1989).

The constituent parts of the Intellectual Property include ideas, inventions/inventions and research results; innovative startup enterprises at different stages of development; venture capitalists; members of the startup team; angel investors; masters of entrepreneurship; startup mentors; people with a willingness to take risks other dangers; and various start-up organizations (Figure 2.1).

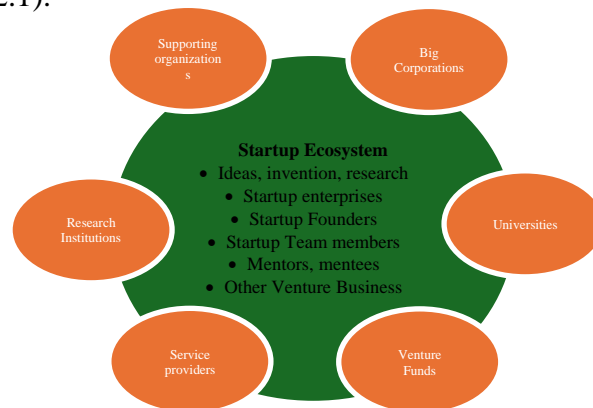


Figure 1. Components of a Startup Ecosystem

Start-up organizations include universities; start-up consulting and vocational training organizations; incubator organizations; organizations to accelerate startups; service providers (consulting, accounting, legal, etc.); event organizers; startup competitors; network of investors; venture capital companies; electronic transaction gateways to raise crowdfunding (loans, sponsorships, etc.); startup blogs or other business media; other supporting means.

- Operating mechanism: The above-mentioned constituent parts are the internal elements of the Startup Ecosystem. They interact with each other and interact with the external environment to form a flowing network to mobilize and allocate resources (money, time, skills) to the most active parts of the system in the direction of creating innovative startup enterprises, stimulating the emergence and encouraging the implementation of ideas and inventions. This network even turns failed innovative startup enterprises into favorable factors, because they provide people who have accumulated knowledge and skills for the Startup Ecosystem, who will either establish new innovative startup enterprises, or will work for existing enterprises.

- Environment: The environment (also known as external factors) of the Startup Ecosystem is the general economic, cultural and social conditions that affect the functions of the system. For example, the economic growth or recession, whether there is a financial crisis,

whether the market fluctuates or not, how the business situation of large companies, etc., all have a great influence on the formation and development of the Startup Ecosystem; The two geographical regions have similar conditions but may have very different Ecosystem simply because they have different cultural values.

In summary, the Startup Ecosystem is a gathering of individuals with an entrepreneurial spirit and other stakeholders in the ecosystem who have an interrelationship. These elements have an impact on each other, determining the existence and sustainable development of the whole system.

2.1.4. Concept of Innovative Startup for Ethnic Minority Youth

From the above theories, innovative startup for ethnic minority youth is a situation where young people have cherished their own business, operating under the model of an enterprise or cooperative or business household in which ethnic minority youth are managers, founders or co-founders. Products made by ethnic minority youth are innovative products, innovative services or items that are already on the market but apply new production and/or new business models, scientific and technological achievements to improve the productivity or quality of indigenous products for socio-economic development in ethnic minority areas and mountainous areas of Lao Cai province.

2.2. The role of innovative start-ups for ethnic minority youth

First, contributing to economic growth

Innovative start-up enterprises will be a driving force of all economies in the coming period. SMEs are contributing more and more to the total GDP due to their increasing number and distribution in most sectors, sectors and localities. In addition, the growth rate of SMEs is much higher than that of other business sectors and can maintain the pace of economic growth and development even when the economy is in crisis. SMEs have a very positive belief and attitude towards the economy and the development trend of the economy. Thus, SMEs are the world's economic development trend, as well as the nucleus for economic recovery and development in the 4.0 era.

Second, creating many jobs for workers

The common feature of innovative start-up enterprises is that they employ few workers, but with many start-up enterprises, many workers will have a job, especially young and qualified workers. Helping young people reach their full potential through funding, funding or consulting, mentoring, job opportunities and training through practical work. The SME sector mobilizes resources in the social population.

Third, mobilizing social resources.

Currently, many innovative start-up enterprises are seriously lacking capital, so there is still a lot of idle capital in the population but cannot be mobilized. When innovative start-up enterprises have direct contact with people and mobilize capital for business. Taking advantage of capital resources from family members is the first thing that innovative start-up enterprises do and is very suitable for innovative startups just starting out. Although it is a spontaneous form, it has also made good use of idle resources in society.

Fourth, contributing to the dynamism of the economy in the market mechanism

The flexibility of innovative start-up enterprises has created the dynamism of the economy. The rapid transformation to fill the gaps in the market has spoken of the role of economic stability of innovative start-up enterprises. Innovative start-up enterprises give the economy a new image of dynamic development, becoming a new driving force of the economy. The birth of innovative start-up enterprises has increased the competitiveness of the economy, reducing monopolies, forcing businesses to innovate technology to increase competitiveness. Businesses must constantly innovate to survive and develop. With their

flexibility, innovative start-up enterprises will create a competitive attraction, and at the same time, they will also play a role in promoting the process of specialization and division of labor in production.

Fifth, contributing to accelerating the process of economic restructuring

Innovative start-up enterprises often choose niches of the market, so the coverage is very large. Because of their small scale and capital, start-up enterprises often choose industries in technology or services and trade. The above choice will shift the service industry compared to the manufacturing, manufacturing and agriculture, forestry and fishery industries. In addition, SMEs create conditions for rural economic transformation and create conditions for women to participate in management through projects on high-tech agriculture. The establishment of many innovative start-up enterprises in different regions and areas, especially in rural areas, will reduce the proportion of the agricultural sector, increase the proportion of industries and services. This will help the restructuring of the entire economy in the direction of reducing the proportion of the agricultural sector, increasing the proportion of industry and services.

Sixth, incubating business talents

Innovative start-up enterprises are not only motivated by economic benefits, but besides the purposes of revenue and profit, leaving benefits to society is also the leading driving factor for the development of innovative start-up enterprises. Other motivators include making a positive contribution to the community and inspiring and engaging others to follow their aspirations. Innovative start-up enterprises also demonstrate a strong commitment to supporting and developing young people such as creating internship and apprenticeship opportunities. This shows that the influence of both the entrepreneurial spirit and the supporting role of innovative start-up enterprises on young people is great to help the startup movement develop, and it can be said that innovative start-up enterprises are the place where the entrepreneurial spirit is born, where businesses and entrepreneurs are trained and born, bringing profound changes to the economy.

2.3. The current situation of innovative start-ups of ethnic minority youth in Lao Cai province

2.3.1. General information about the subjects of investigation

The study conducted a survey of 450 ethnic minority youth who started or intend to start a business (collectively referred to as youth start-ups) of Lao Cai city and 8 districts/towns in Lao Cai province. In which, 100 young people started a business in Lao Cai city and 350 young people started a business in 8 districts/towns in the area, showing that:

Urban youth starting a business in Lao Cai city: The starting age of urban youth is 27.46 years old. Rural youth have a lower average start-up age of 24.12 years. Urban youth are female start-ups accounting for 36%, rural youth account for 34%.

- Regarding the educational and professional qualifications of young entrepreneurs:

Table 2.1 shows that the education and professional qualifications of urban start-up youth are higher than those of rural youth, specifically, urban areas have 30% of untrained start-up youth, 64% are trained through university and post-university, while in rural areas, youth start-ups have not been trained at 58.57% and only 22.28% of young people have been trained at the university and post-university levels.

Table 1. Education and expertise of young entrepreneurs

Unit: %

		Urban youth	Rural youth
Education	Primary education	2	0.86
	Secondary School	5	12
	High School	93	87.14
Qualifications	Untrained	30	58.57
	Intermediate - College	6	19.14
	University	63	21.14
	Postgraduate	1	1.14

Source: Research team survey

The training professions of young entrepreneurs surveyed are agriculture, economics, information technology, tourism, etc. Main start-up fields: Clean agricultural product business, interior design, ceramics business, freight transportation, opening a café, online business, ornamental plant services, tourism service business, Cun Cun animal food, fashion business, catering service business, entertainment services, hotel business, making VACR economic models (gardens, ponds, barns, fields, forests), tour guide services, logistics, etc.

2.3.2. Results of start-up activities of ethnic minority youth in Lao Cai province

- The form of organization that young people choose to start a business:

Results of a survey of urban and rural youth on the form of organization that ethnic minority youth in Lao Cai province choose to start a business:

Figure 2.1 shows that the percentage of young people choosing the start-up model in the form of business households accounts for the majority: urban youth account for 76%, rural youth account for 81%; Cooperative model: urban youth account for 7%, rural youth account for 6%; Cooperative group model: urban youth account for 12%, rural youth account for 11%; Business model: urban youth account for 5%, rural youth account for 2%.

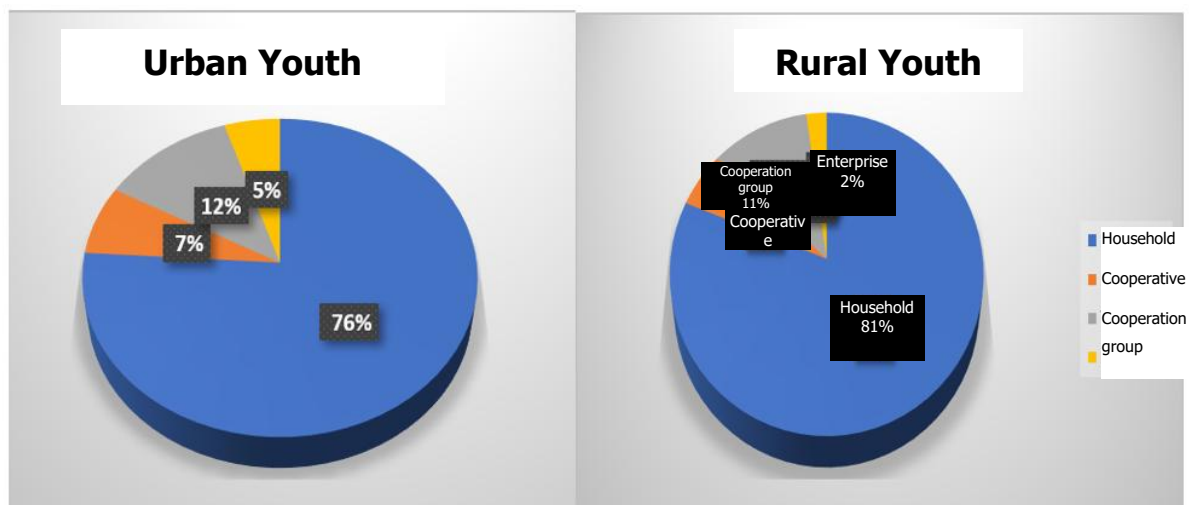


Figure 2. Forms of production and business organization of start-up youth

- Reasons for young people to start a business:

When asked about the reasons why young people choose start-up fields, rural youth have a higher rate of desire to get rich than urban youth.

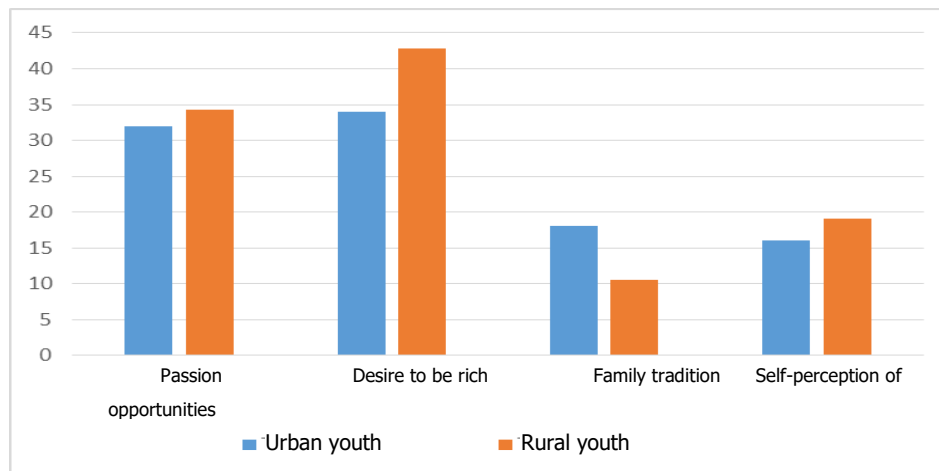


Figure 3. Percentage of reasons why young people choose to start a business

Urban youth starting a business from family tradition have a higher rate than rural youth. However, rural youth have realized the opportunity for themselves to start a business from the potential of the region rather than urban youth.

Regarding the source of capital for start-ups: The results of a survey of 450 young start-ups in Lao Cai province show that most of them are household sizes, the initial investment capital is quite low, specifically:

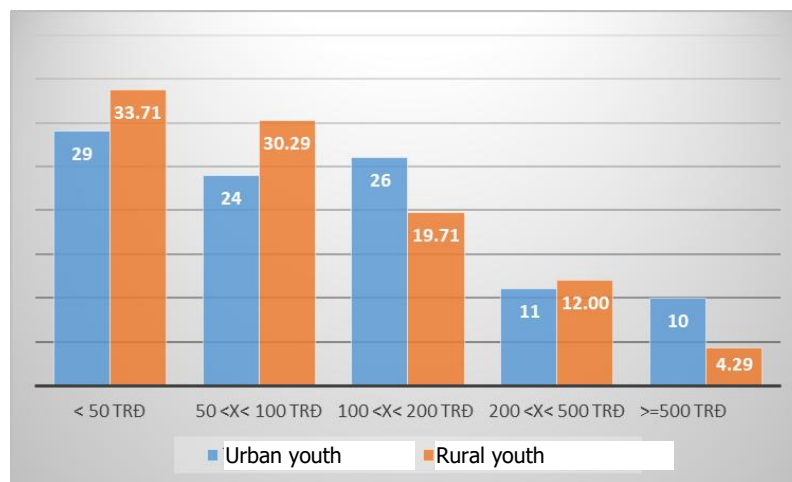


Figure 4. Percentage of initial investment capital in startups of young people

Figure 4 shows that rural youth start-ups have a lower initial investment capital in start-ups than urban youth. Specifically, 33.71% of young people starting a business in rural areas have a start-up capital of less than 50 million VND, while 29% of urban youth are 29%; the capital level is from 50 to 100 million VND, urban youth account for 24%, and rural youth account for 30.29%; start-up investment capital from 100 to 200 million VND for urban youth accounted for 26%, while rural youth accounted for 19.71%.

The survey results also show that the initial start-up capital for young people in urban and rural areas is mostly from relatives and personal savings and from banks, and very few young people are supported with loans from other financial institutions, from friends or from investors.

3. Some solutions to improve the quality of promoting innovative start-ups for ethnic minority youth in Lao Cai province

3.1. Solutions to raise awareness

Continue to implement plans 274/KH-UBND dated 24/10/2017 of the Provincial People’s Committee on Supporting the innovative start-up ecosystem in Lao Cai province in the period of 2017 - 2020, with a vision to 2025; Plan No. 350/KH-UBND dated 04/9/2023 on the implementation of the Prime Minister’s Decision No. 897/QD-TTg dated 26/7/2022 approving the program “Supporting youth start-ups, period 2022 - 2030” in Lao Cai province; Plan No. 290/KH-UBND dated July 4, 2023 of Lao Cai Provincial People’s Committee on Science, Technology Innovation and Science and Technology Budget Estimates in 2024.

To promote innovative start-up activities among young people, the province needs to raise the awareness of young people and people as well as all levels and sectors about start-ups, the importance of start-ups, especially for young people. At the same time, raise awareness for organizations and individuals in the application of science and technology to production and business, raise awareness for organizations and individuals about the integration and role of intellectual property rights protection of products. From there, it helps individuals and organizations change their mindset and move towards creative startups through some specific activities as follows:

Firstly, continue to promote information and propaganda about innovative start-up programs among young people, especially ethnic minority youth in the province. Develop and complete the Startup Youth Newsletter. Strengthen the promotion of KNST skills training for youth and union officials in charge of start-ups, organize “start-up forums” as a place to share and exchange start-up experiences. Promote the role of start-up youth clubs in ethnic minorities and mountainous areas.

Secondly, continue to organize annual seminars between provincial leaders and young entrepreneurs. Organize start-up forums and launch the Creative Start-up Youth Program to remove difficulties and obstacles of young people who intend to start a business or in the process of starting a business in the locality.

Thirdly, continue to direct ministries and unions at all levels to support the formation of a startup ecosystem among young people such as: Organizing a contest to find ideas for young entrepreneurs and commend young entrepreneurs and typical young entrepreneurs. Organize start-up training programs, advanced training and business coaching.

Fourthly, strengthen the search for and development of creative and start-up ideas among young people. The Provincial Youth Union needs to promote training to improve the knowledge and capacity of youth union officials at all levels on entrepreneurship. Implement many forms and solutions to support information, knowledge and skills for young people to start a business and establish a career; focus on organizing startup competitions and forums, thereby connecting startup ideas with potential investors. Ministries and unions at all levels continue to exploit loans to support youth in economic development, job creation, hunger eradication, poverty reduction, and good loans to help union members and youth create jobs and develop the economy. The provincial Vietnam Women’s Union has also coordinated with non-governmental organizations to implement the business incubator model, organize Startup ideas contests, and business initiative challenge contests.

Fifthly, encourage youth union members to proactively and actively participate in economic development activities, start-up and innovation, and establish economic models to set an example for youth union members and youth to care for and innovate. Lao Cai Provincial Youth Union continues to effectively maintain the provincial-level volunteer team for science and technology transfer with 07 members. Direct districts, towns, city unions and affiliated

unions to establish 09 district-level volunteer youth teams for science and technology transfer to organize activities to support youth union members and people in applying new techniques in agriculture, forestry and fishery.

3.2 Solutions to promote innovation in start-up models of ethnic minority youth

To start an enterprise in an innovative manner, enterprises need to be ready to make changes. For a startup, even a small change in one aspect will have a huge impact on other aspects of the business. Managers must accept changes that are even more important in sustainability and digitalization, where changes in technology and policies are happening at a high speed that will change their business results. Provincial authorities need to organize propaganda and training for enterprise owners to have a mindset of innovation in enterprises. In addition to implementing large-scale innovation such as product innovation, changing the entire production process and technology, etc., innovation in enterprises can initially be just expanding production scale, applying new technology to product manufacturing to improve product quality and value, expanding product consumption markets, etc. These changes increase revenue and profits for the enterprise, thereby leading to higher levels of enterprise development.

Perfecting support policies to improve the business investment environment

Improve the business investment environment to support enterprises, support start-up models, implement the “Provincial Competitiveness Index (PCI) Improvement Plan” in Lao Cai province and develop investment incentive policies, policies to support investment in agriculture, policies to support small and medium enterprises, and call for investment in tourism infrastructure development.

Regarding the investment environment and investment incentive policies, although Lao Cai province has made many efforts in attracting investment and encouraging the development of start-up potential, the procedures are still numerous, overlapping, and complicated. Therefore, procedures need to be simpler and reduced, and procedural costs need to be reduced (simplify procedures for enjoying incentives in agricultural investment, loan procedures, and need to decentralize the management of procedures for small-scale products to localities (provinces), etc.). In addition, support and consultation are needed to help enterprises easily carry out procedures (business registration procedures, business expansion, exclusive trademark registration, etc.) and the time to process documents and procedures needs to be quick.

The results of consultations with experts and youth-led startups suggest that it is necessary to create favorable conditions for investment policies and scale expansion. Currently, the policy to encourage enterprises to invest in agriculture and rural areas according to Decree No. 57/2018/ND-CP has been implemented, however, accessing and implementing the policy is not easy. It is not just the agricultural sector, but many policies issued by the State have not really reached the final beneficiaries for many different reasons. Therefore, it is recommended to soon issue documents guiding the implementation of the above policies, creating conditions for enterprises to easily access.

In particular, the role of the Department of Planning & Investment and the Department of Science & Technology of the province is extremely important in accompanying enterprises and economic organizations to apply science and technology, new scientific achievements in the production and business process, increase the value of products and services in the area and ensure sustainable development.

3.3. Technology support solutions and incubation facilities for young entrepreneurs

Continue to establish innovative startup incubators in universities and colleges and establish innovative startup incubators in other areas of strength.

Support production and business premises through incentive policies for investors to build shared service areas for startups, such as supporting part of the costs of building technical infrastructure, operating costs, and rental costs. Specifically: Building infrastructure, establishing shared workspaces, technology parks, and science incubators, thereby providing workspace and equipment at reasonable prices, or exempting rental fees for startups; Supporting infrastructure costs for startups in private workspaces and incubators. Encourage related start-up ideas focusing on high-tech development, refer to successful technology development models in many places at home and abroad to learn lessons for Lao Cai, focusing on applicability and scientific content in products.

Organize experience sharing, replicate successful youth economic models; establish clubs, cooperatives, and youth economic cooperatives; train and provide knowledge on product marketing, especially e-commerce for young people. Learning from the experiences of many localities, specialized units have been established to support local start-ups such as the Youth Start-up Support Center or the Youth Start-up Incubator to organize consulting and support for young people to start businesses. These efforts of the Association organizations have contributed positively to supporting young people to return to their localities after graduation to do business and start businesses.

The Department of Science and Technology develops and implements policies to support SMEs in improving their technological capacity through research, training, consulting, and technology transfer; advises the Provincial People’s Committee on establishing incubators, technical facilities, and co-working spaces, etc. The Provincial Youth Union continues to coordinate with the Provincial Department of Planning and Investment to support young entrepreneurs at the “Startup Incubator” where union members and young people can exchange and learn from experience of entrepreneurs, connect individuals and organizations in supporting young entrepreneurs in starting businesses and innovation.

3.4. Solutions to improve the quality of human resources for ethnic minority youth’s innovative start-up

It is necessary to strengthen education and training for startups. This includes measures to build skills that startups often lack, thereby promoting and facilitating innovative startups.

The goal is to create a spirit of entrepreneurship - innovation - creativity in schools. High schools, universities and colleges need to have many practical learning and working programs, providing knowledge and inspiring students to master their careers and themselves. To develop entrepreneurship in universities, it is necessary to create a common forum for students of different majors, and there must be a place for them to come and interact, meet and exchange ideas. The core role of universities is to create seeds and incubate startup ideas. Schools have the conditions to create a favorable environment for students to participate in innovation, creativity and scientific research activities, organize startup idea competitions, create connections between groups to form startup projects.

For the period when the startup ecosystem in schools is well developed, universities, colleges, and vocational training centers maximize their connecting role. That is the creation of links between students and startups to create jobs; between scientists and startups, bringing knowledge and research projects into life - society, production, and business; connecting resources to support creative student startups. With these activities, universities are not only a place to incubate potential innovative and creative business projects but also create opportunities to attract talents to increase practical experience.

Basically, the group of solutions through education and training to develop startups often includes:

Training programs, guidance on entrepreneurship at universities, colleges, research institutes, higher education institutions (training, coaching on business knowledge, skills, conditions, processes for students to start a business). The Provincial Youth Union and related organizations need to select appropriate training and education materials for the province’s youth. Training programs on management skills, financial management, labor, etc., for founders of start-up businesses.

The capacity of managers and employees plays a very important role in promoting the development of startup models. Experience from many countries and provinces shows that training managers and employees in startup models needs to be given attention by localities and demonstrated through policies and development support programs.

Focus on education and training programs to create a foundation of management knowledge for managers and employees in the model. Encourage the strengthening of links between schools and startup models, between startups and large-scale enterprises, and foreign-invested enterprises in management and business administration training programs. These programs should be organized regularly and widely for new startups and those in management positions.

4. Conclusion

The study has systematized the theoretical basis for innovative startups for young people in general and ethnic minority youth in particular. Through a survey of ethnic minority youth startups in Lao Cai Province, the study has pointed out the advantages, shortcomings, and limitations in the startup activities of ethnic minority youth in Lao Cai Province, thereby proposing solutions to improve the quality and effectiveness of these activities, contributing to the development of sustainable livelihoods in ethnic minority and mountainous areas of Lao Cai Province.

Innovative startups are the way for Lao Cai to break through and are a short, high-speed path for Lao Cai to quickly catch up with other localities in the region. Supporting the innovation - startup ecosystem is a process of continuous innovation, creativity, in terms of policies, policy implementation, organizational structure, network connection, etc., to ensure consistency, connectivity, and sharing among individuals in each organization, between organizations and levels and sectors in the province. Therefore, it is necessary to implement synchronous solutions on organization and connection of apparatus and on perfecting the policy system.

Well implementing the solutions proposed by the study will create an open, attractive, competitive and effective startup environment for Lao Cai Province, helping to spread and promote startup activities among ethnic minority youth in Lao Cai Province in the coming time.

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Application Of Social Networks In Promoting Traditional Cultural Identities Of Ethnic Minorities To Develop Household Economy In Bac Ha District, Lao Cai Province

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Abstract

The emergence of social media platforms, which have grown rapidly over the past two decades, has led to an explosion of information, social connections, and online commerce. Sharing images, videos, stories, and messages on platforms like Facebook, YouTube, TikTok, and Zalo enables cultural messages to spread quickly and widely. This presents a significant opportunity for ethnic minorities to promote their traditional cultural identities, thereby increasing income and fostering the development of household economies. This article focuses on researching solutions for utilizing social media to promote the cultural identities of ethnic minorities in Bac Ha District, Lao Cai Province, with the aim of boosting household economic development within the community.

Keywords: social media, traditional cultural identity, Facebook, YouTube, TikTok, Zalo, Bac Ha, Lao Cai.

1. Introduction

In recent years, social media has become an integral part of daily life for most Vietnamese people, driven by the increasing usage of smartphones and internet access. Social media platforms such as Facebook, Zalo, TikTok, YouTube, Instagram, etc., have become microcosms of society, not only reflecting every aspect of life but also significantly influencing or impacting real-world events. As of the end of February 2024, Lao Cai Province has established 2,788 BTS stations (including 5 BTS 5G stations) installed at 1,279 locations. There are 956 transmission routes (77 underground cable routes and 879 overhead cable routes), ensuring mobile coverage (3G and 4G) in 1,548 out of 1,562 village centers (reaching nearly 99%). Additionally, 1,337 out of 1,562 villages (85.6%) have optical cable infrastructure for internet access. These facilities support 817,281 mobile subscribers and 634,129 broadband internet users, with 109,135 households (57% of total households) connected to fiber-optic internet. Moreover, 100% of the main headquarters of preschool, primary, secondary educational institutions, and healthcare centers have access to fiber-optic internet. The widespread availability of internet services has enabled people, especially ethnic minorities, to easily access technology and participate in social media. For ethnic minorities, social media is not only a tool for connecting with family, friends, and entertainment but also an effective means of promoting traditional cultural identities and increasing income.

This article focuses on analyzing the current status and solutions for applying social media among ethnic minorities in Bac Ha District, Lao Cai Province, using both quantitative and qualitative methods. We conducted a survey using questionnaires, distributing 120 forms and receiving 108 responses from ethnic minorities in Bac Ha District. All respondents were aged 18 and above, with 42% belonging to the Mong ethnic group, 27% to the Tay ethnic group, 19% to the Nung ethnic group, and 12% to the Dao ethnic group.

2. Content

2.1. Current State of Social Media Usage Among Ethnic Minorities in Bac Ha District, Lao Cai Province

Bac Ha is a district located in the northeastern part of Lao Cai Province, bordered by Si Ma Cai District to the north, Bao Yen and Bao Thang Districts to the south, Xin Man District in Ha Giang Province to the east, and Muong Khuong District to the west. Bac Ha covers an area of 681 square kilometers and has a population of 67,472 people, comprising 18 ethnic groups. Among these, the H'mong ethnic group accounts for over 47% of the district's total population. Other ethnic groups include Kinh, Dao Tuyen (Black Dao), Tay, Nung, Phu La, and Hoa, among others. In the era of rapid technological advancements and the widespread influence of information technology, broadcasting, television, and social media have deeply permeated daily life. This has enabled ethnic minorities to easily access a diverse and multi-dimensional range of information. Such access has significantly impacted their ability to increase income and develop household economies.

a. Social Media Connectivity Tools for Ethnic Minorities in Bac Ha District, Lao Cai Province

Survey results indicate that the primary device used by ethnic minorities to access social media is the smartphone. Personal computers, tablets, and desktop computers are not widely used due to economic conditions and the practical needs of the people. These devices are only utilized by a small number of ethnic minorities who work in government offices. Additionally, some individuals visit local internet cafés to access social media and other online services.

The increasing availability of smartphones with diverse models and affordable prices—especially from Chinese brands—aligns well with the financial capabilities of local residents. Smartphones, being highly portable, not only serve as communication tools but also allow users to work while fulfilling entertainment needs. These devices are increasingly equipped with pre-installed social media applications, apps for streaming TV programs, music, and online games.

As a result, in recent years, smartphones have become the top and most practical choice for local residents, contributing to a significant increase in the rate of smartphone ownership and internet usage within the community. Survey findings reveal that 90% of the population owns and uses smartphones.

Table 1. Internet Connectivity Devices Used by Ethnic Minorities in Bac Ha District

Network Connection Devices	Number of people	Percentage
Máy tính bàn	3	2,7%
Máy tính bảng	2	1,9%
Điện thoại	84	77,8%
Thiết bị khác	19	17,6%

(Source: Research Team Survey)

b. Popular Social Media Platforms and Usage Purposes Among Ethnic Minorities in Bac Ha District

Social media platforms are popular communication tools in contemporary Vietnamese society. According to statistics, Vietnam has approximately 73.6 million social media users, with 95% of internet users utilizing Facebook, followed by Zalo as the second most popular platform (Le Duc Tuan, 2023). Recently, TikTok has taken the internet by storm. As shown in Table 2, the usage rates for Facebook and Zalo remain the highest at 90.7% and 92.6%, respectively, followed by TikTok at 62.9%, YouTube at 39%, and WeChat at 23.3%. TikTok has only gained prominence over the past two years, but it has quickly become a platform ripe for business activities. In addition to the four commonly used social media platforms in Vietnam, WeChat is another platform gaining attention and frequent use among ethnic minorities. WeChat, similar to Vietnam’s Zalo, offers many convenient features, particularly its payment and direct money transfer functions, thanks to its integration with banking systems. People who have lived in or maintain connections with China often use WeChat as a communication tool and for professional purposes. In recent years, the increasing wave of cross-border labor migration, trade activities, and economic relationships with Chinese employers has made WeChat even more popular.

Table 2. Usage Rates of Popular Social Media Platforms
Among Ethnic Minorities in Bac Ha District

Social media platforms	Number of people	Percentage
Facebook	98	90,7%
Tiktok	68	62,9%
Zalo	100	92,6%
Youtube	53	49%
Wechat	25	23,2%

(Source: Research Team Survey)

Ethnic minorities living in Bac Ha use the internet and social media platforms to gather information on economics, culture, and society; connect with friends and family; search for job opportunities; and for entertainment, among other purposes. Among these, connecting and communicating with others is the most dominant purpose. However, the purposes of use differ across various applications, and there are also certain differences between ethnic groups. Since the survey participants were individuals aged 18 and above, and the responses to the questionnaires were not fully aligned with the initial design due to some objective reasons, certain usage purposes may not fully reflect the actual situation in the locality. A single individual may use social media for multiple purposes. Therefore, in the survey table on usage purposes, respondents could select multiple answers.

Table 3. Purposes of Social Media Usage Among Ethnic Minorities
in Bac Ha District, Lao Cai Province

Purposes of Social Media Usage	Number of People	Percentage
Giải trí, tìm thông tin	79	73,2%
Liên lạc, kết nối	103	95,4%
Học tập, phát triển	63	58,3%
Kinh doanh	57	52,7%

(Source: Research Team Survey)

According to Table 3 regarding the purposes of social media usage among ethnic minorities in Bac Ha district, Lao Cai province, the majority use it to communicate and connect with relatives and friends, accounting for 95.4%. Following that, 73.2% use it for entertainment, searching for information related to current events, news, culture, and socio-economic issues. 58.3% use social media for studying and personal development, such as participating in online courses, joining skill development groups, and obtaining study materials. The lowest percentage, 52.7%, is for using social media for business purposes. The majority of ethnic minorities do not fully understand the important role social media can play in increasing income, and some who have tried selling products on social media have not been successful. As a result, they simply use social media to post items for sale without fully exploring each platform, how to use it, or how to create posts that attract viewers. Additionally, some low-income ethnic minorities buy inexpensive smartphones, and because the quality of photos and videos is not clear, they fail to attract viewers.

2.2. The distinctive traditional cultural identity of ethnic minorities in Bac Ha district, Lao Cai province.

Cultural identity is the most condensed, enduring, and refined material and spiritual value. It represents the unique and distinctive characteristics of each ethnic group, making one ethnic group different from another. Ethnic identity includes the enduring values and the essence of the Vietnamese ethnic communities, which have been nurtured throughout thousands of years of history. The cultural identity of each ethnic group is often expressed through customs and practices, festivals, language, cuisine, traditional clothing, etc. However, this article focuses on two aspects of cultural identity among ethnic minorities in Bac Ha district, Lao Cai province: traditional festivals and cuisine. This is because these are elements that can easily leverage social media to help ethnic minorities develop household economies.

2.2.1. Traditional festival

Traditional festivals in Bac Ha are one of the unique types of heritage that strongly reflect the cultural identity of the ethnic groups. They clearly express the spiritual and cultural life, the worldview, and other folk cultural activities. Therefore, festivals are one of the special cultural forms that have a great attraction to both domestic and international tourists.

a. Horse Racing Festival

This traditional festival has a history of formation and development spanning hundreds of years and is organized by the Mong, Tay, and Phu La ethnic communities living in the communes of the district. Currently, many households in Bac Ha district still raise horses and care for breeding horses to supply the best racehorses. Horse racing in Bac Ha is not a competition between professional athletes but involves local farmers, and the racehorses are pack horses. Particularly, horse racing in Bac Ha is "wooden racing," where the riders race without saddles, stirrups, or footrests but only with a horse strap and two metal hooks tied to the reins on each side of the horse's jaw to control it.

b. Rice Planting Festival

Every year, on the 15th day of the first lunar month, the Tay people of Na Hoi commune (Bac Ha district, Lao Cai) eagerly prepare for the rice planting festival, a traditional festival rich in folk culture. The rice planting festival here consists of two parts: the religious ceremony and the festival activities. The religious part begins with the ritual of carrying soil and water. The procession always starts very early, even before the first light of day. The festival activities begin with dances and folk art performances unique to the Tay people, such as fan dance, scarf dance, stick dance, love duet singing, and more.

c. Fire Jumping Festival

The Fire Jumping Festival of the Red Dao people in Nam Det commune was first held in 2018 at the district level. It is a unique cultural activity aimed at preserving and promoting the traditional cultural identity, fostering courage, and encouraging people to face challenges. The festival also promotes unity within the community and encourages good deeds. The festival concludes with a lively round of "xoè" dance, which connects the spirit of solidarity between the local people and tourists visiting Bac Ha for sightseeing and relaxation.

d. Say Xán Festival

The Say Xán Festival is an annual celebration of the Mong people, marking a beautiful cultural tradition during the Lunar New Year. It is a time for the local people to pray for favorable weather, a bountiful harvest, and peace and health for all households. The festival is also an opportunity for young men and women to meet, get to know each other, and form romantic relationships. The festival consists of two main parts: the religious ceremony, which includes traditional rituals, and the festival activities, which feature cultural performances, sports events, and folk games. These activities bring a joyful and healthy atmosphere to the community and visitors during the Lunar New Year. It can be affirmed that the festivals, rich in cultural traditions of the ethnic minorities, have truly created a unique identity for the tourism of the highland region of Bac Ha, attracting an increasing number of domestic and international tourists to the "White Plateau."

2.2.2. Cuisine

a. Black Chung Cake

Unlike the green chung cake found in the lowlands, the Tay people of Bac Ha (Lao Cai) have a unique version of the cake, made with rice mixed with charcoal from the Nuc Nac tree and several other local spices. On the outside, the black chung cake is wrapped in green dong leaves, but it is not square-shaped. The Tay people's black chung cake is wrapped in a round, gourd-like shape, similar to the Gai ethnic group's gourd-shaped cake. The ingredients are quite special and have the taste of the highlands: glutinous rice from terraced fields, cardamom, black pig meat, green beans, and notably, the black color of the cake is created from charcoal of the Luc Lac tree in the forest. The charcoal is finely ground and mixed with rice to achieve the black color. To prepare the filling for the cake, cardamom is roasted or fried with its shell and seed, then finely ground and mixed with pork belly to create a fragrant filling. Before boiling, the cakes are soaked in cold water, then placed in a pot and covered with water. Typically, the black chung cake is boiled for about 8 to 9 hours.

b. Five-Color Sticky Rice

This unique dish is often prepared by the Tay, Nung, Mong, and Dao ethnic groups in the highlands of Lao Cai during festivals and holidays. This sticky rice is not only sticky and fragrant but also visually striking with five main colors: green, red, purple, yellow, and white, derived from forest leaves and local specialties only grown in the highlands. The ingredients include fragrant glutinous rice grown in Bac Ha, which is large and round, free from any regular rice. The rice is washed and soaked in water for 6-8 hours, then divided into five equal parts to be dyed using various natural ingredients. Red color comes from gac fruit or red rice leaves, green from ginger or "deng" leaves, yellow from old turmeric root, and purple from a fragrant medicinal leaf. The five-color sticky rice is often featured in wedding banquets, New Year celebrations, and housewarming events. Locals believe that the more vibrant and accurate the colors of the sticky rice, the more luck and happiness the family will have in the new year.

c. Thang Co Bac Ha

Thang Co is a traditional dish of the Mong people in Bac Ha. Over time, this dish has been adopted and adapted by many ethnic groups, yet it still retains its characteristic flavor,

primarily made with the offals and bones of horses and cattle. Thang Co is cooked with numerous herbs such as star anise, cardamom, cinnamon, and five-spice powder. At the weekly market, people often cook Thang Co in large pots for dozens of people, simmering it for several hours until tender. When served, the dish is ladled into small bowls. Enjoying Thang Co with a cup of corn wine or apple cider will surely provide tourists with an unforgettable experience.

d. Corn Wine of Bac Ha by the Mong People

To make this specialty wine, locals spend a considerable amount of time and effort. The water used for brewing comes from mountain springs. After corn is harvested, it is dried for 1 or 2 days before being stored on the rafters. When brewing, the corn is peeled, with damaged or shriveled kernels discarded, and the good kernels are boiled. After boiling, the corn is mixed with a specific amount of "hong my" yeast, then left to ferment on the earth floor of the house. The temperature must be controlled to avoid it being too hot or too cold. When the corn starts to ferment, white powder appears on the kernels, signaling it's time to put the corn into a container. After 5 to 6 days of fermentation, it is placed in a wooden barrel for distillation. The corn wine is brewed over a wood fire, ensuring the heat is steady and low. The wine is topped up with water to prevent burning. Bac Ha corn wine has a clear color like spring water and a strong fragrant aroma. When first drunk, it has a sharp, spicy taste, but as it slides down the throat, a warming sensation spreads throughout the body, followed by a soothing, gentle aftertaste.

3. Solutions for Effectively Using Social Media to Promote Traditional Cultural Identity of Ethnic Minorities

Each social media platform has its own effectiveness and reach, with varying numbers of users. According to the latest social media statistics, the majority of social media users in Vietnam, aged 16 to 64, frequently access Facebook (89.7%), followed by Zalo (88.5%) and TikTok (77.8%), with Facebook Messenger (76.6%) and Instagram (47.6%) next in line. This order reflects the preferences of Vietnamese users for different social media platforms.

However, when considering the time spent on each application, there is a noticeable shift. TikTok leads with 21 hours and 14 minutes, followed by Facebook with 28 hours and 21 minutes, and YouTube in third place with 26 hours and 26 minutes. This indicates that while Facebook has a high usage rate, users spend a significant amount of time on other platforms like TikTok and YouTube. From this, it is clear that Facebook, TikTok, and YouTube are the most popular social media platforms, with the potential to expand the reach for the ethnic minorities of Bac Ha if they are able to engage with and connect to a wider network of customers on these platforms. This presents an opportunity for them to increase income and improve household economies. This study will focus on proposing solutions that correspond to these social media platforms. Ethnic minorities can use the following strategies to enhance influence and sell products for profit:

Firstly, guiding the people to build personal brands and images before selling products: Building a personal brand is understood as the sum of all the impressions, beliefs, and perceptions that people have about an individual. When someone successfully builds a personal brand, they become well-known, their name is remembered, and people follow all their activities. At that point, they can take advantage of this and sell products. For ethnic minorities, they can create clips and post photos showcasing their unique customs, the distinct culture of their locality, and the process of making traditional clothing, to stimulate curiosity from people outside their region. This way, they can build their own brand, get noticed by a wide audience, and eventually start selling the typical products of their ethnic group.

Secondly, training and enhancing the understanding of the people to sell products and local specialties on social media platforms: If starting with personal brand building takes a long time, people can begin promoting and selling their products or local specialties directly on their personal accounts. Methods they can use include posting videos and images about the production process, prices, promotions, and special offers. Especially since social media platforms favor short videos, it's crucial to provide guidance on how to make such videos and use photo and video editing apps. Additionally, they need to be trained on live streaming techniques, customer interaction, and writing engaging posts that contain all necessary information to attract viewers.

Thirdly, guiding people to organize workshops where they can experience making traditional clothing, local dishes, and participating in traditional festivals for tourists and people from other ethnic groups in Bac Ha district and Lao Cai province: Workshops will be an opportunity for people to introduce the cultural identity of their ethnic group. Currently, some programs are already in place, but the promotion of these events is limited, and they haven't attracted as much attention from the local community.

By adopting these strategies, the ethnic minorities in Bac Ha can effectively use social media to showcase their unique cultural heritage and enhance their economic prospects through the sale of local products and experiences.

3. Conclusion

Entering the 21st century, the field of information technology has achieved many accomplishments, allowing the internet and social media platforms to reach everyone and influence their daily lives. Thanks to the attention from the Party and the State, as well as large telecommunications companies in the country, in the past 4-5 years, the 3G and 4G mobile networks have become widely accessible to the public. This development has enabled ethnic minorities in Bac Ha district, Lao Cai province, to easily participate in social media platforms like YouTube, Facebook, Zalo, TikTok, WeChat, and more. These platforms are not only tools to help ethnic minorities find information and stay connected with family and friends, but also provide opportunities to increase income and improve household economies if used effectively.

Especially in Bac Ha town, where 18 ethnic groups coexist, the region boasts an incredibly rich cultural heritage, making it an ideal opportunity for ethnic minorities to showcase their festivals, local products, and unique cultural practices to people throughout the country.

The ability of ethnic minorities to access diverse sources of information has been enhanced, leading to significant changes in their lives. Social connections are becoming easier and more convenient, especially in terms of establishing relationships beyond geographical borders. Ethnic minorities need to take advantage of their unique cultural heritage to promote traditional festivals, customs, and local products like the five-color sticky rice, maize wine, black rice cake, and *thắng cố*, and share them with people across the country. This not only helps improve the economic situation of ethnic minority households but also aids in promoting and preserving the distinctive cultural practices of

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Developing Creative Tourism Towards Sustainable Tourism: Lessons Learned from Thailand and Implications for Vietnam

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Abstract

Creative tourism is a type of tourism where travelers have the opportunity to develop their creative potential through immersive learning experiences at destinations. Drawing from international experiences in creative tourism development, this paper extracts practical lessons for Vietnam. These include: (1) developing creative tourism alongside cultural industries and the creative economy under government and institutional guidance; (2) fostering community-based creative tourism by promoting value co-creation between communities and tourists with a sustainability orientation; (3) establishing a strong destination branding strategy for creative tourism; and (4) emphasizing research on creative tourism development. Learning from the experiences of successful countries, such as Thailand, is an essential component in shaping Vietnam's creative tourism strategy.

Keywords: creative tourism, creative tourism development, sustainable tourism

1. Introduction

Travel for sightseeing, admiring new beauty, or exploring foreign cultures concepts that were prevalent in the past century now seem less engaging and inspiring. To motivate individuals to leave their homes, abandon gaming consoles, favorite TV shows, or other passive entertainment forms to spend time traveling, a more compelling reason is often needed. Modern tourists increasingly seek deeper, more memorable journeys that go beyond merely admiring landscapes or cultural heritage. UNESCO has termed this "the new trend in tourism" creative tourism.

Creative tourism is a subset of cultural tourism. It emphasizes active involvement and sustainable community development, where tourists move beyond passive observation and instead actively participate in and engage with local life. As such, tourists take on roles akin to members of the destination rather than simply being spectators. This form of tourism highlights the connection and interaction between travelers and the local culture, particularly with indigenous communities. In creative tourism, the visitor's activities go beyond relaxation or passive sightseeing to encompass meaningful engagement. While it is a form of cultural tourism, creative tourism stands out as "the tourism of the new generation," distinctly different from traditional forms of cultural tourism.

Whereas cultural tourism emphasizes "observation," "enjoyment," and "reflection," creative tourism focuses on "experience," "participation," and "learning." The hallmark of

creative tourism lies in enhancing awareness, acquiring new life experiences, and accessing unique knowledge from local communities. Creative tourists are not content to remain passive observers of the world through a narrow, subjective lens; they actively seek immersive experiences. For instance, a tourist interested in wine might visit France, someone eager to learn spaghetti-making would go to Italy, and those curious about Sumo wrestling might head to Japan.

From the perspective of sustainable development, both cultural tourism and creative tourism are considered responsible tourism forms. However, while the resources for cultural tourism often involve non-renewable and irreplaceable heritage elements, creative tourism leverages the cultural values, knowledge, and lived experiences of local residents. This represents a robust, evolving, and dynamic resource base that continues to grow and develop over time.

2. Content

2.1. Lessons from Thailand’s Creative Tourism Development

Creative tourism has the potential to generate significant profit growth, address local labor needs, and, more importantly, contribute to the preservation and conservation of cultural identity. The concept of "creative tourism" is particularly well-suited for the exploration and development of craft villages. This has been clearly demonstrated by the success of many countries worldwide, particularly Thailand, Vietnam’s neighboring country.

Thailand is an incredibly appealing destination. Despite recent political instability, the country's ability to attract international tourists remains impressive. Thailand’s tourism sector emphasizes development through the effective utilization of the uniqueness of its history, archaeology, ethnic diversity, traditions, culture, and natural resources. The Thai tourism industry consistently strives to provide visitors with distinct experiences and perspectives, even from human-made resources that may initially seem ordinary. The critical factor is not necessarily the type of resources held but how they are transformed into distinctive attractions.

When establishing creative tourism models in a particular locality, such as the "One Tambon One Product" (OTOP) program, the Thai tourism sector carefully analyzes the advantages and challenges of each region. These models are refined through extensive discussions and feedback sessions. Local communities are encouraged to contribute ideas and actively participate in implementation, thus helping to preserve their cultural identity. Successful ideas and models are promoted and expanded to neighboring regions. Local communities play a foundational role in sharing and applying knowledge, fostering appeal, and ensuring sustainable development through creative efforts.

To date, over 35,000 products have been registered under the OTOP initiative. Among these, approximately 70% of OTOP products are established by community-based businesses. The initiative has identified 569 five-star products, including:

Table 1. List of 5-Star Products of OTOP

Food	263 products	46,23%
Textiles	122 products	21,45%
Decorations	85 products	14,84%
Herbal products	37 products	6,51%
Handicrafts and souvenirs	33 products	5,8%
Drink	29 products	5,1%

Through the operations of OTOP, revenue reached 16,700 million baht in 2002 (equivalent to 6.5 trillion VND) and soared to 38,474 million baht (15 trillion VND) within the first nine months of 2005.

DASTA: Community-Based Creative Tourism for Sustainable Development

Thailand has positioned itself as “Asia’s first creative tourism destination” since the early 2010s (Wattanacharoensil & Schuckert, 2016). Creative tourism in Thailand emphasizes the co-creation of value among multiple stakeholders throughout all phases of the development process from idea generation to implementation and equitable benefit sharing. This approach marks a paradigm shift from a top-down, macro-level imposition to a bottom-up model, where the local community independently participates and is empowered to develop creative tourism products.

The Creative Tourism Development Project, spearheaded by the Designated Areas for Sustainable Tourism Administration (DASTA), has been implemented since 2018. The project aims to leverage the cultural diversity and unique characteristics of each locality to create distinctive and appealing tourism products rooted in the culture of the destination. These products are co-created through collaborative experiences and innovations. After its pilot phase, DASTA successfully implemented 39 community-based creative tourism development projects. Eight projects in two regions, NAN and SUKHOTHAI, were selected for further development due to their readiness and market accessibility. Since the inception of DASTA’s creative area development initiatives, local communities at the destinations have shown increased participation in tourism innovation and management, as well as enhanced collaboration with stakeholders. Indigenous communities have been further empowered and guided to preserve and innovate upon their cultural foundations.

The VICM and 3S models were introduced, establishing responsible value chains to deliver sustainable and meaningful creative products to the appropriate consumer groups. The core focus of these models lies in fostering engagement and interaction among stakeholders, with particular emphasis on the co-creation of value throughout the tourism process.

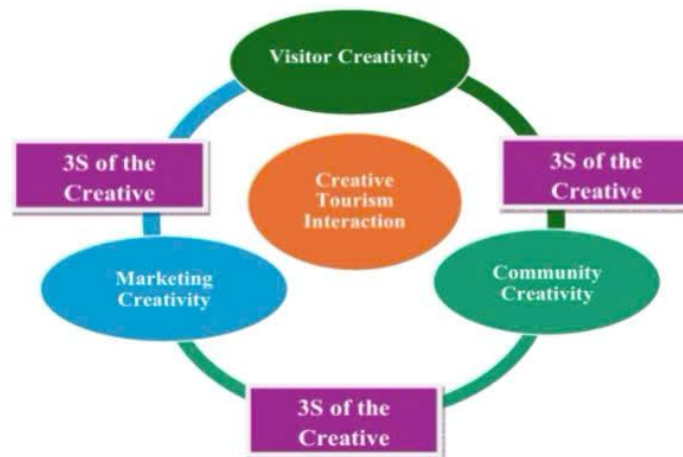


Figure 1. VCMI (Visitors - Community - Marketing - Interaction) model in Creative Tourism

The process and significance of connection in creative tourism are based on the 3S model (Stories, Senses, Sophistications), aimed at optimizing creative exchange, experiences, and perceptions through learning activities and deepening understanding of cultural and creative values. The 3S model outlines 10 core components of creative tourism that destinations and localities should consider when developing creative tourism:

Stories: Meaningful narratives about local heritage and cultural resources.

- (1) All activities, products, and creative experiences should originate from profound and comprehensive storytelling about local heritage and lifestyles.
- (2) Local storytellers or artists should craft captivating narratives and experiences that inspire visitors to learn and engage.

Senses: Genuine, immersive perceptions of cultural resources and heritage through participatory creativity.

- (3) Creative activities should be designed to provide learning experiences that engage tourists in a profound understanding of culture, guided by local experts and artisans.
- (4) Creative activities should offer hosts and tourists opportunities to connect, participate, share, learn, and co-create.
- (5) Creative activities should engage all senses, including hearing, touch, taste, sight, and smell, for a comprehensive experience.
- (6) Creative spaces should be designed to stimulate and showcase the creativity of all stakeholders involved.

Sophistications: Refinement in crafting experiences, presenting heritage, and conveying creativity.

- (7) Programs should encourage creativity and allow both communities and tourists to express their creative potential.
- (8) Activities should enable tourists to develop and showcase their creative potential effortlessly.
- (9) Creative tourism designers should define messages, establish branding, and create marketing campaigns for creative tourism.
- (10) Designers should communicate the uniqueness of activities and continuously innovate upon that foundation.

The 3S model has become a crucial guideline for localities, destinations, organizations, and individuals in implementing creative tourism development. Furthermore, the DASTA

project has successfully developed a **Creative Tourism Design Toolkit**, which provides guidelines for local communities to expand services and design experiences. The toolkit emphasizes the development, conceptualization, and enrichment of tangible and intangible cultural elements (Richards, Wisansing & Paschinger, 2019).

At the national level, the Tourism Authority of Thailand (TAT) has launched a program titled “**Discover Yourself**”, aimed at enhancing awareness among tourists and Thai citizens of their creative potential within the framework of Thai culture. Currently, DASTA continues to act as a coordinator, fostering ongoing positive dialogue between localities and related economic sectors to sustainably deliver diverse, distinctive creative products, services, and experiences across various regions of the country.

2.2. Experienced lessons for

Vietnam possesses numerous conditions and opportunities to develop creative tourism, thanks to its rich and diverse tourism resources, including unique cultural values, appealing cuisine, and beautiful natural landscapes. Additionally, the rapid development of tourism infrastructure and information technology allows tourists to easily access new social trends. The development of creative tourism in Vietnam contributes to diversifying and enhancing the quality of the tourism product system, increasing product competitiveness, preserving cultural values, engaging the community in tourism development, and creating a distinctive tourism brand that attracts visitors through social media effects.

From Thailand's lessons on constructing and developing creative tourism destinations and products based on co-creation experiences between tourists and local communities, as well as integrating culture, history, creativity, and tourism to form creative tourism destinations, it can be seen that the development of creative tourism can take many different directions, models, and approaches. The choice of methods, management models, and development strategies depends on the characteristics of each destination and the specific stage of development of tourism and the cultural and creative industries. For the development of creative tourism in Vietnam, key lessons include:

First, the Government and relevant state agencies for tourism and culture should consider the development of a comprehensive strategy for the cultural industries, creative economy, cultural preservation, and tourism. This strategy would serve as a crucial foundation for policies, planning, and development strategies in each field, ensuring a multi-faceted, unified, and sustainable approach. From a top-down management perspective, the government and tourism and culture agencies should establish regulations to implement and promote the creative economy, cultural industries, and tourism. There should be a priority for investment in developing tourism clusters and destinations in underdeveloped regions, supporting minority areas in building cultural institutions such as museums, galleries, theaters, and cultural and artistic programs. These initiatives aim to develop new cultural creativity while preserving and promoting the traditional cultural values of local communities. Moreover, the government should also create favorable mechanisms to boost and attract investment in the development of the cultural industry, creative tourism, and digital technology applications, as well as the use of social media for culture and creativity. The focus should be on creating outstanding and attractive creative experiences. Gradually, the cultural and creative tourism industries should become distinctive strengths within the broader development of the creative economy, contributing to expanding global recognition of Vietnamese culture.

Second, local communities must always be at the center of creative tourism and cultural industry development. Local communities should be empowered to develop diverse products, experiences, and creative tourism destinations based on the distinctive cultural values of each

region. In this regard, the role of the state and tourism agencies in supporting local communities should include activities such as guidance, training, public outreach, and encouraging benefit-sharing. These actions aim to gradually enhance the capacity of local communities and stakeholders regarding creative tourism, product development, and creative tourism experiences. Experimental models of creative tourism and products should also be implemented. Drawing on Thailand's experiences, Vietnam can experiment with models that embrace the diversity and unique features of each region's culture to create unique and attractive tourism products connected to local culture through co-creation experiences. In addition to designing creative tourism products, attention should be given to preserving heritage at risk of disappearing and creating opportunities for younger generations to understand, engage in, and contribute to the preservation of traditional culture. Models should be tested, and if successful, they can serve as exemplary models to be replicated in other regions. Furthermore, it is essential to research and develop tools and guidelines for smaller communities and local artists interested in developing creative tourism products, services, and activities with the participation of tourism experts, community leaders, creators, and enterprises. These individuals should also act as facilitators to encourage ongoing, positive dialogue between regions and relevant economic sectors to ensure the sustainable provision of diverse, distinctive creative products, services, and experiences across the country.

Third, positioning creative tourism destination brands. Thailand's experience shows that positioning as an event and entertainment tourism destination not only generates significant revenue from entertainment and creative products and services but also serves as a core strategy for attracting tourists to consume products and services from the tourism, hospitality, and food sectors. Positioning the creative tourism destination brand will allow Vietnam to harness the unique strengths of each region and destination.

Fourth, attention should be given to research and development in creative tourism. Implementing in-depth research will provide the foundation for effective planning, cultural and artistic value exploitation, and the development of creative tourism products that are adaptable, diverse, and highly personalized. Vietnam has significant opportunities for creative tourism development, thanks to its rich tourism resources with diverse cultural traditions, appealing cuisine, and stunning natural landscapes. Furthermore, the rapid development of tourism infrastructure and information technology allows tourists easy access to new social trends. The development of creative tourism in Vietnam will help diversify and enhance the quality of the tourism product system, increase competitiveness, preserve cultural values, and engage communities in tourism development.

3. Conclusion

The above are some insights and lessons for the potential application of creative tourism in Vietnam, aiming towards sustainable tourism development. However, for this model to develop and truly benefit local residents, in addition to the inherent cultural and ecological values of the destination, the following conditions need to be considered:

- Implement a bottom-up management model, originating from the community, fostering sustainable development rather than mass tourism.
- Develop community-based tourism models (such as homestays) in suitable villages, ensuring quality accommodation, food, sanitation, food safety, and healthcare facilities.
- Improve the management skills and train local community members in tourism, while also integrating professional staff.
- Refine creative tourism products and programs.

- Build a destination promotion plan, with a strong focus on online communication channels.

Furthermore, the greatest challenge lies in the issue of **human resources**. It is no coincidence that the concept of "creative tourism" emphasizes the local population as the core foundation for tourism development. No one can understand a tourism destination better than those who were born and raised in that area. It is these people, with their lifestyles, customs, and habits, that are the resources that enhance the destination and make it attractive to tourists. And if they are fully aware of the benefits and the unique values of their homeland, they will be the most active and effective agents in preserving and maintaining the cultural identity.

The attraction of people is both easy and difficult. The friendliness, the natural hospitality, and the cozy family atmosphere that international tourists find particularly appealing as a manifestation of the "happiness index" these are things that Vietnamese people have always been proud of. But is this still intact today? Can we achieve something like Yufuin, transmitting a powerful message - "Feel your travel like a living" and "Feel your life like a travelling"? In other words, "Experience your trip as if you are living, and perceive your life as if it is a journey."

When interacting with such local residents, which tourist would not be willing to work alongside them, learn their crafts, eat at the same table, and become a part of the family, experiencing that simple happiness that no amount of money could buy? Above all, this is about culture in tourism the sincere emotions expressed by local people in welcoming visitors. Tourists come, experience, and then return to their familiar places. Cultural tourism is not just a service, but the spark that shines through all the tourism services offered. Perhaps this is the fundamental philosophy that explains why tourists desire to return to these destinations, not just once or twice, but think of them as a place to long for

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Develop Speaking Skill for Learners Through Some Experiential Activities

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Abstract

The development of socioeconomic in the context of globalization requires new criterions for employees about foreign language capability, which also raises the new requirements for education in teaching language to young learners and national human resources. One of the basic orientations in reforming of teaching language methods is changing from academic theory to focus on developing skill, capacity, and creativity for learners. It should be better to teach language as a skills course, from using traditional teaching methods to teach language to help learners how to use it in their future career. In fact, learners are not very good at using language in communicating. Therefore, teaching foreign language through experiential activities to help develop learners' competency. This article introduces some experience activities that used for some classes at Thai Nguyen University Lao Cai Campus.

Keywords: Learning activity, experiential activity, develop, speaking skills, learner

Introduction

1. Statement of the problem

In today's trend of globalization, integration and development, English is considered the key to open the door to international integration. English is also an important language in all areas of social life and plays an important role as a communication tool for the development of economic, scientific and technological the country and regional integration, as well as for cultural exchange between countries in the region and the world. However, the ability to use foreign languages for communication of learners is still limited due to objective and subjective reasons. Therefore, teaching and learning foreign languages at all levels of education need to focus on forming and developing foreign language skills for learners through experiential activities, active and creative learning methods closely linked to practical activities.

Teaching through experiential activities in the early years of the 20th century, and has been studied and applied in many countries, including vocational education and training (Kolb and Kolb, 2011). Training linked to practice, enhancing professional experiences is one of the innovative solutions in teacher training in our country today to meet the needs of human resources to serve the educational innovation (Ministry of Education and Training, 2005). According to Steve et al. (1995), teachers play a very important role in contributing to a successful experience, which is the role of guiding the organization of teaching so that learners can participate in the experience.

Learning from experience is like learning through doing, but learning through experience helps learners not only gain the ability to perform but also experience emotions,

willpower and many different psychological states. Through their own experiential activities, each student is both a participant and a designer and organizer of their own activities, so they not only know how to actively promote themselves, explore themselves and adjust themselves, but also know how to organize activities, organize their lives and know how to work with a plan and responsibility.

2. Some general issues about experiential teaching

Experiential teaching comes from the term experiential education, which is a teaching perspective that includes many methods that encourage learning with specific experiences and focus on reflecting on the experiences gained to enhance knowledge, develop skills, values and personal character (Association for Experiential Education, 1977). The study uses the term experiential teaching to emphasize the process of applying teaching methods and forms according to the experiential education perspective to specific teaching activities in schools, including two closely related teaching and learning processes.

3. Experiential learning cycle

According to David Kolb, the experiential learning model has 04 stages corresponding to 04 learning styles including; experience, reflection, summary and application.

Concrete Experience

At this stage, learners experience – experiencing, acting, creating a certain new experience. Learning through experiential activities, specific situations and operations, directly linked to real-life contexts creates a vibrant, positive, dynamic learning environment, contributing to the lively class hours.

Reflective Observation

Entering the stage of observation and reflections, learners analyze and evaluate experiences. Systematically review and check past experiences. Students share, analyze and discuss to unify the viewpoints and the ways of looking at the problems. During this process, learners will have their own lessons and directions.

Abstract Conceptualization

After observing and reflecting, learners will conceptualize the experiences they have received, synthesize and analyze what they have observed to convert into a new knowledge concept system and retain it in their brains.

Active Experimentation

Active experimentation is the stage where learners apply. At this stage, the learning process is through suggestions and testing of problem-solving solutions. Learners use theory to solve problems and make decisions. Kolb's experiential learning model is cyclical, the stages support each other and develop progressively. Learners can enter any stage of the cycle and follow its logical sequence. However, learning is only effective when learners complete the cycle.

Applying Kolb's cycle, learning activities can be designed for learners to go through 4 stages of experience. Starting from which stage is appropriate and effective will depend on the content, characteristics of the learner (learning style) or teaching objectives. The teacher's task is to identify the learner's inherent experience, thereby designing learning tasks in the zone of proximal development, creating an interactive learning environment for learners to learn independently, transforming them into new experiences for themselves.

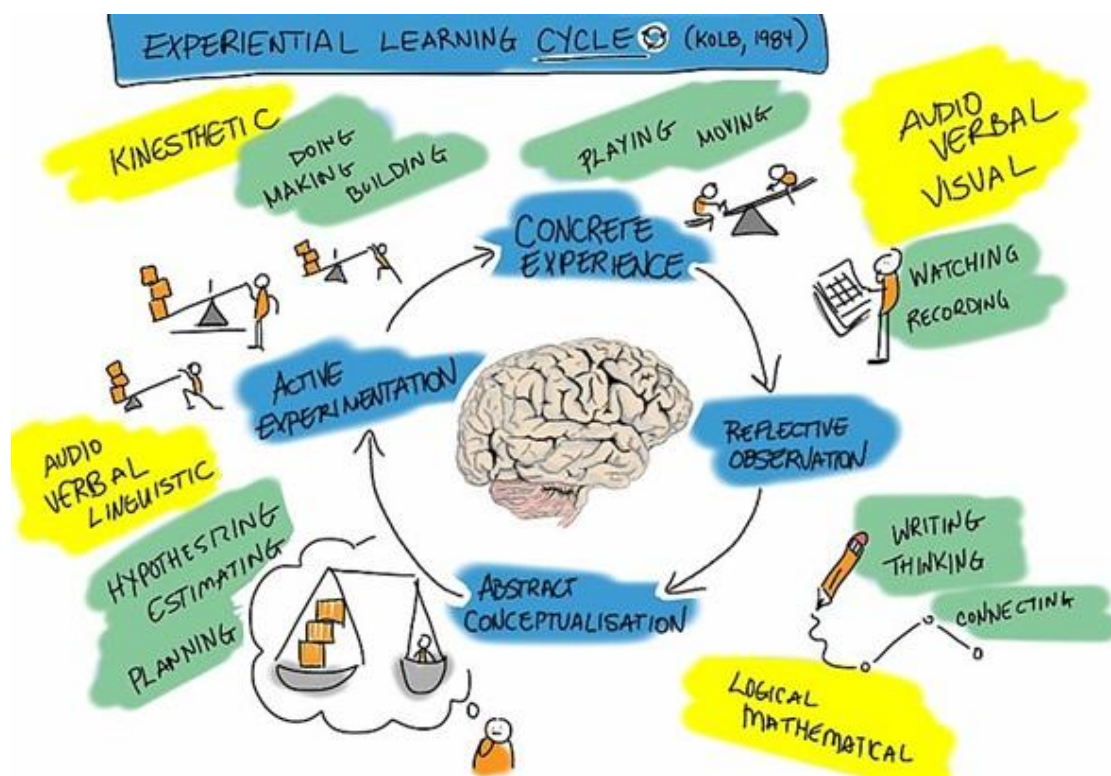


Figure 1. Mô hình học trải nghiệm (David Kolb)

The influence of experiential activities in learning.

Experiential activities are carried out in parallel with teaching activities, and can be carried out during or outside of regular school hours. Through practical activities, specific tasks and activities, learners will be able to demonstrate their potential, have a sense of independence and community. Participating in experiential activities, learners can promote their role as subjects, positivity, initiative, self-awareness and creativity. Learners can experience, express their opinions and ideas, evaluate and choose activity ideas, express and assert themselves, self-evaluate and evaluate the results of their own activities, their group's activities and those of their friends, etc., thereby forming and developing for them life values and necessary capacities.

Experiential activities often have practical content and close to real life, meeting the needs of learners' activities, helping them apply their knowledge to express their ideas and opinions easily and conveniently. Experiential activities aim to orient and create conditions for learners to observe, think and participate in practical activities, thereby encouraging, motivating and motivating them to actively research, find new solutions, create new things on the basis of knowledge learned and what they have experienced in real life, thereby forming awareness, qualities, life skills and abilities for learners.

Some experiential activities.

According to Kolb (1984), Moon (2004), Michelle (2012), Kolb (2014), forms of organizing experiential teaching can be divided into 2 groups: Experiential activities in the classroom (classroom-based learning) and experiential activities outside the classroom (field-based experiences)

1. Game activities.

Game activities are organized for students to learn about a problem or perform actions, jobs or form attitudes through a certain game.

Games are highly creative activities, expressed in choosing a game theme, assigning roles to create situations and playing circumstances.

Game activities are a means of educating and comprehensively developing students' abilities, helping them improve their understanding of the real world around them, stimulating their intelligence, curiosity, and learning how to solve problems and tasks. Games are an active and effective form of entertainment, bringing joy, excitement, innocence, and love of life to students so that they have the motivation to continue studying and practicing better. During the game, all members of the group participate wholeheartedly and from there they will experience, because each individual as well as the group is living in a different situation from what they have lived in real life.

Some language games applied in foreign language classes of students of the branch of the University of Natural Sciences in Lao Cai:

Hot seat

Word jumble race

Word of mouth

Games online: kahoot, Bamboozle, wordwall, Quizizz

2. Role-playing activities.

Role-playing is a method that helps students experience and practice how to behave and express attitudes in hypothetical or imaginary situations. This is also a method that helps them think deeply about an issue and present their opinions, views, and arguments to successfully perform the role. The purpose of this method is not to point out what needs to be done but to start a discussion. Role-playing activities are very important in forming and developing communication skills for students. Through role-playing activities, students are trained and practiced in the ability to behave and express themselves in a communication environment, creating conditions for developing creativity and encouraging positive changes in attitudes and behaviors towards a certain issue or subject.

3. Group work.

Group work is a method of organizing teaching and education, in which teachers divide students in the class into study groups in a way that creates direct interaction between members, from which students in the group discuss and coordinate together to complete the learning task.

Group work is meaningful in promoting the role of the subject, self-awareness, positivity, creativity, dynamism and sense of responsibility. This learning activity creates opportunities for students to express themselves, affirm their own abilities and capacities to perform well the assigned tasks.

4. Talkshow

Talkshow is an interesting speaking activity that helps to enhance interaction and cooperation of students in class. This activity also helps students practice speaking skills and develop soft skills such as acting skills, cooperation skills, teamwork skills, and improve communication skills. Talkshow also helps students quickly remember vocabulary and grammar topics. Talkshow reduces pressure for students in speaking lessons. Through Talkshow activities, it helps to create an interesting learning environment. Talkshow is also understood as Awaken learners' speaking and listening skills. It is an opportunity to learn and an adventure to awaken yourself through developing speaking and listening skills.

5. Exchange between student classes

In teaching and learning English, instead of the teacher speaks, students listen and take notes, teachers should organize interesting activities such as presentations, poster design, and even Tik Tok clips of students speaking English according to trends. All of these activities are related to the lesson and help students remember the lesson faster and become more confident when using English. When organizing exchange classes, students will have the opportunity to demonstrate their abilities and strengths. Exchanging helps students have the opportunity to communicate and exchange English.



Figure 2. Photo of Non-English Learners vs English learners interacting in speaking skills class

6. Experiential college tour

The University of Natural Sciences branch is a beautiful place that many schools in and outside the province come to visit and experience. Thanks to such a scale, students have the opportunity to have us design Tour lessons to help them learn independently and proactively, while also helping students have better interest in studying. Tours in the school space are also a lively and interesting activity in which students play the role of tour guides and visitors.

Although organizing tours takes a lot of time to prepare, it brings a lot of excitement because it combines both knowledge and new outdoor excursions. Tours help students expand their knowledge of natural sciences, history, etc. In addition, students also practice confidence and English listening and speaking skills.

Conclusion

Developing students' capacity through experiential activities aims to train people with aspirations, orientation, creativity, who know how to actively apply learned knowledge into practice, and at the same time know how to share and care for people around them and the community. Know how to use their foreign language skills in practical activities and future careers.

Experiential activities are collective activities based on the spirit of individual autonomy, aiming to develop the creativity and personal capacity of each individual in the group.

The experiential activities presented in this article are suggestions to help innovate teaching methods, develop learners' capacity effectively, and meet educational goals in universities.

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What contributed to the upward mobility in Vietnam?

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Abstract

This paper investigates the trends and drivers of upward mobility in Vietnam from 2002 to 2020. By applying Ray and Genicot's (2023) upward mobility measures, the study shows that Vietnam has achieved economic development without worsening income inequality. After decomposing RG upward mobility, we find that while the composition effect initially drove upward mobility, return effects have become more significant over time. The analysis underscores the importance of economic growth for enhancing pro-poor growth, offering policymakers critical insights for sustainable development.

Keyword: upward mobility, decomposing, Vietnam

Introduction

In recent years, the concept of upward mobility has been extensively discussed in development economics. Upward mobility expresses the capacity of individuals, households, or social groups to rise to a higher social or economic position. In this context, upward mobility strongly correlates with inclusive growth (Ray & Genicot, 2023) and inequality (Corak, 2013). Upward mobility refers to economic growth that generates social benefits, addresses inequalities, and ensures a more equitable distribution of opportunities and outcomes across individuals and regions. This topic has garnered significant attention because many scholars have observed that economic growth contributes to poverty reduction (Dollar et al., 2016). However, the degree of its impact is not even for all individuals in society (Chetty et al, 2020). Existing research on upward mobility has evaluated the extent to which growth benefits the poor (Datt and Ravallion, 1992; Kakwani and Pernia, 2000; Kakwani and Son, 2008; Lakner et al., 2022; Balasubramanian et al., 2023), but it falls short of identifying the factors that enable such growth. On the other hand, studies on upward mobility have offered policy recommendations for achieving inclusivity (Ianchovichina and Lundström, 2009). However, these analyses are often descriptive and lack rigorous empirical evidence, partly due to the absence of a standardized definition and measurement framework for pro-poorness growth. Therefore, the question, of whether economic growth is good for the poor is still not answered well.

In this study, we use a new metric Ray and Genicot (2023) proposed to assess upward mobility and propose decomposition analyses to identify the factors contributing to upward mobility. We apply these new methods to household data from Vietnam which has experienced remarkable economic growth and equality (Benjamin, Brandt, and McCaig, 2017).

Our findings reveal that Vietnam has achieved inclusive growth in the period 2002-2020. Our analysis shows that in the earlier periods, composition effects were the primary drivers of pro-poor growth. Over time, however, return effects have become increasingly significant. Besides that, the composition effect (the impact of household demographic factors such as education levels and job status) is relatively minor. In Vietnam, regional economic performance emerged as a key driver of pro-poorness growth. These findings underscore the importance of economic growth. It suggests that a comprehensive approach that fosters overall economic development while ensuring that the benefits of growth are accessible to the poor is necessary for achieving substantial and sustainable improvements in poverty reduction.

Objectives

- 1) Apply Ray and Genicot(2023)’s measure to show whether Vietnam achieved inclusive growth.
- 2) Propose the decomposing analyses to find out which factors contributed to the upward mobility in Vietnam.

Body

1.Methodology

1.1 Ray and Genicot (2023) and its interpretation

Ray and Genicot (2023) proposed a novel index of upward mobility defined as

$$M_{\alpha}(\mathbf{y}, \mathbf{g}) \equiv \frac{\sum_{i=1}^n y_i^{-\alpha} g_i}{\sum_{i=1}^n y_i^{-\alpha}} \quad (1)$$

where $\mathbf{y} = (y_1, y_2, \dots, y_n)$ is the vector of individual baseline income, $\mathbf{g} = (g_1, g_2, \dots, g_n)$ is the vector of the instantaneous growth rate of income, and $\alpha > 0$ is a parameter that determines the weight placed on the income growth of the poor, or the degree of inclusive of growth. A larger value of α places greater weight on the income growth of the poorer individuals. For example, with $\alpha = 0.5$, individuals earning \$400 receive twice as much weight as those earning \$1,600. If $\alpha = 1$, this relative weight between these two individuals increases to four. Since the actual data typically take the form of discrete-time and no available data at every instant of time, the instantaneous upward mobility (1) does not apply to the existing data. To derive a discrete-time version of the upward mobility that can be applied to the actual data set, Ray and Genicot (2023) impose additional two natural conditions, namely reducibility, and additivity. The reducibility requires that the upward mobility over a given time interval should be fully determined by the collection of the instantaneous upward mobility during the interval. The additivity requires that the upward mobility measure over a given time interval should be the additive aggregation of the upward mobility measures of the sub-interval. With these two conditions, they derive an empirical measure of the upward mobility applicable to the discrete-time data as

$$M_{\alpha}^{\Delta}(\mathbf{y}(s), \mathbf{y}(t)) \equiv \frac{1}{t-s} \ln \left[\frac{\sum_{i=1}^n y_i^{-\alpha}(t)}{\sum_{i=1}^n y_i^{-\alpha}(s)} \right]^{-\frac{1}{\alpha}} \quad (2)$$

where $\mathbf{y}(\tau)$ are the vector of income at time $\tau = s, t$.

We compute the discrete version of the Ray and Genicot (RG) upward mobility (2) by using household survey data. Since they are repeated cross-section data and the sample sizes differ across surveys, we measure the sample analog of the RG upward mobility:

$$\hat{M}_\alpha^\Delta(\mathbf{y}(s), \mathbf{y}(t)) \equiv \frac{1}{t-s} \ln \left[\frac{\frac{1}{n_t} \sum_{i=1}^{n_t} y_i^{-\alpha}(t)}{\frac{1}{n_s} \sum_{i=1}^{n_s} y_i^{-\alpha}(s)} \right]^{-\frac{1}{\alpha}}$$

In the analyses, we set $\alpha = \{0.01, 0.1, 0.5, 1, 2\}$, where the case of $\alpha = 0.01$ puts the weight for the poor only slightly greater than the non-poor

1.2 Decomposing

To investigate the factors affecting the RG index (upward mobility index), we conducted decomposition. The approach decomposes the RG index into the part explained by the observable characteristics and the unexplained part, as in the Blinder-Oaxaca decomposition. This requires several assumptions but is useful for exploring the factors contributing to upward mobility or pro-poor growth.

In the standard Blinder-Oaxaca decomposition, the detailed decomposition is derived from the following expressions:

$$\begin{aligned} \hat{\Delta}_S^\mu &= [\hat{\beta}_0(t) - \hat{\beta}_0(s)] + \sum_{k=1}^M \bar{X}_k(t) [\hat{\beta}_k(t) - \hat{\beta}_k(s)] \\ \hat{\Delta}_X^\mu &= \sum_{k=1}^M [\bar{X}_k(t) - \bar{X}_k(s)] \hat{\beta}_k(s), \end{aligned}$$

where $\hat{\beta}_0(t) - \hat{\beta}_0(s)$ represents the omitted group effect, $\bar{X}_k(t) [\hat{\beta}_k(t) - \hat{\beta}_k(s)]$ the contribution of the k th covariate to the composition effect, and $[\bar{X}_k(t) - \bar{X}_k(s)] \hat{\beta}_k(s)$ the contribution of the k th covariate to the wage structure effect.

For the detailed decomposition of the RG upward mobility, we employ RIF regressions as suggested by Firpo, Fortin, and Lemieux (2009).

The RIF regression is simply a standard regression replacing the dependent variable y with the recentered influence function (RIF) of the statistic of interest. The RIF of our distributional statistic $\nu(\mathbf{y}(\tau))$ can be written as:

$$RIF(y(\tau); \nu) = \nu(\mathbf{y}(\tau)) - \frac{1}{\alpha(t-s)} \left[\frac{y_i(\tau)^{-\alpha} - E(y^{-\alpha})}{E(y^{-\alpha})} \right].$$

Then assuming that the conditional expectation of the RIF $RIF(y; \nu)$ is expressed as the linear function of the covariates:

$$E[RIF(y(\tau); \nu) | \mathbf{X}(\tau)] = \mathbf{X}(\tau) \gamma(\tau),$$

we can obtain the the detailed decomposition of RG index by the following procedure:

- 1) Obtain the estimates of RIF ($y; \nu$)

$$R\hat{I}F(y_j(\tau); \nu) = \nu(\mathbf{y}(\tau)) - \frac{1}{\alpha(t-s)} \left[\frac{y_j(\tau)^{-\alpha} - \frac{1}{n_t} \sum_{i=1}^{n_t} y_i^{-\alpha}(\tau)}{\frac{1}{n_t} \sum_{i=1}^{n_t} y_i^{-\alpha}(\tau)} \right].$$

And run the linear regression of $R\hat{I}F(y; \nu)$ on \mathbf{X} to get the estimates of γ for year $\tau = s, t, \hat{\gamma}_\tau$.

- 2) The detailed decomposition can be obtained as

$$\hat{\Delta}_O^\nu = \bar{\mathbf{X}}_t(\hat{\gamma}_t - \hat{\gamma}_s) + (\bar{\mathbf{X}}_t - \bar{\mathbf{X}}_s)\hat{\gamma}_s,$$

where the second term represents the detailed decomposition of the composition effect

$$(\bar{\mathbf{X}}_t - \bar{\mathbf{X}}_s)\hat{\gamma}_s = \sum_{k=1}^K (\bar{X}_{k,t} - \bar{X}_{k,s})\hat{\gamma}_{k,s}$$

and the first term the structure effect

$$\bar{X}_t(\hat{\gamma}_t - \hat{\gamma}_s) = \sum_{k=1}^K \bar{X}_{k,t}(\hat{\gamma}_{k,t} - \hat{\gamma}_{k,s})$$

2. Data

We use the Vietnam Household Living Standard Survey (VHLSS) data to compute the upward mobility. VHLSS is the nationally representative survey with stratified random sampling, which has been conducted biannually since 2002, and the latest available data is for 2020. One important feature of VHLSS is its consistency in the questionnaire, which enables us to compute upward mobility for relatively long periods based on household data.

We calculate upward mobility based on per capita income and expenditure after adjusting for the Consumer Price Index (CPI). Most of the analyses will focus on upward mobility over 6 years. Additionally, we also perform calculations of upward mobility for periods of 12 years and 18 years. Since upward mobility depends on the growth rate, adjusting the inflation appropriately is crucial for obtaining valid estimates of upward mobility. To account for the sampling variation, we compute the standard errors for the upward mobility by bootstrapping clustered by commune which is the primary sampling unit.

Given the disproportional weight to the poor, this measure is also subject to sampling errors, because the sample minimum is not the consistent estimator of the population minimum. Hence we winsorize y_i at 1th and 99th percentiles, as the percentiles are the consistent estimators.

We use many covariates to run the linear regression in calculating RIF, including ethnicity, rural vs. urban, agricultural sector employment, household member employment ratio, dependency ratio, education level of household head, and higher education completion.

Regional Development Metrics include Average agricultural revenue, industrial output, and GDP at the provincial level.

3. The result

First, we compute the RG index over 6 years during the period from 2002 to 2020. Figure 1 reports the trend of the RG index (blue solid lines) with $\alpha \in \{0.1, 0.3, 0.5, 1.0, 2.0\}$, along with their 95% confidence intervals computed by wild cluster bootstrapping. As a reference, we also present the trend of the average per capita growth, which corresponds to the case of $\alpha = 0$. We use per capita expenditure in Panel (A) and per capita income in panel (B) to compute the RG index. The dotted lines report the 95% confidence intervals computed by bootstrapping. The narrow confidence intervals suggest that sampling survey can produce quite accurate estimates of the upward mobility. Reflecting the sustained economic growth during the time period, the measure of the RG index of per capita expenditure consistently takes positive values. Choice of parameter value α did not affect the trajectory of the inclusive growth. Since a larger value of α put more weight on the income growth of the poor, the insensitivity of the upward mobility to the value of α implies that the poor benefited from the economic growth as the non-poor. This argument is supported by the results of the relative upward mobility (red solid lines) close to zero, implying that the income distribution had not been worsened for the poor.

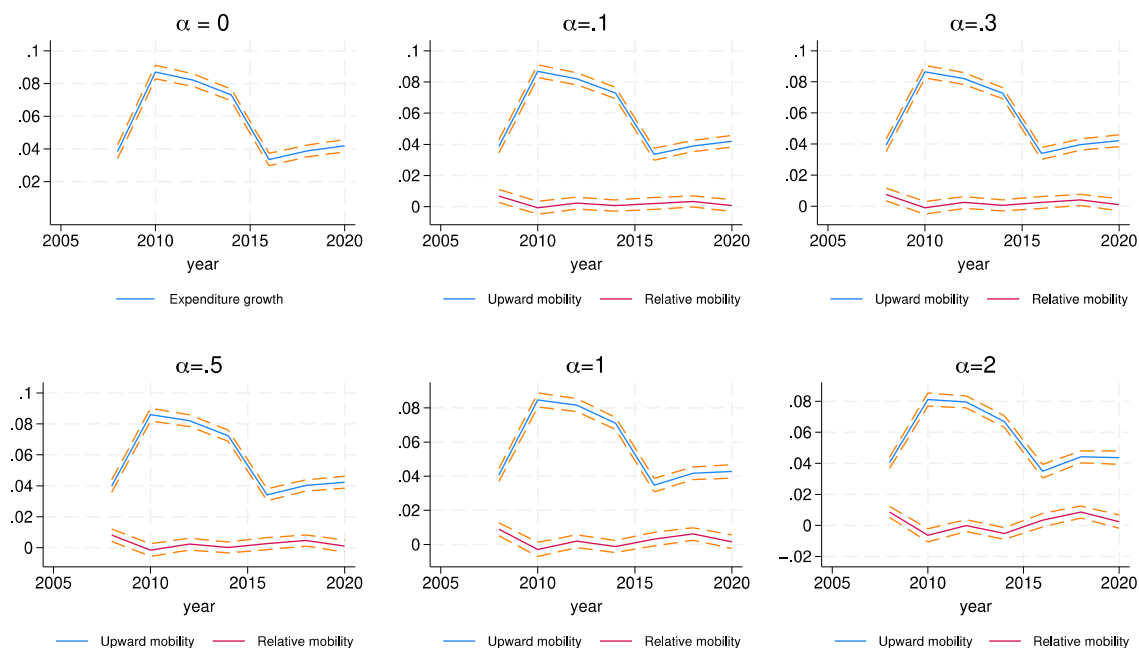
The upward mobility of per capita expenditure also recorded positive values throughout the survey periods, though the trend is slightly different from that of per capita expenditure. Since the trends of the average growth of per capita expenditure and income were similar to those of upward mobility, the different trajectory of expenditure upward mobility and income upward mobility is attributed to the household consumption response to income changes.

Note that the reported upward mobility over 6 years depends on the baseline year, and hence will be high if per capita expenditure or income in the baseline year was not favorable to the households. To mitigate the sensitivity to the difference in the baseline years, we plot the upward mobility setting year 2002 as the baseline year in Figure 2. Compared with Figure 1, the values of the upward mobility are rather stable. The figure shows that Vietnam steadily achieved pro-poor growth since 2002, especially after 2010.

Figure 2 presents the aggregate decomposition results of the upward mobility of per capita expenditure (panel (A)) and per capita income (panel (B)) over 6 years using the RIF regression approach. In panels (A1) and (B1), we include the same variables as in the reweighting approach. In panels (A2) and (B2), we further include provincial-level variables such as the logarithm of provincial GDP per capita, the logarithm of provincial industrial output, and the average agricultural income of households engaging in agricultural activity at the provincial level. For the sake of brevity, we only report the results for $\alpha = \{0.1, 0.5, 2\}$.

Including the provincial-level variables considerably changed the decomposition results, especially for the earlier periods. The improvement in the upward mobility during 2002–2008 was entirely explained by the composition effect once we take into account the changes in the provincial-level variables. This indicates the importance of facilitating regional economic development in achieving inclusive economic development. However, the importance of the composition effect had declined over time even after accounting for the provincial-level variables. Figure 3 presents the results of a similar exercise for upward mobility over 18 years. The magnitude of the composition effect gets larger once we include the regional variables, though its effect is modest reflecting the greater role of structure effects in the later periods.

A. Expenditure percapita



B. Income percapita

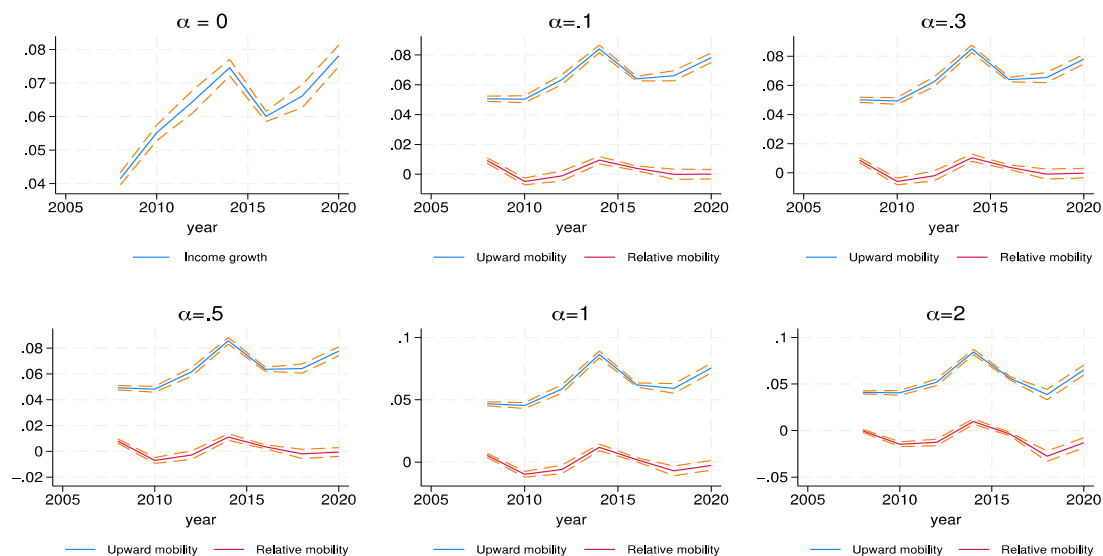
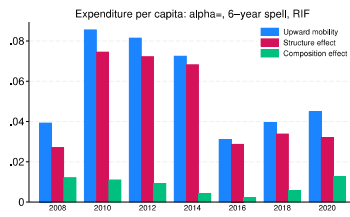


Figure 1. Upward mobility trend in Vietnam (RG index)

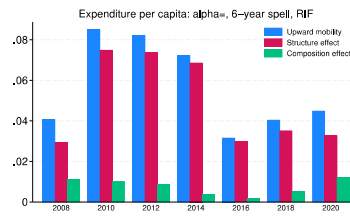
(A) Expenditure per capita

(A1) No regional variables

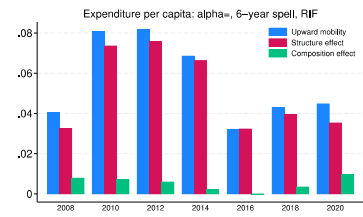
(a) $\alpha = 0.1$



(b) $\alpha = 0.5$

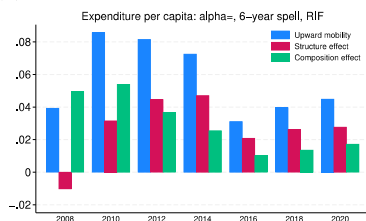


(c) $\alpha = 2$

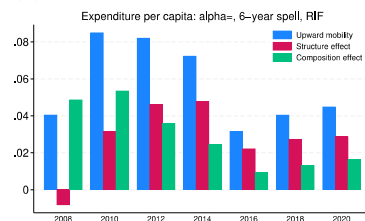


(A2) With regional variables

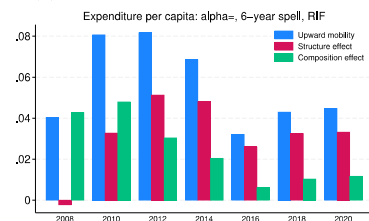
(a) $\alpha = 0.1$



(b) $\alpha = 0.5$



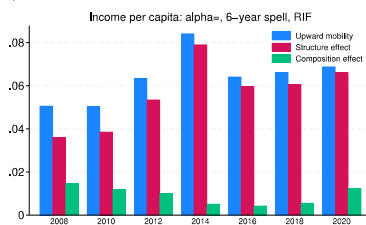
(c) $\alpha = 2$



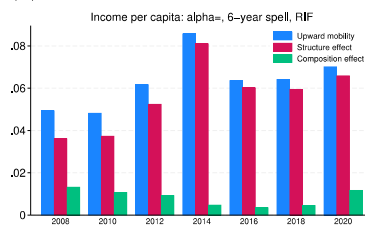
(B) Income per capita

(B1) No regional variables

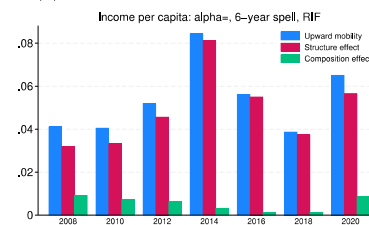
(a) $\alpha = 0.1$



(b) $\alpha = 0.5$

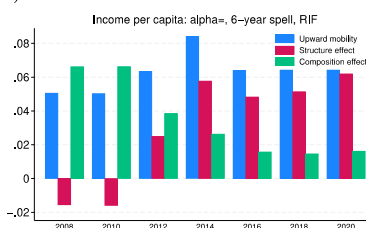


(c) $\alpha = 2$

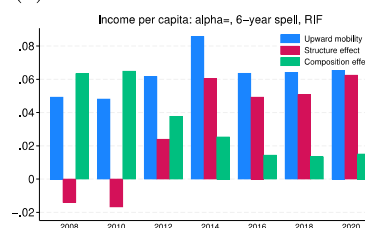


(B2) With regional variables

(a) $\alpha = 0.1$



(b) $\alpha = 0.5$



(c) $\alpha = 2$

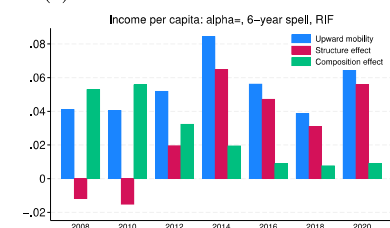


Figure 2. Decomposition using RIF regression approach: over 6 years

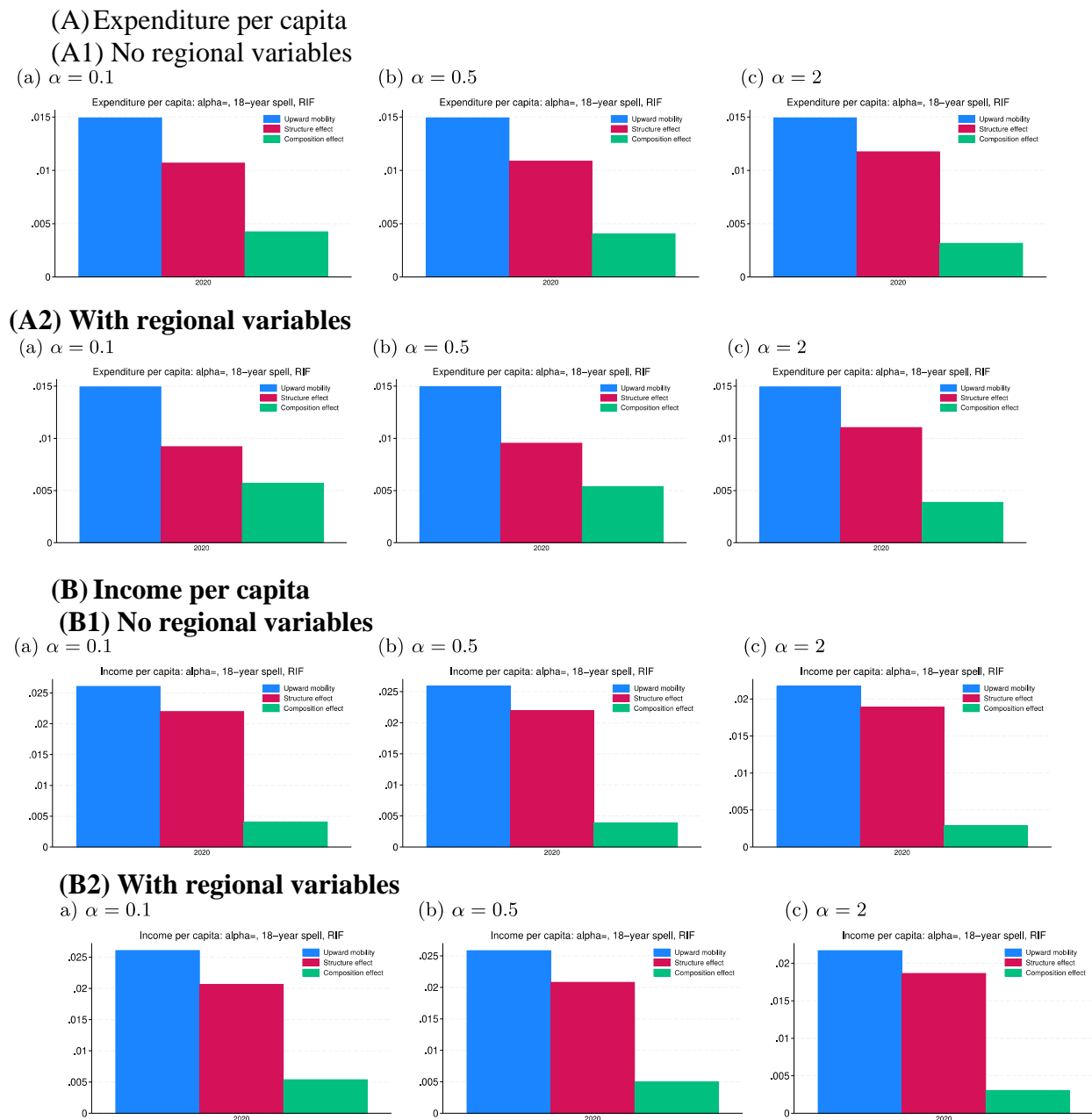


Figure 3. Aggregate decomposition (RIF regression approach over 18 years)

To facilitate the examination of the contributions of various factors to upward mobility, we categorize covariates into three groups: family background, which encompasses household characteristics; education, which includes the educational attainment of the head of the household and whether any family members have attained higher education (university degree or higher); and regional factors, which consist of provincial level variables. Figure 4 present the proportional contributions of these factors to composition effects, while Figure 5 illustrate their contributions to return effects.

The results indicate that, in the initial stage, local economic factors predominantly influence composition effects, irrespective of whether upward mobility is assessed based on income or average per capita expenditure. However, since 2016, education has increasingly played a significant role in affecting composition effects. Regarding return effects, regional

factors consistently have a positive and crucial impact. This highlights the critical importance of economic development.

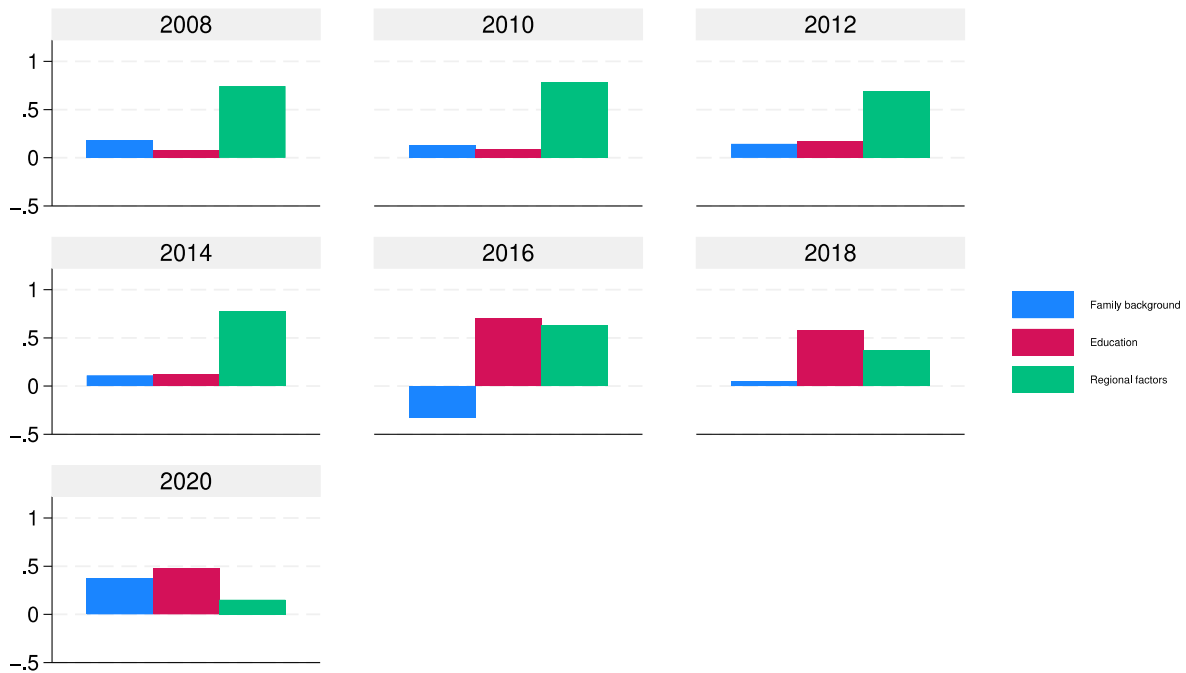


Figure 4. Detailed composition of factors on the aggregate composition of expenditure ($\alpha = 0.5$)

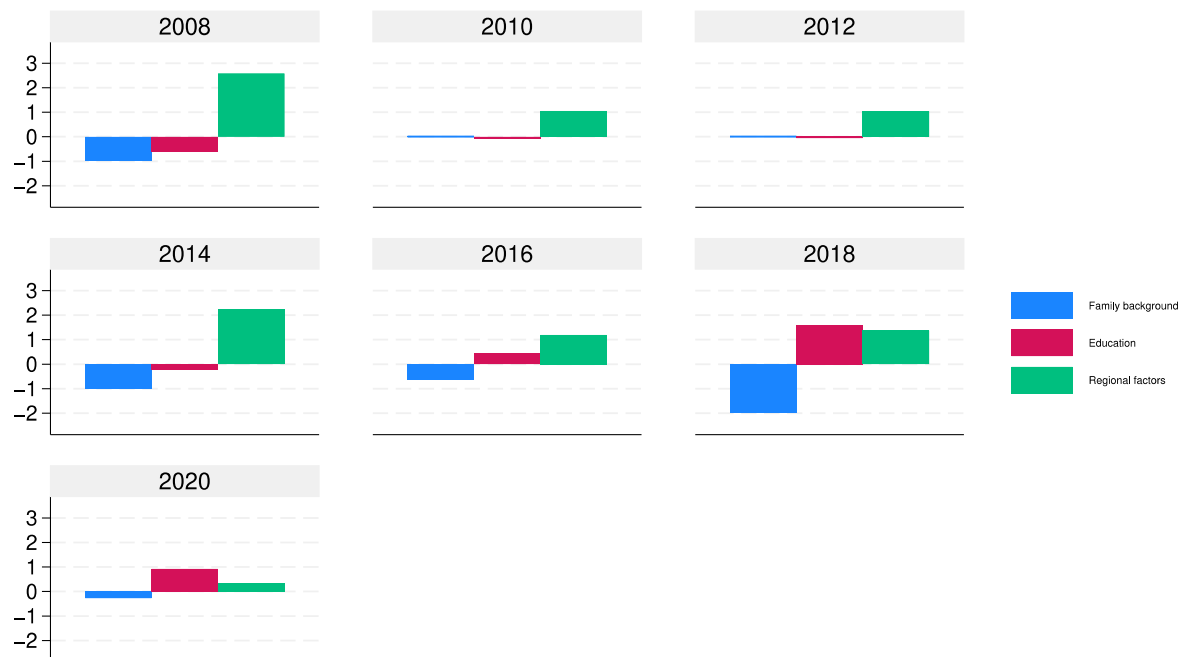


Figure 5. Detailed return of factors on the aggregate return of expenditure mobility ($\alpha = 0.5$)

Conclusion

This study utilized the methodology proposed by Ray and Genicot (2023) to calculate upward mobility, providing a suitable framework for assessing inclusive growth. By performing decomposition analyses of upward mobility, the research offers profound insights into the trends and characteristics of inclusive growth in Vietnam.

The findings demonstrate that Vietnam has achieved economic growth accompanied by support for the poor. Initially, the composition effect was the predominant driver of upward mobility; however, over time, the structure effect has gained increasing importance. The detailed decomposition analysis indicates that economic growth consistently exerts a significant influence on upward mobility. While this study acknowledges the critical roles of family background and education, it underscores that investment in education alone is insufficient for the poor to attain upward mobility. Instead, sustained economic development is essential for enhancing living standards and addressing income inequality.

Methodologically, this study makes two significant contributions. First, it represents the inaugural application in a developing country of the upward mobility calculation method proposed by Ray and Genicot (2023). This research demonstrates the method's suitability for analyzing upward mobility with data that is not a balanced panel, thereby opening up opportunities for similar studies in countries without extensive panel data. Given the structure of the VHLSS dataset in Vietnam, this method can be readily applied to datasets from other countries, facilitating cross-national comparisons of upward mobility. Second, we develop decomposition methods for upward mobility, allowing us to identify the factors influencing or driving upward mobility during different periods. The findings from these analyses can help policymakers understand the dynamics of pro-poor growth and formulate appropriate policies accordingly.

This study suggests two directions for future research. First, it recommends applying this methodology to data from other developing countries to compare the results and determinants of upward mobility, thereby identifying potential differences across nations. Second, it advocates for an investigation into the mechanisms by which factors such as education and economic development influence upward mobility. This would enhance our understanding of these dynamics and inform the development of effective policies.

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Corporate social responsibility and customer loyalty of Commercial banks in Hue city, Vietnam: mediating role of corporate I mage

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Abstract

The purpose of the paper is to evaluate the essential role of corporate social responsibility (CSR) on customer loyalty (CL) by exploring the mediating role of corporate image (CI) in the context of commercial banks in Hue city, Vietnam. Based on an extended literature review on CSR, CI, and CL studies, the authors evaluate the impact of CSR on CL and CI, the effects of CI on CL, and investigate the mediating role of corporate image (CI) in the relationship between CSR and CL. The study follows a quantitative approach. The study sample was composed of 395 customers of commercial banks in Hue city, the Smart PLS SEM version 4.1.0.3 was used to test the hypotheses. The authors' findings reveal that CSR significantly influences CI and CL. Likewise, CI positively influences CL and CI partially mediates the relationship between CSR and CL. It implies that CSR and CI are critical variables for CL of customers in Hue commercial banks. The findings of this study support the results of previous research that explains why operations should engage in CSR activities and CSR, CI can enhance CL.

Keywords: Corporate social responsibility, corporate image, customer loyalty

Introduction

Corporate social responsibility (CSR) topics attract broad attention from researchers, academics, economists and business practitioners around the world for their possible outcomes to aid businesses, society and the environment. Therefore, global enterprises are paying more attention to the strategic role of CSR for their business survival and development (Xiangyu et al., 2020). Latapi Agudelo et al. (2019) provided readers with a comprehensive view of the development process of CSR, the core issues of CSR, helping researchers update research directions and affirming that CSR continues to be a topic receiving the attention of scholars, businesses, stakeholders and especially CSR will be widely accepted in developing economies. Generally, CSR presents the firm's responsibilities to the environment, society, and its stakeholders by balancing the businesses' interests with stakeholders' concerns and social environmental issues.

Due to pressure from the community and stakeholders, along with the context of integration and sustainable development, CSR is receiving increasing attention in the banking industry in Viet Nam in general and in Hue city in particular. Deputy Governor Pham Quang Dzung emphasized that, as a pioneering force in the transformation process and an important

financial supply channel for the economy, the banking sector always identifies its role and responsibility in “greening” the investment capital flows and applying Environmental, Social and Governance criteria to contribute to the implementation of the sustainable development goals (Le Hang, 2024)

The banking system is the lifeblood of the economy; it serves as the primary channel for capital mobilization to support production and business activities, contributing to economic restructuring, building an independent and self-reliant economy, and improving people's livelihoods. Although banking is an important economic sector, research on CSR and the impact of CSR on corporate image and customer loyalty in this industry has so far received little attention from domestic researchers. Meanwhile, empirical studies on CSR and its influence on customer intentions and behaviors in the banking industry in developed countries have shown some interesting results.

1. Research Objectives

1.1 To evaluate the essential role of corporate social responsibility (CSR) and customer loyalty (CL)

1.2 To examine corporate image's (CI) mediating role concerning corporate social responsibility (CSR) and customer loyalty (CL) of Hue commercial banks.

2. Review of Related Literatures and hypotheses development

Corporate social responsibility (CSR)

CSR includes four dimensions namely ethical, legal, economic and discretionary expectations of organization (Carroll, 1979). The concept of CSR has emerged in the early 1950s because of increasing strategic role of companies' contributions toward society's and customer's long term welfare (Carroll, 1999). CSR has many advantages for companies among which, increased loyalty, trust, positive brand attitude and combating negative publicity, are well documented (McDonald and Rundle-Thiele, 2008). Dahlsrud (2008) identified that there were approximately 37 definitions of CSR in literature which were approached from different perspectives. CSR enhances the productivity of the employee, commitment to the organization, and corporate citizenship (Lin et al., 2012). Therefore, socially responsible firms will get more customer responses from society which will generate more revenues than other competing firms (Lichtenstein et al., 2004).

Corporate social responsibility and customer loyalty

Customer loyalty (CL) is a popular concept that “has become a cornerstone for competitive success” (Oliver, 1999). It reflects the customer's positive attitude towards the business and this attitude positively affects their future intention to support the business's offerings continuously (David et al., 2019). Meanwhile, CL also generates a “resistance in consumers to (listen to) possible offers from the competitors” (Oliver, 1999). Moreover, several research studies showed the positive impact of CSR on customer maintenance and loyalty (Aurier and N'Goala, 2010), CSR can also affect loyalty either directly or indirectly (Shin and Thai, 2015). Therefore, the *hypothesis H1 is proposed*:

H1. CSR activities positively influence CL

Corporate social responsibility and corporate image

Corporate image (CI) is the image of an organization as a whole, so not the image of its products and services (Baines et al., 2016). Gürlek et al. (2017) mention that corporate image is the result of one's beliefs, ideas, feelings, and impressions of the company. Numerous studies have explored the influence of corporate social responsibility (CSR) on corporate image across various service sectors (Rasoolimanesh et al., 2023). For instance, when customers perceive

the services of commercial banks as socially responsible, customers develop a positive image in their minds. CSR has a positive relationship with CI according to the findings of Kim et al. (2020). Maldonado-Guzmán et al. (2017a, b) demonstrate that CSR initiatives can enhance the corporate image of small and medium-sized enterprises (SMEs), while Valdez-Juárez et al. (2018) emphasize that socially responsible actions contribute to a stronger corporate image. Furthermore, Sen and Bhattacharya (2001) found that CSR practices foster positive customer attitudes toward businesses, which is a key factor in building both corporate prestige and a strong CI. Therefore, the *following hypothesis is proposed*:

H2. CSR activities positively influence CI

Corporate image and customer loyalty

Corporate image is a mirror that reflects the company as an object and its crops. Loyal customer is more willing to buy the same product over and over, give favorable word-of-mouth and be ready to pay more (Cretu et al, 2007). In the business field, the researchers have exposed crucial part for corporate image in consumption behaviors for customers in products or services enterprises (Ishaq, 2012). Oliver (2006) revealed that corporate image is linked favourably with customer loyalty; producing perfect services, having efficiency, being creative, having long-term strategy and customizing customer needs. Nguyen and Leblanc (2001) found that corporate image is significantly associated with customer loyalty in various industries like education and telecommunication in multiple areas. The results of the study reveal that the degree of customer loyalty tends to be higher when perceptions of corporate image are strongly favourable, contributing to better explaining customer loyalty. Recent studies concluded the considerable effect of corporate image to customer loyalty (Helgesen, 2010).

Therefore, the *following hypothesis is proposed*:

H3: CI activities positively influence CL

Corporate social responsibility and customer loyalty: mediating role of corporate image

Andika et al. (2017) studied Indonesian bank customers and found that CSR activities influence customer loyalty through corporate image. Similarly, in the study of bicycle buyers in Taiwan, Wang (2018) confirmed that corporate image plays a mediating role between CSR and customer purchase intention. Shabbir et al. (2018) studied Islamic banks in Pakistan and found that CSR influences customers' behavioral and attitudinal loyalty commitment through corporate image. Martinez et al. (2014) in the Spanish tourism industry also confirmed that the influence of CSR on customer loyalty is enhanced by the mediating role of corporate image in this relationship. Therefore, the *following hypothesis is proposed*:

H4. CI mediates the relationship between CSR and CL.

Research Methodology

1. The Research Procedure Includes 2 Steps which are:

1.1 Based on an extended literature review on CSR, CI, and CL studies, the authors evaluate the essential role of corporate social responsibility (CSR), customer loyalty (CL) and examine corporate image's (CI) mediating role concerning corporate social responsibility (CSR) and customer loyalty (CL) of Hue commercial banks. Figure 1 below is the proposed conceptual model of this research.

1.2 The research follows a quantitative approach. The study sample was composed of from 395 customers of commercial banks in Hue City. The Smart PLS SEM version 4.1.0.3 was used to analyses the data.

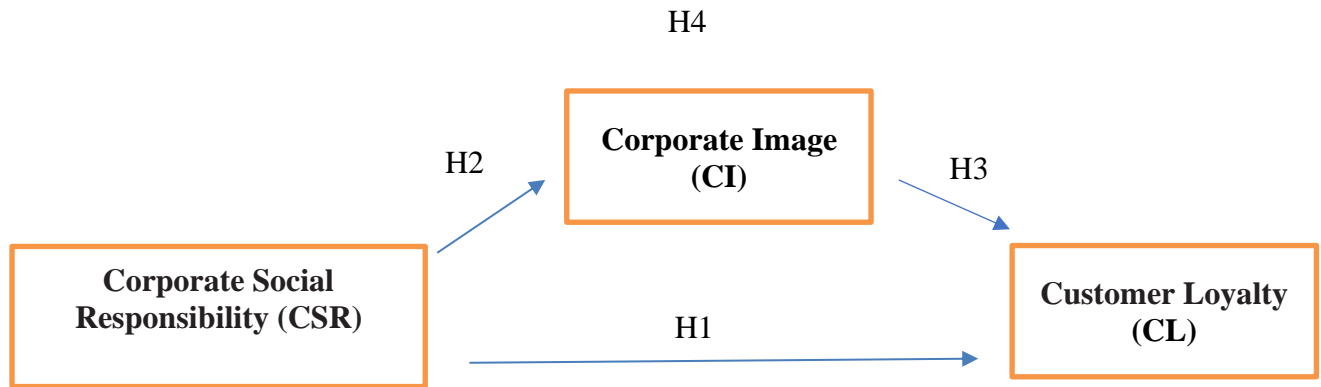


Figure 1. The proposed conceptual model

(Source: Author's work)

2. Research Instruments

2.1 Data collection procedure

Printed questionnaires were used to gather data for this research. The data were gathered from the customer's various commercial banks in Hue city between May 2024 to August 2024.

2.2 Variable measurement

The variables' items were basically adapted from the previously verified studies. However, they were adjusted where necessary to adapt to the research context. The content of the questionnaires was then validated by experts to ensure its clarity and that no irrelevant questions were included. The pilot survey was then performed to make sure that the survey's questions are correctly understood for responses accuracy. Survey questions used an adapted version of the five-point Likert-scale.

Corporate social responsibility scale: CSR has five items that are adapted from Carroll and Shabana (2010)

Corporate image scale: CI has four items that are adapted from Nguyen and Leblanc (2001)

Customer loyalty scale: CL has five items that are adapted from Ishaq (2012).

Table 1 below presents the items and the sources of CSR, CI and CL.

Table 1. Measurement scales

Variables	Items	Description	Sources
Corporate Social Responsibility (CSR)	CSR1	This bank fulfills its legal obligation	Carroll and Shabana, 2010
	CSR2	This bank conserve the environment	
	CSR3	This bank shows its commitment toward society by improving the welfare of the communities in which it operates	
	CSR4	This bank helps to enhance quality of life in the local community	
	CSR5	This bank operation is consistent with expectations of societal and ethical norms	
Corporate Image (CI)	CI1	I have always had a good impression of my bank	Nguyen and Leblanc, 2001
	CI2	In my opinion, my bank has a good image in the minds of consumers	
	CI3	I believe that my bank has a better image than its competitors	
	CI4	I believe that my bank has a better image than its competitors	

Variables	Items	Description	Sources
		Better image of my bank motivates me to take financial services	
Customer Loyalty (CL)	CL1	I would like to recommend this bank who seek my advice	Ishaq, 2012
	CL2	I say positive things about this bank to other people	
	CL3	I would encourage friends and relatives to use this bank	
	CL4	I would post positive messages about this bank on some internet message board	
	CL5	I intend to continue to use financial services with the present bank	

(Source: Author's work)

3. Populations and Samples

Samples for this research were customers of 25 commercial banks in Hue city. This research applies the principle of “10-times rule” to calculate the number of samples needed for the study (Hair et al., 2016). However, as a precaution against non-response bias, this research also determined that the initial sample size should be 500. 500 questionnaires were distributed, of these, we received 432 responses and used 395 for subsequent statistical analysis.

4. Statistics for Data Analysis.

SEM is a helpful technique for a wide range of research problems due to its capacity to model latent variables, account for various types of measurement error and test complete hypotheses. The two SEM techniques are covariance-based SEM (CB-SEM) and variance-based SEM (PLS-SEM), PLS-SEM fits appropriately with explanatory studies, and therefore matches well for this research. (Henseler et al., 2016).

PLS-SEM version 4.1.0.3 is used to analyze the structure model. Cronbach's Alpha values of all variables and all composite reliability amongst the identified constructs are greater than 0.7, which confirms the reliability of all scales in this study AVE for the latent variables, which are measured by reflective indicators, are suggested to be greater than 0.5. (Hair et al., 2016). According to Fornell and Larcker (1981), discriminant validity is established when the square root of the AVE of each construct is greater than that of the correlations between the constructs.

Results

1. Sample characteristics

There were 395 complete answers selected for the final analysis, the sample's characteristics are presented in Table 2 below.

The demographic outputs present that majority of the respondents were female (52.9 percent) whose age in between 25 and 45 years (63 percent). On the other hand, a large number of respondents had college education 41 percent. It represents a significant characteristic in the context of Hue city because customers with higher education are more knowledgeable about the concept of CSR.

Table 2. Sample characteristics

Characteristics	Distribution	Frequency	%
Gender	Male	186	47.1
	Female	209	52.9
Age	Under 25	82	20.8
	25 to 35	96	24.3
	35 to 45	153	38.7
	Over 45	64	16.2
Education	Secondary school	25	6.3
	High school	139	35.2
	College	162	41.0
	Master	69	17.5
Occupation	Student	95	24.1
	Employed	189	47.8
	Unemployed	22	5.6
	Housewife	45	11.4
	Retired	44	11.1

(Source: Author's work)

2. Measurement model

The measurement model was tested to ensure the reliability and validity of the items used to measure CSR, CI, and CL. Table 3 provides a clear summary of the indicators used to assess reliability and validity. Namely, Cronbach's Alpha values for all variables and composite reliability values for the identified constructs exceed 0.7, confirming the reliability of all scales in this study (Hair et al. 2016). For convergent validity, the results indicate that all factor loadings and average variance extracted (AVE) values for the items are above 0.5, meeting the accepted thresholds (Henseler et al., 2016). Thus, convergent validity was supported.

Regarding discriminant validity, as defined by Fornell and Larcker (1981), discriminant validity is established when the square root of the AVE for each construct exceeds the correlations between constructs. Table 4 presents these values, showing they meet the criteria of Fornell and Larcker (1981). Therefore, the discriminant validity is confirmed.

Table 3. Result support reliability and convergent validity

Construct	Items	Loading	Cronbach's Alpha	Composite Reliability	AVE
CSR	CR1	0.835	0.908	0.919	0.730
	CR2	0.878			
	CR3	0.846			
	CR4	0.888			
	CR5	0.822			
CI	CI1	0.814	0.865	0.867	0.712
	CI2	0.798			
	CI3	0.880			
	CI4	0.810			
CL	CL1	0.876	0.889	0.899	0.690
	CL2	0.830			
	CL3	0.887			
	CL4	0.787			

Construct	Items	Loading	Cronbach's Alpha	Composite Reliability	AVE
	CL5	0.767			

(Source: Author's work)

Table 4. Result support discriminant validity

	CI	CSR	CL
CI	0.844		
CSR	0.331	0.854	
CL	0.775	0.361	0.831

(Source: Author's work)

3. Hypotheses testing

The hypotheses in this research can be tested by the structural model, using path coefficients and p-values. According to Table 5 and as expected in H1, H2, H3, CSR was significantly and positively related with CL ($\beta=0.08$; $p < 0.05$), CI ($\beta=0.331$; $p < 0.05$). The result also confirm that CI has a positive effect on CL ($\beta=0.848$; $p < 0.05$). The results of the structural model analysis are presented in Table 5 and Figure 2.

Table 5. Results of structural model path coefficient

Hypotheses	Standardised beta (β)	t-statistics	p-values	Conclusion
H1: CSR \rightarrow CL	0.080	2.726	0.006	Supported
H2: CSR \rightarrow CI	0.331	5.711	0.000	Supported
H3: CI \rightarrow CL	0.848	11.421	0.000	Supported

(Source: Author's work)

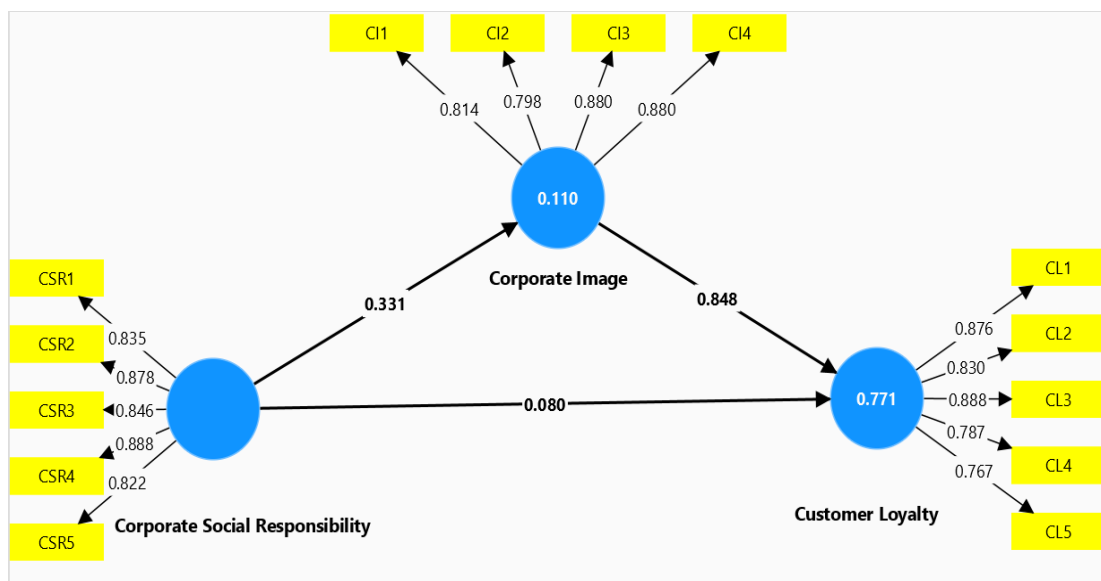


Figure 2. SEM analysis result

(Source: Author's work)

4. Mediation analysis

This study used bootstrapping method to conduct the mediation analysis, which included bias-corrected confidence estimations (Preacher and Hayes, 2008). With 5,000 resamples, a 95% confidence interval for the indirect, direct and total effects was estimated (Preacher and Hayes, 2008) (Table 6). H4 examines whether CI mediates the effect of CSR on CL. Table 5 shows that the result revealed a significant indirect effect of CSR on CL through CI (H4: $\beta = 0.281$, $t = 5.780$, $p < 0.01$). The total effect of CSR on CL was significant ($\beta = 0.361$, $t = 6.690$, $p < 0.01$), and with the inclusion of the mediator CI, the effect of CSR and CL was significant ($\beta = 0.080$, $t = 2.726$, $p < 0.01$). This shows CI's complementary partial mediating role in the relationship between CSR and CL. Hence, H4 was supported.

Table 6. Mediation analysis result

Constructs	Standardised beta (β)	t-statistics	p-values	Conclusion
Direct effect CSR \rightarrow CL	0.080	2.726	0.000	Supported
Specific indirect effects CSR \rightarrow CI \rightarrow CL	0.281	5.780	0.000	Supported
Total effects CSR \rightarrow CL	0.361	6.690	0.000	Supported

Discussion

After thoroughly reviewing the literature on CSR, CI, and CL, it was found that most of CSR research has been conducted in developed economies, with findings generally being more positive and consistent. This study aims to examine whether CI has as a mediating effect in the relationship between CSR and CL in the banking industry in Hue City, Vietnam - developing country. The results presented in the previous section indicate that CSR practices significantly and positively impact CL, demonstrating that socially responsible banks can effectively enhance CL. This aligns with Aurier and N'Goala's (2010) findings, which also identified a positive relationship between CSR and CL. Additionally, CSR practices were found to have a significant positive effect on CI, suggesting that banks can establish a favorable and compelling corporate image through CSR initiatives. This finding is consistent with the findings of Maldonado-Guzmán et al. (2017a, b) that CSR as a mechanism for enhancing a company's image among target customers. Furthermore, CI was shown to have a significant positive effect on CL, supporting the findings of Nguyen and Leblanc (2001). The study also reveals that CI partially mediates the relationship between CSR and CL, which is consistent with the finding of Andika et al. (2017).

Conclusion

The findings of this research confirmed the significant positive relationship between CSR and CL, with CI as a mediator between CSR and CL in commercial banks in Hue city. Customers are well aware of CSR activities through different media, and the results suggest that banks should prioritize CSR initiatives to maintain a strong corporate image, which can lead to improved CL. The study emphasizes that the CL of commercial bank customers is influenced both directly and indirectly by CSR. To strengthen customer loyalty, banks should engage in specific CSR activities that enhance CI. Additionally, banks could optimize their time, effort, and financial resources to achieve the greatest benefits in improving both CI and

CL. Additionally, the findings indicate that the indirect effect of CSR on CL through CI is greater than the direct effect of CSR on CL. Therefore, the commercial banks in Hue city could prioritize improving corporate image to strengthen CL. This implies that a positive customer perception of the organization’s image will lead to an increase in CL.

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Development of Small and Medium Hydropower in Vietnam, Cambodia and Laos from Policy to Practice to achieve Sustainable Development Goals (SDGs)

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Abstract

Objective: The objective of this study is to investigate the development of small and medium Hydropower in Vietnam, Cambodia and Laos, with the aim of measuring the diversification impacts of different perspectives since dam instillation to operation on local livelihoods. **Theoretical Framework:** This study employs the theories of human right based approach, multi-local participations and the participatory action research implementation.

Method: The entire sample size comprised 611 households: 220 from Vietnam, 200 from Laos, and 241 from Cambodia. This study utilized a mixed-method approach, combining qualitative techniques like focus group discussions and key important interview with quantitative methods, chiefly descriptive statistics. **Results and Discussion:** The results demonstrated that, notwithstanding several benefits, small hydropower also caused significant environmental and social damage, requiring rigorous management and appropriate supportive policies. The view points on the impacts of small-scale hydropower dams among the communities of the three nations differ due to different reasons like the location of hydropower instillations, management and operational difficulties, resource distributions, and varied livelihood practices.

Research Implications: There are a much to provide well-designed policies, including community engagement and transparent compensation structures, are essential for the long-term sustainability of these efforts. Moreover, collaboration and coordination among the three nations are crucial for effective water resource management and hydropower system design to guarantee that hydropower operations and development provide reciprocal advantages for the region, thereby fostering sustainable resource and energy development.

Originality/Value: The study firstly highlights how impacts of small and medium scale hydropower development in among three countries – Vietnam, Laos and Cambodia by applying the different perspectives from local communities to experts. Additionally, a glance of policy interplay among country relating to the development plants have been providing a general context to adjust regional policies to achieve the Sustainable Development Goals (SDG).

Keywords: small scale hydropower development, livelihood impacts, perception, participatory action research

Introduction

Accelerated advancement. The advancement of small-scale hydropower in Vietnam, Cambodia, and Laos (VCL) has been integral to the national energy strategy, aimed at ensuring energy security, fostering economic development, and mitigating greenhouse gas emissions (Antwi et al., 2015; Bauer et al., 2022; Chuang et al., 2018; Égré & Senécal, 2003). The swift and uncoordinated proliferation of small hydropower initiatives has resulted in various environmental and social challenges, including land and forest encroachment, disruption of natural watercourses, and adverse effects on the livelihoods of local communities (Cernea, 2008; Delang & Toro, 2011; Fearnside, 2006; García et al., 2021; Gillian & Souza, 2019; Mayer, Lopez, & Moran, 2022; Mayer, Lopez, Cavallini Johansen, et al., 2022). These concerns prompt inquiries on the sustainability and efficacy of existing policies in the advancement of small-scale hydropower (Arantes et al., 2023; de Faria et al., 2017; Sivongxay et al., 2017).

Issues. The management and distribution of water at small-scale hydropower projects are leading to considerable consequences for water security and inequitable resource consumption practices. In instances of heavy rains or flash floods, small scale hydropower dam often release water without prior warning to adjacent residents, endangering their life and property. Nguyen The De et al. (2017) stated that unregulated water discharges from the Dak Mi 4 hydropower plants for example in Vietnam have led substantial damage to local activities and their livelihoods, notably causing the heavy impacts on marginal groups. This frequently occurred as dams prioritize water retention for electricity production during arid seasons, resulting in extended drought in downstream regions, depleting irrigation resources and severely impacting agricultural output (Nguyen The De et al., 2017; Baird, 2011). Unsustainable water management not only results in agricultural losses but also deteriorates the ecosystem and heightens the risk of soil erosion, so depriving impoverished people of limited land resources. Baird (2011) also indicated that the execution of hydropower projects in Southeast Asia, notably the Don Sahong Dam, has substantially altered fish migration patterns and endangered the lives of communities dependent on aquatic resources. This problem transcends Laos, affecting rural areas of Vietnam, where women and ethnic minorities face considerable challenges stemming from inequities in access to water and cultivable land. Moreover, water storage for energy generating frequently results in droughts during periods when water is essential for agricultural output, leading to crop failures and diminished yields. Imhof and Lanza (2010) assert that the absence of transparency in the administration and allocation of water resources from hydropower projects significantly undermines social justice and the safeguarding of local populations' rights. This is especially relevant to vulnerable groups, including as women, the destitute, and ethnic minorities, who often suffer the most severe consequences from the water management decisions of hydropower manager. The interaction of unregulated flooding and prolonged droughts creates a harmful cycle that negatively affects the livelihoods, agricultural productivity, and living standards of communities in remote areas. Thus, the management and allocation of resources from small-scale hydropower plants necessitate substantial improvement to alleviate negative impacts, especially on marginalized societal groups, including women and ethnic minorities (Nguyen The De et al., 2017; Baird, 2011; Imhof & Lanza, 2010).

Research gap. Reviewing current literatures highlighted that there have been previous studies (Pichamon, 2014; Hijhuis, 2017; Rujivanarom, 2018; Boyle and Narin, 2018; Resurreccion, et al, 2018,) conducted on this theme with a focus on large – scale hydropower plants construction and water governance issues in Mekong Region. The results of these studies

shown that hydropower plant in Mekong River leading the impact on fisheries resource depletion and food insecurity (Nijhuis, 2010; Rujivanarom, 2018); challenging water governance, poverty and gender issue (Sokhem and Himesha, 2013; Resurrección, 2018). Some studies (Nijhuis, 2017; Yeophantong, 2014) focused on environment assessment, social equity, and water governance of hydropower plan construction in Mekong Region. The literature review also revealed the gap of scholarly results. There has been no studies investigate the water insecurity for small-scale hydropower plants in the tributary of Mekong Region, particularly in Vietnam, Laos and Cambodia. Meanwhile, there are hundreds of small-scale hydropower dams installed in rivers and streams with negligible impact investigation.

1. Research Objectives

The objective of this study is to investigate the development of small and medium Hydropower in Vietnam, Cambodia and Laos, with the aim of measuring the diversification impacts of different perspectives since dam instillation to operation on local livelihoods.

2. Review of Related Literatures

Challenges. Recent studies have demonstrated that small-scale hydropower development provides an effective energy solution for communities. However, if the arrangement is inefficient, it also brings many systemic challenges. Aggidis et al., (2010) argued that small-scale hydropower investment requires large capital - this will become a pressure for localities with difficult economic conditions. In addition, a significant challenge is related to finding a suitable location related to stable water flow - usually in the core of primary forests, which leads to many disturbances to biodiversity systems. Seasonal factors combined with the impact of climate change create many changes in hydrology that can seriously affect the amount of electricity, thereby shaking the confidence of communities and stakeholders in hydropower projects (Zeng et al., 2016). There can be no double standards in hydropower development since it must comply to accepted principles both nationally and internationally. According to Mishra and Singal (2020), poorly built transmission infrastructure in rural areas makes it particularly difficult to include SHP into national grids. To address these issues and promote the long-term viability of SHP, new technological advancements and flexible policy frameworks are required (Kougias & Szabó, 2017; Paish, 2002). This is because renewable energy sources like solar and wind are advancing at a faster rate than SHP.

Functions of promulgated policies. Policies for hydropower project development are essential for ensuring national energy security and sustainable development. These policies create supportive mechanisms such as financial incentives, taxation, and environmental protection laws, while also providing a legal framework for the licensing, regulation, and operation of hydropower projects (Aggidis et al., 2010; Zeng et al., 2016). Tax incentives or alternative financial assistance may stimulate private investment in the hydropower sector, especially for small-scale projects that serve remote and rural regions (Aggidis et al., 2010). Moreover, EIA regulations ensure that hydropower initiatives are conducted with due regard for environmental and social factors, hence mitigating negative impacts on ecosystems and the welfare of the local community (Egré & Milewski, 2002; Bréthaut & Pflieger, 2020). In transboundary water management, policy is essential for facilitating the prudent utilization of water resources, especially in shared river basins such as the Mekong (Gleick, 1993). Incorporating these supplementary regulations enables hydropower projects to be executed in a manner that safeguards social and environmental values while generating economic benefits and ensuring sustainability and efficiency (Scudder, 2005). Through policy support and

guidance, countries can effectively harness the potential of hydropower in their national energy frameworks by balancing environmental conservation with economic development (Zeng et al., 2016; Bréthaut & Pflieger, 2020).

Perceptions of various stakeholders. Evaluating the effects of hydropower initiatives via the perspectives of policymakers and local communities is crucial for promoting sustainable development and mitigating potential conflicts. The involvement of stakeholders, particularly local people, can enhance the efficacy of the environmental impact assessment process (Bui & Schreinemachers, 2021). Research indicates that including community viewpoints into the decision-making process improves the legitimacy and acceptance of hydropower projects (Li, Sun, & Yuan, 2022). Nonetheless, other obstacles to public engagement exist, including insufficient transparency and the intricacy of legal procedures (Petts, 2003). Public participation enhances decision-making and aids in identifying and mitigating potential social repercussions (Tilt, Braun, & He, 2009). Research in India indicates that community perceptions of hydropower impacts can affect the success of these projects (Kumar & Kumar, 2019). In several regions globally, enhancing public participation has augmented the sustainability of hydropower initiatives and guaranteed a balance among economic, social, and environmental advantages (Bréthaut & Pflieger, 2020). Integrating the perspectives of policymakers and local communities in impact assessment is essential for attaining sustainable hydropower development.

Research Methodology

1. Sample sites selections.

There were three study sites selected for this research project, including Quang Binh, Quang Tri and Thua Thien Hue province in Vietnam, Pursat province in Cambodia and Attapeu province in Lao PDR. The mixed research methods were used to collect data for this project, including qualitative methods (key informant interviews; focus group discussion) and quantitative methods (questionnaire surveys). There were 24 key informant interviews conducted in country study site, 9 focus group discussions have been conducting and 220 questionnaire completed in Vietnam, 200 questionnaire completed and 241 questionnaire completed in Cambodia, respectively. The qualitative data analysis techniques and quantitative data analysis ones have been being used to analyze collected data for this project.

Research site descriptions. In Viet Nam: Quang Binh, Quang Tri and Thua Thien Hue provinces (Binh Tri Thien province) were selected for study site of this study (figure 1). Locating in North Central Region of Vietnam, Binh Tri Thien province is characterized by general geographical condition and socio-economic diversity of Mekong Region Countries. Large number of households, including farmers, fishers, and other stakeholders have access to water for their production, livelihoods and daily lives. Up to date, there were 26 small-scale hydropower dams constructed and being operated in this region. The construction and operation of these dams have caused various impact on environment, local livelihoods, water shortage in the summer and flood in the rainy season, changing the land use patterns, food insecurity and huge damage to crops and houses.

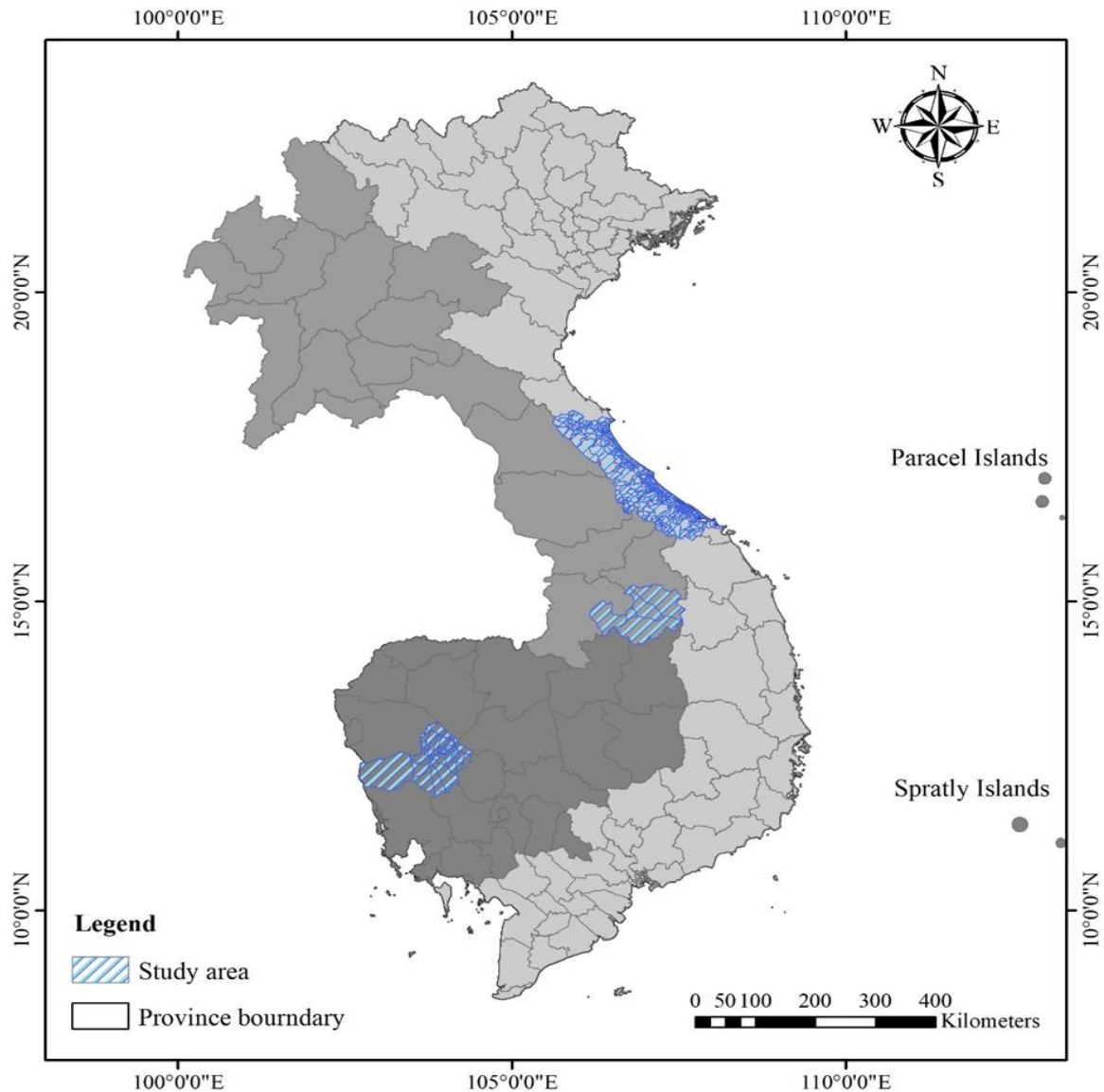


Figure 1. Map of research sites

(Prepared by authors)

In Cambodia: Pursat province of Cambodia was selected as the targeted study site of this research project based on various reasons (figure 3). Pursat province of Cambodia was selected as the targeted study site of this research project based on various reasons. It is one among four provinces in Cambodia that has hydropower plant, called Stung Atay I, which has been operating since 2014. The geographical location of this hydropower plant was built Stung Atay-an upstream tributary of Stung Ruxeg Chrumin, Pursat Province of Cambodia. There were 6 communes living in the catchment areas of Stung Atay small-scale hydropower dam being selected in Pursat province, Cambodia, including Krapeu Pir, Anlong Reab, Pramaoy, Thma Da, Leach, and Samraong. It is selected as study site because there are diversification issues related to the research project. Since the operation of this dam, there have been critical issues and conflict have been identified, such as water insecurity, livelihood of poor communities, and various ethnic groups. Many communities along this tributary are highly depending on water resource for agricultural production, fisheries, aquaculture, and living.

However, as a result of building hydropower plants, these communities have experienced unexpected flood and drought, which are threatening to their current and future livelihood activities.

In Lao PDR: Attapeu province was selected as study site in Laos PDR (figure 3). Attapeu is a province of Laos in the Southeast of the country. To the north it is bounded by Sekong, to the west by Champasak Province. To the east, the Annamite Mountain Range separates Attapeu from Vietnam. This province covers an area of 10,320 square kilometres with a population of 127,285. In Houay Ho hydropower dam constructed in Attapeu province, Lao PDR. Under the construction and operation of Houay Ho Dam, there were around 3,000 people from 12 villages were forcibly evicted to make way for the Houay Ho hydropower Dam construction. It is estimated that fishing households living in Ban Thang Ngao and Ban Nam Ha lost their livelihoods due to loss of its fisheries and inundation. There will be 6 villages living in the upstream and downstream of Houay Ho small-scale hydropower dams being selected, including of Ban Thang Ngao, Ban Nam Han, Houay Kong, Nya Heun, Namnoy, Lavaen Villages.

2. Materials

Sources. This study uses both secondary and primary data.

The secondary sources encompass data and reports regarding national small hydropower planning, resolutions pertinent to hydropower development from 2005 to the present, and reports on small-scale hydropower projects that have been, are currently, or are planned for operation and construction, along with those in various phases of investment research. Desk review. This entails the compilation and analysis of papers, resolutions, and reports pertinent to the advancement of small-scale hydropower initiatives. The objective is to collect detailed information on policy frameworks, project outcomes, and regulatory standards that regulate small-scale hydropower development. Furthermore, examining the prior and contemporary practices of small-scale hydropower projects was crucial for assessing their efficacy and environmental consequences. This entailed conducting on-site evaluations to collect data regarding operational efficacy, environmental impacts, and the socio-economic advantages or disadvantages of these initiatives. The objective is to deliver a comprehensive assessment of the performance of small-scale hydropower projects in real-world situations and their conformity with sustainability objectives.

The principal data sources comprise interviews with professionals proficient in research, policy suggestions, and implementation, alongside data gathered from citizens residing in regions where small and medium hydropower projects are under construction. Methods of collection. Key Informant Interviews and Focus Group Discussions. Gathering perspectives from energy specialists, environmental administrators, and representatives of impacted communities is essential. This qualitative approach elucidates the diverse viewpoints on small-scale hydropower production, its advantages, and its socio-environmental repercussions. The interviews seek to obtain expert perspectives on energy efficiency, environmental sustainability, and community welfare.

3. Analytical methods

Approach. The participatory action research approach and human right-based approach were used in this study to investigate research issues and answer above problem statement. The participatory action research is powerful strategy to advance both science and practitioners as it involves both stakeholders in the research process from the initial design of the research through data collection and analysis to conclusions and action arising out of

research.

Data analysis. General statistics. We conducted descriptive statistics and compared the changes in particular livelihood capital, impacts of hydropower dam development. To quantify the impacts of small-scale hydro dam development on households' livelihoods, we conducted stratification and established the description of perception perceived by different local communities measured by Likert ranking with different levels depending on specifically targeted questions.

Findings and discussion

1. Related policies of small-scale hydropower dam development

While each nation adapts its strategy to local demands, a comparison of the hydropower development plans in Vietnam, Laos, and Cambodia reveals a common focus on sustainable energy development. Vietnam has a well-established regulatory framework with comprehensive laws and programs that place a major emphasis on renewable and varied energy sources. Examples of these are the modified Electricity Law (2022) and the Renewable Energy Strategy to 2030. Laos, which has an abundance of water resources, places a high priority on national programs like the National Power Development Plan (2020–2030) and laws that allow cross-border energy trading, such as agreements with Thailand. Ensuring environmental compliance and enticing investments in hydropower are the main goals of their rules. Although it is not as comprehensive, Cambodia's policy framework stresses the need of developing hydropower as a means of increasing domestic energy capacity, including policies such as the Renewable Energy Development. All three countries rely on regional cooperation frameworks, such as the 1995 Mekong Agreement, to ensure sustainable water resource management. However, they face challenges in balancing energy needs with environmental preservation, highlighting the need for careful policy implementation and regional collaboration.

Table 1. Importantly related laws and policies related to small scale hydropower dam development

No	Vietnam	Laos	Cambodia
1	Electricity Law (amended 2022) - 03/2022/QH15 - National Assembly - 2022	Electricity Law (amended 2017) - National Assembly - 2017	Electricity Law - National Assembly - 2001
2	Water Resources Law - 17/2012/QH13 - National Assembly - 2012	Water Resources Law - National Assembly - 2017	Water Resources Law - National Assembly - 2007
3	Decree 114/2018/ND-CP on Dam and Reservoir Safety Management - Government - 2018	Renewable Energy Development Strategy to 2030 - Government - 2020	Electricity Development Strategy to 2030 - Government - 2019
4	Decision 13/2020/QD-TTg on Incentives for Solar Power	Decree 112/PM on Hydropower Licensing - Government - 2017	Decree 77/2002 on Energy Licensing - Government -

No	Vietnam	Laos	Cambodia
	Projects - Prime Minister - 2020		2002
5	Renewable Energy Development Strategy to 2030 - Prime Minister - 2021	EIA Regulation - Ministry of Natural Resources and Environment - 2019	EIA Regulation - Ministry of Environment - 2009
6	Resolution 55-NQ/TW on National Energy Strategy - Politburo - 2020	Tax Incentives Policy for Renewable Energy - Government - 2020	Renewable Energy Support Policy - Government - 2013
7	Power Plan VIII - Government - 2023	Agreement on Power Export to Thailand - Government - 2016	Renewable Energy Development Plan to 2025 - Government - 2020
8	Circular 09/2021/TT-BCT on Project Development - Ministry of Industry and Trade - 2021	Dam Safety Management Regulation - Government - 2019	Dam Safety Management Regulation - Government - 2019
9	Decree 40/2019/ND-CP on Environmental Impact Assessment - Government - 2019	National Power Development Plan (2020-2030) - Ministry of Energy and Mines - 2020	Investment Incentives Policy for Renewable Energy - Government - 2018
10	Agreement on Sustainable Development of the Mekong River - MRC - 1995	Agreement on Sustainable Development of the Mekong River - MRC - 1995	Agreement on Sustainable Development of the Mekong River - MRC - 1995

(Source: collected by authors)

2. Statistics on small scale hydropower between Vietnam, Laos and Cambodia

Number of planed projects. In Viet Nam. Policy for small-scale hydropower development: In 2005, the Ministry of Industry approved the National Small Hydropower Plan with 239 projects. By 2013, there were 1,237 approved hydropower projects, of which 1,108 were small-scale hydropower projects with a total installed capacity of 6,773MW. However, this rapid development has led to many incidents and damages, forcing the National Assembly and the Government to adjust management and planning policies. Resolution 62/2013/QH13 and Resolution 11/NQ-CP in 2014 required a review of hydropower projects, eliminating ineffective projects and adversely affecting the environment. To date, 480 small hydroelectric projects have been removed from planning. Practice of small-scale hydropower development. Currently, the whole country has 1076 hydroelectric projects in planning, of which 440 projects are in operation, 166 projects are under construction, 322 projects are under investment research and 148 projects have not yet been researched for investment. . A number of large hydroelectric

projects such as Son La, Lai Chau, Huoi Quang have come into operation, making important contributions to the national energy source. Power Plan VIII forecasts that Vietnam's small hydropower potential is about 6,000MW, accounting for 1/3 of the medium and large hydropower potential.

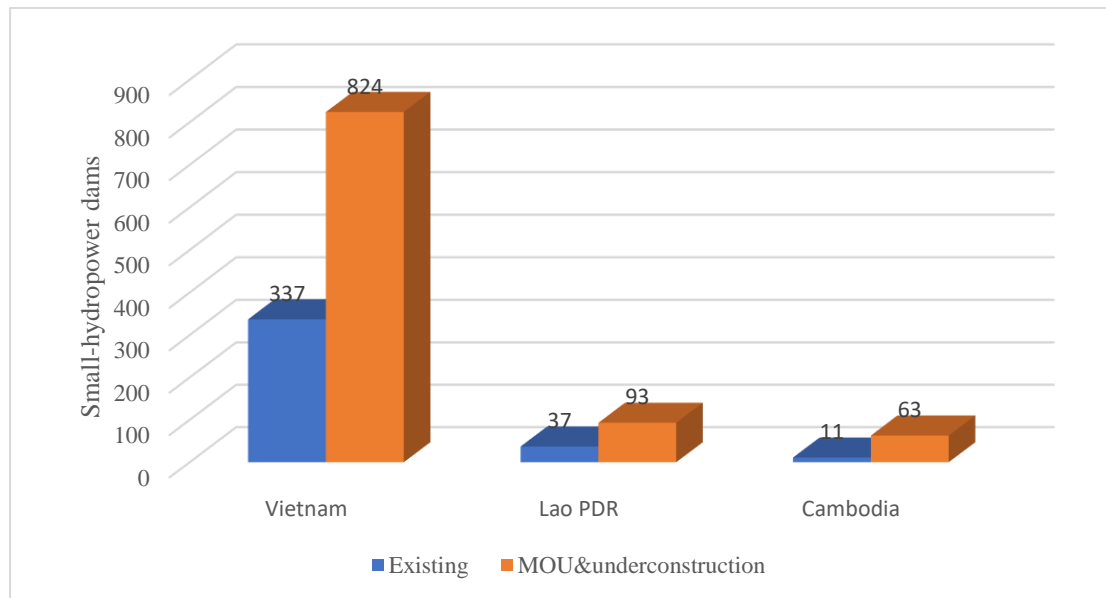


Figure 2. Statistics on hydropower capacity between Vietnam, Laos and Cambodia
(Source: composed by authors from World Bank, IEA, IRENA)

Number of small-scale hydroelectric plants in operation. This analysis compares the growth of small-scale hydropower projects in Vietnam, Laos, and Cambodia from 2005 to 2023. Small-scale hydropower projects are crucial for these countries as they offer a sustainable energy source that contributes to rural electrification and local economic development.

Vietnam. Vietnam has shown significant growth in the number of small-scale hydropower projects. Starting with just one project in 2005, the number steadily increased, reaching 100 projects by 2023. This rapid growth can be attributed to the Vietnamese government's supportive policies and incentives for renewable energy development. Vietnam's diverse topography, with numerous rivers and streams, provides an ideal environment for hydropower projects. The increasing number of projects reflects Vietnam's commitment to expanding its renewable energy capacity and reducing its reliance on fossil fuels.

Laos. Laos, known for its vast hydropower potential, has also seen considerable growth in small-scale hydropower projects. From no projects in 2005 to 77 in 2023, the development trajectory indicates a strong focus on utilizing its abundant water resources. The Lao government's emphasis on becoming the "battery of Southeast Asia" has led to significant investments in hydropower. These projects not only aim to meet domestic energy needs but also to export electricity to neighboring countries, thus boosting the national economy.

Cambodia. Cambodia's growth in small-scale hydropower projects has been relatively slower compared to Vietnam and Laos. Starting with no projects in 2005, the number of projects increased to 60 by 2023. The slower growth rate can be attributed to various factors, including limited financial resources, less favorable geographic conditions, and a slower pace of policy implementation. However, the Cambodian government has been making strides in promoting renewable energy, recognizing the importance of hydropower in achieving energy security and sustainability.

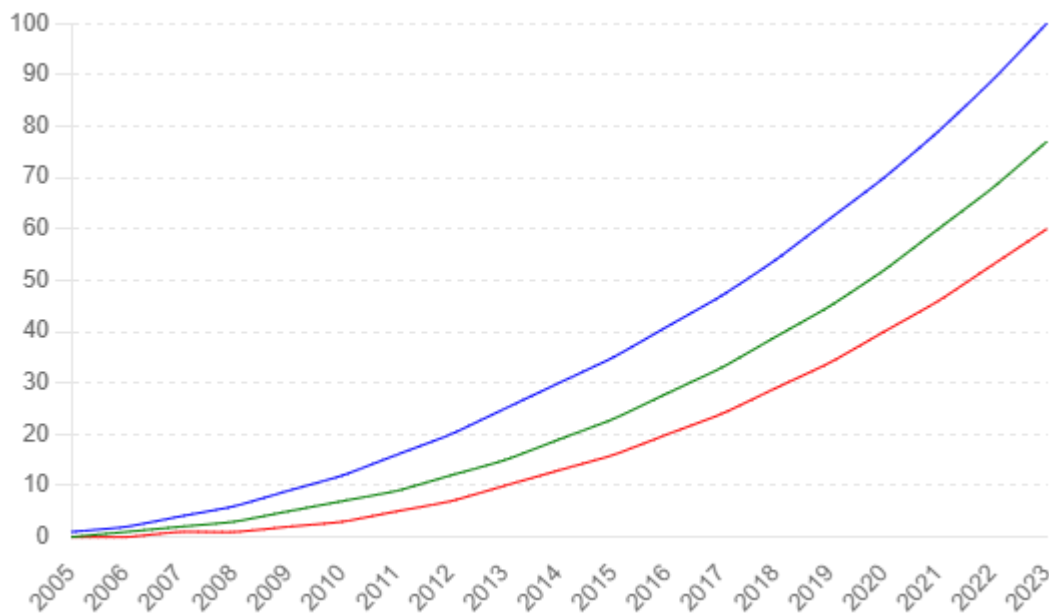


Figure 3. Number of small-scale hydropower plants developed and in operation (2005-2023)
(Source: composed by authors from World Bank, IEA, IRENA)

Comparative Insights. Comparing the three countries, Vietnam leads in the number of small-scale hydropower projects, followed by Laos and Cambodia. Vietnam's rapid growth highlights its proactive approach and favorable conditions for hydropower development. Laos, with its abundant hydropower resources, shows a consistent increase, aligning with its regional energy export ambitions. Cambodia, despite slower growth, is making progress in integrating hydropower into its energy mix. Overall, small-scale hydropower projects play a vital role in the renewable energy strategies of Vietnam, Laos, and Cambodia, contributing to sustainable development and energy security in the region.

3. Impact of small-scale hydropower from an expert's perspective

Contribution of small-scale hydropower: Small-scale hydropower makes an important contribution to national energy security, accounting for more than 26% of hydropower potential (Aksed by KIIs). Electricity prices from small hydropower are lower than other renewable sources, contributing to reasonable regulation of electricity prices. In addition, small hydroelectric plants also contribute to local budgets, improving infrastructure and living conditions for people in mountainous areas (Aksed by KIIs). Small-scale hydropower also helps reduce greenhouse gas emissions, contributing to Vietnam's renewable energy development strategy until 2030, with a vision to 2050. **Damages caused by small-scale hydropower development:** Small-scale hydropower development also causes many damages such as land occupation, forest occupation and affecting the ecosystem (Aksed by KIIs). Small hydroelectric dams interrupt the flow, which can cause rivers and streams downstream to dry up. Flooding incidents and lack of management control also cause a lot of damage to people and property (Aksed by KIIs).

4. Impact of hydropower from affected households

4.1. Information of survey households

This study examines social and economic indicators of households in Vietnam, Laos, and Cambodia, focusing on family roles, main occupations, educational levels, age of

interviewers, and ethnicity. In terms of family roles, 75.9% of respondents in Vietnam are heads of households, which is higher than in Laos (45.5%) and Cambodia (54.8%). Spouses are more common in Laos (36.5%) and Cambodia (39.4%) than in Vietnam (15.5%). Children only appear in Cambodian samples (3.3%), while parents are more prevalent in Laos (18.0%). Regarding main occupations, farming is the primary occupation in all three countries, with the highest percentage in Vietnam (83.6%). Laos has the most government staff (16.0%), while forest farming is unique to Vietnam (5.5%). Self-employment is notable in Laos (17.0%), and free labor is significant in Cambodia (25.7%).

Table 2. General Information of surveyed households

Table 2: General information of surveyed households

No	Indicators	VN		Lao		Cambodia	
		No	%	No	%	No	%
<i>Role in the households</i>							
1	Head of households	16				13	
		7	75.9	91	45.5	2	54.8
2	Spouse and partner	34	15.5	73	36.5	95	39.4
3	Children	0	0.0	0	0.0	8	3.3
4	Parents	0	0.0	36	18.0	5	2.1
5	Others	19	8.6	0	0.0	1	0.4
		22				24	
	Total	0	100	200	100	1	100
<i>Main occupation</i>							
		18				14	
1	Farmers	4	83.6	109	54.5	3	59.3
2	Government staff	2	0.9	32	16.0	6	2.5
3	Forest farmers	12	5.5	0	0.0	0	0.0
4	Self-services	0	0.0	34	17.0	11	4.6
5	Free Labors	16	7.3	11	5.5	62	25.7
6	Unemployment's	0	0.0	0	0.0	0	0.0
7	Others	6	2.7	14	7.0	19	7.9
		22				24	
	Total	0	100	200	100	1	100
<i>Educational level</i>							
						13	
1	Primary School	55	25.0	4	2.0	3	55.2
2	Secondary school	59	26.8	28	14.0	42	17.4
3	High school	55	25.0	92	46.0	18	7.5
4	College	19	8.6	76	38.0	1	0.4
5	Illiteracy	26	11.8	0	0.0	45	18.7
6	Others	6	2.7	0	0.0	2	0.8
		22	100			24	
	Total	0	%	200	100	1	100
<i>Age of interviewer</i>							
1	Under 30 years old	40	18.2	59	29.5	47	19.5
2	30-40 Years old	40	18.2	72	36.0	82	34.0
3	41 - 50 Years old	46	20.9	33	16.5	37	15.4

No	Indicators	VN		Lao		Cambodia	
		No	%	No	%	No	%
4	51 - 0 years old	60	27.3	34	17.0	38	15.8
5	over 60 years old	34	15.5	2	1.0	37	15.4
		22				24	
	Total	0	100	200	100	1	100
Ethnicity							
1	Cham	0	0.0	0	0.0	2	0.8
						22	
2	Khmer	0	0.0	0	0.0	1	91.7
		13					
3	Kinh	6	61.8	0	0.0	0	0.0
					100.		
4	Laoloum	0	0.0	200	0	0	0.0
5	Other	0	0.0	0	0.0	18	7.5
6	Van Kieu	84	38.2	0	0.0	0	0.0
		22				24	
	Total	0	100	200	100	1	100

(Source: survey households in 2022)

In terms of educational levels, Cambodia leads in primary education (55.2%), while Laos excels in high school (46.0%) and college education (38.0%). Vietnam has the highest secondary school attendance (26.8%), and illiteracy is most prevalent in Cambodia (18.7%). The age distribution of interviewers shows that Laos has the most interviewers under 30 (29.5%) and aged 30-40 (36.0%), whereas Vietnam has the highest proportions of interviewers aged 41-50 (20.9%) and 51-60 (27.3%). Ethnically, Vietnam's main ethnic group is Kinh (61.8%), Laos is exclusively Laoloum (100%), and Cambodia is predominantly Khmer (91.7%). This analysis highlights the diverse social and economic structures in these countries, reflecting their unique cultural characteristics.

4.2. Impact and people's awareness of the role of small scale hydropower

Impacts of small scale hydropower dam on land used pattern, it could be affirmed that the construction of the hydropower dam has significant impacts, particularly on land resources (Le Anh Tuan, 2016). However, the extent of land loss varies depending on several factors. Research findings indicated that households in Cambodia experience the least land loss, as previously mentioned, due to the considerable distance from their homes to the hydropower dam, with some cases as far as 120 kilometers. On the other hand, in Vietnam and Laos, households were relatively close to the hydropower dam's location, resulting in larger areas of land loss. Specifically, in Vietnam, the land loss is nearly 1,000 square meters, accounting for around 3% of the land. The highest land loss reaches up to 10,000 square meters, with agricultural land loss making up about 30% of the total loss. Planted forest land and pond land represented relatively significant portions of the total loss, at 216 square meters and 118 square meters, respectively, while other land types show negligible loss. In Laos, the average land loss was relatively high at 2,700 square meters, accounting for about 17% of the total loss, with agricultural land and forest land being the most affected.

Table 3. Land loss by small scale hydropower dam operation

No	Indicators	Vietnam					Lao					Cambodia				
		N	Min	Max	Mean	S.D	N	Min	Max	Mean	S.D	N	Min	Max	Mean	S.D
A	Total land loss (m2)	220	0	10,005.0	991.5	1,452.1	200	0	25,000.0	2,692.8	5,507.8	241	0	900.0	7.7	81.9
1	Loss of arable land (m2)	220	0	2,500.0	354.4	586.8	200	0	17,209.0	890.7	2,994.0	241	*-	-	-	-
1.1.	Loss of wet rice (m2)	220	0	5,000.0	59.1	486.0	200	0	0	0	0	241	-	-	-	-
1.2	Loss of Upland rice land (m2)	220	0	1,000.0	54.6	180.1	200	0	0	0	0	241	-	-	-	-
1.3.	Loss of vegetable land (m2)	220	0													
2	Loss of residential land (m2)	220	0	1,000.0	29.8	126.6	200	0	0	0	0	241	-	-	-	-
3	Loss of industrial tree land (m2)	220	0	5,000.0	63.6	492.5	200	0	0	0	0	241	-	-	-	-
4	Loss of protection Forest land (m2)	220	0	10,000.0	90.9	951.3	200	0	10,000.0	411.0	1,810.4	241	-	-	-	-
5	Loss of plantation forest land (m2)	220	0	2,500.0	216.4	494.5	200	0	17,000.0	768.0	3,020.3	241	-	-	-	-
6	Loss of pond (m2)	220	0	2,000.0	118.2	334.0	200	0	0	0	0	241	-	-	-	-
7	Loss of none land use (m2)	220	0	500.0	4.5	47.6	200	0	11,000.0	623.0	2,304.2	241	-	-	-	-

(Source: survey households in 2022)

(*: in Cambodia, there was a miss of information relating to detailed kind off land losses. “-“: denotes for miss information)

4.3. Perception of small-scale hydropower development

The table 4. presents survey results on the perceptions and impacts of small hydropower projects in Vietnam, Laos, and Cambodia. The survey covers various aspects, including asset loss, compensation, receipt of operation guidelines, adherence to these guidelines by dam owners, water release for crops in dry seasons, and flood management during rainy seasons. The data provides insights into the socio-economic and environmental effects of small hydropower projects on local communities in these three countries.

Table 4. Perceptions of the Impact of Small Dam Construction and Operation: Asset Loss, Compensation, and Dam Operation Guidelines

Indicators		Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
Lost asset due to small dam constructions	None loss	87	39,5	154	77,0	219	90,9
	Loss	119	54,1	46	23,0	3	1,2
	Unsure	14	6,4	0	0,0	19	7,9
		220	100,0	200	100,0	241	100,0
Compensations from dam owners	Not received compensations	145	65,9	154	77,0	100	41,5
	Received compensations	60	27,3	46	23,0	130	53,9
	Unsure	15	6,8	0	0,0	11	4,6
		220	100,0	200	100,0	241	100,0
Dam operation guideline	Not received dam operation guidelines	82	37,3	0	0,0	158	65,6
	Received dam operation guidelines	87	39,5	160	80,0	23	9,5
	Unsure	51	23,2	40	20,0	60	24,9
		220	100,0	200	100,0	241	100,0
Operation guidelines	Dam owner completely follow dam operation guidelines	75	34,1	150	75,0	15	6,2
	Yes, some times, dam owners follow it, but other time dam owners did not follow guidelines	22	10,0	0	0,0	10	4,1

Indicators		Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
	Dam Owners did not follow dam operation guidelines	8	3,6	50	25,0	212	88,0
	Unsure	115	52,3	0	0,0	4	1,7
		220	100,0	200	100,0	241	100,0
In dry season, dam owners release water for our crops production	Dam owners did not release	84	38,2	0	0,0	50	20,7
	Dam owners released	58	26,4	200	100,0	26	10,8
	Unsure	78	35,5	0	0,0	165	68,5
		220	100,0	200	100,0	241	100,0
In rainy season, particularly in floods, dam owners discharge flood water follow request of local governments	Dam owners did not discharge water follow local government	38	17,3	0	0,0	27	11,2
	Dam owners discharge waters follow local government	90	40,9	200	100,0	45	18,7
	Unsure	92	41,8	0	0,0	169	70,1
		220	100,0	200	100,0	241	100,0

(Source: survey households in 2022)

Community assessments of the impacts of small hydropower dam construction and operation in Vietnam, Laos, and Cambodia differ significantly. Survey data provide insight into the extent of property loss, compensation received, compliance with operating procedures by dam owners, and flood releases during the wet season and water supply during the dry season. To provide further clarity, we analyze these factors and compare them with similar studies.

Property loss due to dam construction. In Vietnam, 54.1% of people reported property loss due to hydropower dam construction, while in Laos and Cambodia, the proportion was significantly lower (23.0% and 1.2%, respectively). This may reflect differences in the scale of hydropower projects, compensation levels, and people's dependence on land and water resources in each country. Scudder (2005) found that large dam projects often have negative impacts on community livelihoods, especially in areas with high dependence on agriculture.

Compensation from dam owners. In Vietnam, only 27.3% of people received compensation, compared to 53.9% in Cambodia. In Laos, 77% of people did not receive compensation. Research by Ziv et al. (2012) found that uneven and opaque compensation policies often cause dissatisfaction among communities affected by hydropower projects. Inadequate compensation can lead to issues of inequality and social conflict.

Dam operating procedures. In Laos, 80% of people reported that they had received dam operating procedures, compared to 39.5% and 9.5% in Vietnam and Cambodia, respectively. This discrepancy may stem from dam management policies in each country. According to

Grumbine, Dore, and Xu (2012), transparent dam operation procedures and community participation are important factors in minimizing conflicts and increasing local community satisfaction.

Impact of water releases during the dry and wet seasons. In Laos, 100% of people reported that dam owners released water during the dry season for agricultural production, while this rate was only 26.4% in Vietnam, and 10.8% in Cambodia. Similarly, during the wet season, in Laos, dam owners always complied with local authorities' requests for flood releases, but in Vietnam and Cambodia, this compliance was not fully implemented, with rates of 40.9% and 18.7%, respectively. This may reflect better dam management in Laos, or differences in demands and pressures from local authorities between countries. Research by Kuenzer et al. (2013) highlights that improper water releases can lead to severe flooding events and impact community livelihoods, especially in areas with high water dependency such as Vietnam.

Overall, communities in Vietnam appear to be more severely affected by the construction and operation of hydropower dams than those in Laos and Cambodia, particularly in terms of compensation and water management. Inequalities in the implementation of dam operation and compensation procedures may cause social conflicts and have long-term impacts on the economic and environmental development of these countries.

4.4. Perceptions on impact of small hydropower dam on water insecurity and agricultural livelihood activities.

The survey data (table 5) reveals significant regional differences in the impact of small dam operations on households in Vietnam, Laos, and Cambodia. Vietnam and Laos show more pronounced negative impacts on water sources, crops, agricultural land, and livestock, whereas Cambodia exhibits a mixed but substantial level of vulnerability. The high levels of uncertainty reported by many respondents suggest a need for better communication and management practices to address the challenges posed by dam operations. Comprehensive policies and enhanced coordination among stakeholders are essential to mitigate these impacts and ensure sustainable development in these regions.

Assessments of the impacts of hydropower by communities in Vietnam, Laos and Cambodia show marked differences, with diverse reflections on the extent of impacts on factors such as water resources, agriculture, aquaculture and life in general. To better understand these results, we can compare and contrast with similar studies on the impacts of hydropower.

Impacts on water resources and flooding. According to the data, in Vietnam, 30.5% of people believe that hydropower has a negative impact on water resources, while in Laos and Cambodia, this percentage is much lower, with the majority of people in these two countries believing that there has been no significant change. This can be explained by the local context and the level of dependence on water resources for agriculture. The study by Ziv et al. (2012) pointed out that hydropower dams on the Mekong River have seriously affected the ecosystem and flow of the river, especially in Vietnam, where the river plays an important role for both agriculture and daily life. Regarding flooding, up to 46.4% of people in Vietnam believe that hydropower dams increase the level of flooding, while the percentage in Laos and Cambodia is lower (44.5% and 62.7% are not sure). The study by Fan et al. (2015) also pointed out that the regulation of the flow of hydropower dams can lead to an increased risk of flooding in downstream areas, which is especially dangerous in densely populated areas that depend on natural irrigation systems like Vietnam.

Impacts on agriculture. The impacts of hydropower on agriculture are assessed differently among the three countries. In Vietnam, 37.7% of respondents believed that severe water shortages due to hydropower negatively affected crop yields, while only 10% in

Cambodia did so. This difference may be related to the size and scope of hydropower projects and the dependence on agriculture. According to Molle et al. (2009), large hydropower projects can disrupt irrigation systems, causing localized drought problems and reduced crop yields in downstream areas, which is particularly evident in Vietnam.

Impacts on aquaculture and livestock. The impacts of hydropower on aquaculture and livestock also vary across countries. In Vietnam, 39.1% of respondents felt that water shortages had a major impact on aquaculture ponds, while in Cambodia this proportion was much lower (8.7%). Scudder (2005) noted that hydropower projects often affect water quality, reducing the availability of clean water for both aquaculture and livestock. This may explain why Vietnamese people, with their heavy reliance on aquaculture systems, are more affected than those in neighboring countries.

The results from this study show a clear pattern: regions that are heavily dependent on natural water resources and agriculture, such as Vietnam, are more affected by hydropower projects. This is consistent with previous studies such as Kuenzer et al. (2013), which emphasized that hydropower development in Southeast Asia needs to carefully consider the long-term impacts on livelihoods and the environment. Although hydropower brings benefits in terms of energy and economic development, the negative impacts on the environment and people's livelihoods cannot be ignored. Studies such as Fan et al. (2015) and Ziv et al. (2012) both recommend that community participation is needed in the environmental impact assessment of hydropower projects to ensure that economic benefits do not come at too great an environmental and social cost.

Table 5. Perceptions on water insecurity and agricultural livelihood activities.

Indicators				Vietnam		Lao PDR		Cambodia	
				No	%	No	%	No	%
Impact on water source			Very strong impact	26	11,8	0	0,0	0,0	0,0
			Negative impact	67	30,5	0	0,0	28,0	11,6
			No changes	97	44,1	167	83,5	146,0	60,6
			Unsure	30	13,6	33	16,5	67,0	27,8
				220	100,0	200	100,0	241,0	100,0
Water quality and quantity			Better water quality and quantity	29	13,2	0	0,0	27,0	11,2
			No, we have not sorted out yet	91	41,4	83	41,5	87,0	36,1
			Yes, we sorted it out	54	24,5	54	27,0	9,0	3,7
			Unsure	46	20,9	63	31,5	118,0	49,0
				220	100,0	200	100,0	241,0	100,0
More serious floods since its operations			Moderate level	2	0,9	1	0,5	0,0	0,0
			No changes	108	49,1	103	51,5	80,0	33,2

Indicators		Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
	Yes, it made flood more serious	8	3,6	7	3,5	10,0	4,1
	Unsure	102	46,4	89	44,5	151,0	62,7
		220	100,0	200	100,0	241,0	100,0
Dam caused water lack more vulnerable	Moderate	16	7,3	18	9,0	24,0	10,0
	Not at all	38	17,3	51	25,5	38,0	15,8
	Little vulnerable lack of water	32	14,5	45	22,5	143,0	59,3
	Unsure	134	60,9	86	43,0	36,0	14,9
		220	100,0	200	100,0	241,0	100,0
Impact of dam on water for crops	More vulnerable lack of waters	83	37,7	75	37,5	24,0	10,0
	Very vulnerable lack of waters	36	16,4	32	16,0	0,0	0,0
	High level of lack of waters	3	1,4	3	1,5	0,0	0,0
	Not at all	22	10,0	19	9,5	40,0	16,6
	Little vulnerable lack of water	13	5,9	13	6,5	144,0	59,8
	Unsure	63	28,6	58	29,0	33,0	13,7
		220	100,0	200	100,0	241,0	100,0
Impacts on agricultural land	More vulnerable lack of waters	85	38,6	77	38,5	22,0	9,1
	Very vulnerable lack of waters	36	16,4	32	16,0	0,0	0,0
	Not at all	20	9,1	17	8,5	41,0	17,0
	Little vulnerable lack of water	14	6,4	13	6,5	145,0	60,2
	Unsure	65	29,5	61	30,5	33,0	13,7
		220	100,0	200	100,0	241,0	100,0
Impacts of on your aquaculture pond	More vulnerable lack of waters	86	39,1	78	39,0	21,0	8,7
	Very vulnerable lack of waters	36	16,4	32	16,0	0,0	0,0
	Not at all	18	8,2	16	8,0	45,0	18,7
	Little vulnerable lack of water	16	7,3	15	7,5	144,0	59,8
	Unsure	64	29,1	59	29,5	31,0	12,9

Indicators	Vietnam		Lao PDR		Cambodia	
	No	%	No	%	No	%
	220	100,0	200	100,0	241,0	100,0
Impact of dam on water daily uses						
More vulnerable lack of waters	83	37,7	75	37,5	14,0	5,8
Very vulnerable lack of waters	38	17,3	34	17,0	3,0	1,2
Not at all	21	9,5	18	9,0	43,0	17,8
Little vulnerable lack of water	14	6,4	14	7,0	146,0	60,6
Unsure	64	29,1	59	29,5	35,0	14,5
	220	100,0	200	100,0	241,0	100,0
Impacts on water for livestock						
More vulnerable lack of waters	83	37,7	75	37,5	16,0	6,6
Very vulnerable lack of waters	36	16,4	32	16,0	1,0	0,4
Not at all	12	5,5	11	5,5	41,0	17,0
Little vulnerable lack of water	23	10,5	21	10,5	146,0	60,6
Unsure	66	30,0	61	30,5	38,0	15,8
	220	100,0	200	100,0	241,0	100,0

(Source: survey households in 2022)

4.5. Level of impact on households' livelihoods

The table 6 highlights significant regional differences in the perceptions and impacts of small dam operations on households in Vietnam, Laos, and Cambodia. Vietnam and Laos generally report more pronounced negative impacts on water sources, crop productivity, and livelihood changes, while Cambodia exhibits a mix of positive and negative perceptions. The high levels of uncertainty reported by many respondents suggest a need for better communication and management practices to address the challenges posed by dam operations. Comprehensive policies and enhanced coordination among stakeholders are essential to mitigate these impacts and ensure sustainable development in these regions.

Table 6. Perceptions of impacts of small-scale hydropower dam operation

Indicators	Level	Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
Crop productivity	Not agreement a	14	6,4	0	0,0	2	0,8
	Not Agreement	70	31,8	0	0,0	43	17,8

Indicators	Level	Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
	Unsure	65	29,5	38	19,0	54	22,4
	Agreement	55	25,0	104	52,0	130	53,9
	Very Agreement	16	7,3	58	29,0	12	5,0
		220	100,0	200	100,0	241	100,0
Water quality	Not agreement a	4	1,8	96	48,0	8	3,3
	Not Agreement	23	10,5	40	20,0	124	51,5
	Unsure	62	28,2	46	23,0	87	36,1
	Agreement	114	51,8	18	9,0	21	8,7
	Very Agreement	17	7,7	0	0,0	1	0,4
		220	100,0	200	100,0	241	100,0
Agricultural production							
	Not agreement a	1	0,5	0	0,0	0	0,0
	Not Agreement	43	19,5	0	0,0	28	11,6
	Unsure	59	26,8	14	7,0	73	30,3
	Agreement	101	45,9	68	34,0	133	55,2
	Very Agreement	16	7,3	118	59,0	7	2,9
		220	100,0	200	100,0	241	100,0
Deforestation	Not agreement a	0	-	0	0,0	2	0,8
	Not Agreement	10	4,5	26	13,0	35	14,5
	Unsure	39	17,7	24	12,0	76	31,5

Indicators	Level	Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
	Agreement	81	36,8	78	39,0	87	36,1
	Very Agreement	90	40,9	72	36,0	41	17,0
		220	100,0	200	100,0	241	100,0
Lack of water for villagers	Not agreement a	8	3,6	6	3,0	19	7,9
	Not Agreement	5	2,3	4	2,0	153	63,5
	Unsure	44	20,0	24	12,0	48	19,9
	Agreement	78	35,5	76	38,0	19	7,9
	Very Agreement	85	38,6	90	45,0	2	0,8
		220	100,0	200	100,0	241	100,0
Decreased in crop producti	Not agreement a	3	1,4	12	6,0	15	6,2
	Not Agreement	14	6,4	18	9,0	149	61,8
	Unsure	58	26,4	16	8,0	64	26,6
	Agreement	115	52,3	90	45,0	11	4,6
	Very Agreement	30	13,6	64	32,0	2	0,8
		220	100,0	200	100,0	241	100,0
Serious lack of water villagers	Not agreement a	10	4,5	10	5,0	20	8,3
	Not Agreement	17	7,7	6	3,0	172	71,4
	Unsure	49	22,3	22	11,0	41	17,0
	Agreement	107	48,6	72	36,0	7	2,9
	Very Agreement	37	16,8	90	45,0	1	0,4

Indicators	Level	Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
		220	100,0	200	100,0	241	100,0
More serious floods	Not agreement a	9	4,1	4	2,0	18	7,5
	Not Agreement	15	6,8	24	12,0	171	71,0
	Unsure	71	32,3	14	7,0	40	16,6
	Agreement	92	41,8	88	44,0	10	4,1
	Very Agreement	33	15,0	70	35,0	2	0,8
		220	100,0	200	100,0	241	100,0
Reduced agricultural lan villagers	Not agreement a	0	0,0	8	4,0	15	6,2
	Not Agreement	17	7,7	2	1,0	165	68,5
	Unsure	26	11,8	20	10,0	50	20,7
	Agreement	144	65,5	72	36,0	10	4,1
	Very Agreement	33	15,0	98	49,0	1	0,4
		220	100,0	200	100,0	241	100,0
Women and children's d water insecurities	Not agreement a	3	1,4	2	1,0	17	7,1
	Not Agreement	16	7,3	24	12,0	134	55,6
	Unsure	46	20,9	18	9,0	79	32,8
	Agreement	118	53,6	82	41,0	10	4,1
	Very Agreement	37	16,8	74	37,0	1	0,4
		220	100,0	200	100,0	241	100,0
Reduced agricultural lan villagers	Not agreement a	2	0,9	0	0,0	16	6,6
	Not Agreement	10	4,5	2	1,0	163	67,6
	Unsure	58	26,4	22	11,0	52	21,6
	Agreement	131	59,5	72	36,0	9	3,7
	Very Agreement	19	8,6	104	52,0	1	0,4
		220	100,0	200	100,0	241	100,0
Water allocation	Not agreement a	7	3,2	0	0,0	2	0,8
	Not Agreement	86	39,1	20	10,0	68	28,2
	Unsure	59	26,8	18	9,0	59	24,5
	Agreement	58	26,4	88	44,0	110	45,6
	Very Agreement	10	4,5	74	37,0	2	0,8

Indicators	Level	Vietnam		Lao PDR		Cambodia	
		No	%	No	%	No	%
		220	100,0	200	100,0	241	100,0
Fruits productivity	Not agreement a	1	0,5	2	1,0	19	7,9
	Not Agreement	15	6,8	4	2,0	158	65,6
	Unsure	63	28,6	20	10,0	55	22,8
	Agreement	127	57,7	74	37,0	9	3,7
	Very Agreement	14	6,4	100	50,0	0	0,0
		220	100,0	200	100,0	241	100,0
Industrial crops productivity	Not agreement a	2	0,9	0	0,0	16	6,6
	Not Agreement	43	19,5	4	2,0	136	56,4
	Unsure	41	18,6	18	9,0	77	32,0
	Agreement	121	55,0	86	43,0	12	5,0
	Very Agreement	13	5,9	92	46,0	0	0,0
		220	100,0	200	100,0	241	100,0
Reduced income livestock	Not agreement a	9	4,1	10	5,0	18	7,5
	Not Agreement	63	28,6	16	8,0	159	66,0
	Unsure	68	30,9	18	9,0	56	23,2
	Agreement	75	34,1	82	41,0	8	3,3
	Very Agreement	5	2,3	74	37,0	0	0,0
		220	100,0	200	100,0	241	100,0
Changes in our land use pattern	Not agreement a	4	1,8	8	4,0	9	3,7
	Not Agreement	12	5,5	10	5,0	142	58,9
	Unsure	37	16,8	22	11,0	70	29,0
	Agreement	143	65,0	66	33,0	20	8,3
	Very Agreement	24	10,9	94	47,0	0	0,0
		220	100,0	200	100,0	241	100,0
Changes in our livelihood	Not agreement a	2	0,9	14	7,0	0	0,0
	Not Agreement	14	6,4	10	5,0	95	39,4
	Unsure	45	20,5	20	10,0	71	29,5
	Agreement	136	61,8	74	37,0	62	25,7
	Very Agreement	23	10,5	82	41,0	13	5,4
		220	100,0	200	100,0	241	100,0

(Source: survey households in 2022)

Community assessments of the impacts of hydropower on indicators such as crop yield, water quality, agricultural production, and other environmental issues show a diversity of perceptions among Vietnam, Laos, and Cambodia. The clear difference in the level of consensus suggests that the geographical, economic, and hydropower-dependent contexts of each country have influenced people's views.

First, the indicator on crop yield shows that in Cambodia, up to 53.9% of people agree

that hydropower has a positive impact on crop yield, while in Vietnam, only 25% agree and a large proportion (31.8%) disagree. This may stem from Cambodia's less dependence on large-scale agriculture or because they have adopted better measures to adapt to environmental changes. Meanwhile, in Vietnam, the agricultural sector is greatly affected by changes in water flow, which can lead to crop failures or reduced crop yields (Ziv et al., 2012).

Regarding water quality, Vietnamese people have a higher rate of agreement (51.8%) that hydropower causes problems with water quality, while in Laos only 9% agree and in Cambodia there is a higher rate of disagreement (51.5%). This is consistent with previous studies on the impact of hydropower on Vietnam's river system, where the construction of hydropower dams has caused pollution and reduced water quality, directly affecting agriculture and people's lives (Fan et al., 2015). Research by Ziv et al. (2012) also shows that hydropower projects in the Mekong River basin have changed the ecosystem and degraded water resources, which explains the dissatisfaction of Vietnamese people with water quality.

The indicator on agricultural production showed a strong consensus in Laos, with 59% strongly agreeing that hydropower is beneficial to agricultural production, compared to only 7.3% in Vietnam. This may be because Laos is in the early stages of hydropower development and sees immediate economic benefits, while Vietnam and Cambodia have seen longer-term environmental and agricultural impacts (Molle et al., 2009).

In addition, the indicator on water shortages showed strong concerns in Vietnam and Laos, with high levels of agreement (35.5% and 38%, respectively), while in Cambodia, the majority disagreed that hydropower causes water shortages (63.5%). The study by Fan et al. (2015) also demonstrated that hydropower projects on the Mekong River have affected water allocation, especially in rural areas in Vietnam, where people rely heavily on natural water sources for irrigation.

The loss of agricultural land is also a concern, especially in Vietnam (65.5% agree). This is consistent with previous studies that have shown that the construction of hydropower dams can flood agricultural areas, reducing the amount of arable land and causing loss of livelihoods for many farming households (Wang et al., 2013).

Overall, compared to previous studies such as Molle, Foran, and Kähkönen (2009), the views of communities in Vietnam, Laos, and Cambodia show a significant divide in their assessment of the benefits and impacts of hydropower. Although hydropower brings some economic benefits, such as providing energy and promoting industrial development, the environmental and social issues that these projects cause cannot be ignored. Other studies in the Mekong River Basin have also emphasized that the economic benefits of hydropower need to be carefully weighed against the long-term impacts on livelihoods, the environment, and public health (Kuenzer et al., 2013).

Conclusions

Conclusion. This study highlights the crucial role of policy in shaping the development and implementation of small-scale hydropower projects in Vietnam, Laos, and Cambodia. Through examining the perceptions of local communities and policymakers, it becomes evident that effective policy frameworks can significantly enhance the benefits of hydropower development while minimizing adverse impacts on the environment and local livelihoods. The findings suggest that well-designed policies, which prioritize community engagement and transparent compensation mechanisms, are essential for ensuring the long-term sustainability of these projects. The differences in policy implementation among the three countries underscore the importance of tailored approaches that address the unique social, economic, and environmental contexts of each region. Furthermore, integrating community feedback into the

planning and operational phases can foster a sense of ownership and increase the acceptance of hydropower projects.

Limitations. Despite the contributions of this research, there are several limitations that should be acknowledged. First, the study relies heavily on qualitative data from interviews and surveys, which may be influenced by respondents' subjective views and potential biases. Second, the scope of the study is limited to selected sites in Vietnam, Laos, and Cambodia, which may not fully represent the diversity of conditions across all hydropower projects in these countries. Additionally, the study did not account for the long-term environmental changes caused by hydropower development, focusing primarily on immediate community perceptions and short-term impacts. Future research should incorporate a more extensive range of case studies and quantitative data, as well as longitudinal studies to better understand the evolving impacts of hydropower projects on both local communities and ecosystems. These efforts could help refine policy recommendations and improve the management practices of small-scale hydropower development in the region.

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Combining Machine Learning and Natural Language Processing in Aspect-Based Sentiment Analysis from Tourist Reviews: A case study of hotels in Hue City

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Abstract

This study applies machine learning techniques to aspect-based sentiment analysis of tourist reviews regarding hotel service quality in Huế City. The research aims to classify overall sentiment and analyze detailed sentiments across specific aspects using the advanced PhoBERT language model combined with machine learning algorithms such as SVM, Naïve Bayes, and LSTM. The dataset includes 1,749 Vietnamese comments collected from TripAdvisor. Experimental results demonstrate the superiority of the PhoBERT-SVM model with an accuracy of 97%. In comparison, PhoBERT-LSTM achieved a performance of 82% for overall sentiment analysis and 52% for aspect-based sentiment analysis. These findings not only confirm the effectiveness of the PhoBERT model in Vietnamese natural language processing but also provide valuable insights for improving hotel service management, particularly in understanding tourists’ needs and expectations.

Keywords: Sentiment Analysis, Aspect-Based Sentiment Analysis (ABSA), PhoBERT, Machine Learning, Hotel Management

Introduction

Sentiment Analysis is a prominent field within Natural Language Processing (NLP) and has been extensively applied to mining unstructured data from online reviews. In particular, Aspect-Based Sentiment Analysis (ABSA) enables a detailed assessment of user sentiment toward specific aspects of a product or service. This represents a significant advancement over overall sentiment analysis by providing more in-depth insights.

With the rapid development of Machine Learning (ML) and Deep Learning (DL) technologies, numerous studies have successfully applied ABSA in fields such as e-commerce, customer service, and especially tourism. Popular models like Support Vector Machines (SVM), Random Forest (RF), and more recently, neural network-based models like BERT and RoBERTa, have achieved high performance in analyzing user-generated review data. However, most of these studies primarily focus on widely spoken languages such as English, Chinese, or Spanish (Cambria et al., 2017; Do et al., 2021).

In Vietnam, while some studies have applied ABSA in the context of the Vietnamese language, the dataset scales have remained limited, and the focus has primarily been on fields such as e-commerce (Nguyen et al., 2020). In the tourism sector, particularly in hotel services, the exploitation of online review data from tourists has not been deeply explored. Hue City, one of Vietnam's leading tourist destinations, attracts over 3.5 million visitors annually, including more than 1.2 million international tourists (Le Chung, 2024). The tourism and hospitality industry in Hue plays a crucial role in the local economy, with 893 accommodation establishments, including 205 hotels, accounting for 22.9% of total lodging facilities (Thua Thien Hue E-Government Portal, 2024). However, there has been little research leveraging sentiment and feedback data from tourists regarding hotel services in this area.

Applying ABSA to analyze tourist reviews not only sheds light on overall sentiment but also provides detailed insights into specific aspects such as location, staff attitudes, food quality, and pricing. Current studies in Vietnam often stop at overall sentiment analysis, lacking depth and practical applications, leaving a significant research gap. Meanwhile, as Vietnam's tourism industry, particularly in Hue, accelerates its digital transformation (Ministry of Culture, Sports, and Tourism, 2023), the need to harness online review data through ABSA becomes increasingly urgent.

Given such scientific and practical significance, this study utilizes a dataset of 1,749 reviews collected from TripAdvisor concerning hotel service quality in Hue City. By combining ML and NLP techniques, the research aims not only to contribute to the development of ABSA applications in the Vietnamese context but also to deliver practical value, fostering the sustainable growth of the tourism industry in Hue City.

1. Research Objectives

1.1. To build and preprocess the dataset from tourist comments and reviews about hotels in Hue City.

1.2. To apply the PhoBERT model combined with machine learning models (SVM, Naïve Bayes, LSTM) to label and analyze both general sentiment and aspect-based sentiment.

1.3. To compare the analysis results between models and with previous studies.

1.4. To contribute to Vietnamese NLP research.

2. Review of Related Literatures

Sentiment Analysis

Sentiment Analysis is a crucial field in NLP that aims to extract and classify user emotions (e.g., positive, negative, or neutral) from text data. This technique is widely applied not only in marketing and education but also holds particular significance in the hospitality industry, where customer perceptions directly impact service quality and business performance (Liu, 2012).

Aspect-Based Sentiment Analysis

ABSA is an extension of Sentiment Analysis. ABSA goes beyond identifying overall sentiment to delve into specific aspects, providing more detailed and actionable insights. This is especially important in the context of hotel service management, where customers often express emotions about factors such as location, pricing, service attitude, and facilities (Pontiki et al., 2016).

Machine Learning and Its Application in Sentiment Analysis

ML is a key branch of artificial intelligence that enables computers to learn from data and improve their performance over time without explicit programming (Mitchell, 1997). In recent years, machine learning has become a primary tool for various applications, including NLP, image recognition, and big data analysis. Algorithms like Support Vector Machines

(SVM), Naïve Bayes, and Deep Neural Networks have demonstrated their effectiveness in analyzing and predicting based on unstructured data.

Notably, the advent of advanced language models such as BERT and PhoBERT has significantly enhanced the ability to process natural language, delivering superior performance in text-related tasks (Devlin et al., 2019; Nguyen et al., 2020). ML has been widely used to process and analyze sentiments in online reviews, product ratings, and social media interactions (Pang & Lee, 2008). Advanced techniques like ABSA provide more granular insights by determining sentiments about specific aspects, such as service quality, pricing, or amenities. Recent studies have shown that ML models based on BERT and its variants, such as PhoBERT, achieve high effectiveness in sentiment analysis tasks by combining robust semantic representations with deep contextual understanding (Nguyen & Tuan, 2020; Sun et al., 2019).

The PhoBERT Model

PhoBERT is an advanced language model specifically designed for Vietnamese, developed based on the RoBERTa architecture (Liu et al., 2019). Trained on a large-scale Vietnamese dataset, PhoBERT excels in NLP tasks such as text classification, entity tagging, and sentiment analysis (Nguyen & Nguyen, 2020). Compared to traditional dictionary-based methods or conventional machine learning models, PhoBERT leverages contextual embeddings, significantly improving accuracy and semantic comprehension.

Research Overview

Sentiment Analysis has emerged as a key research area in NLP, driven by the development of machine learning and deep learning models. Traditional methods like SVM and Naïve Bayes were once dominant approaches for sentiment classification (Sun et al., 2019). However, the introduction of advanced language models, particularly BERT (Bidirectional Encoder Representations from Transformers), has led to remarkable advancements in NLP tasks, including sentiment analysis (Devlin et al., 2019).

ABSA extends the scope of Sentiment Analysis by focusing on specific aspects within review content rather than merely assessing overall sentiment. Recent studies have successfully applied BERT-based models to ABSA, demonstrating significant improvements in accuracy compared to traditional methods (Bao et al., 2020). Research by Sun et al. (2019) showed that fine-tuning BERT on labeled datasets substantially improved results in sentiment-related tasks.

In Vietnam, research on sentiment analysis has primarily focused on the Vietnamese language, with significant challenges in terms of data and cultural context. The PhoBERT model, developed based on the BERT structure and optimized for Vietnamese, has opened new opportunities in sentiment analysis, especially when applied to online reviews (Nguyen et al., 2019). PhoBERT, trained on a large Vietnamese corpus, offers a significant advantage in handling NLP tasks related to this language.

In the hospitality sector, sentiment analysis studies have provided valuable insights for service management and improvement. Zhu et al. (2020) and Huang et al. (2021) applied deep learning models to analyze tourist reviews, identifying factors influencing customer satisfaction. However, most of these studies focus on major languages such as English or Chinese, while studies specific to Vietnamese, especially in contexts like hotels in Hue City, remain limited.

The lack of standardized Vietnamese datasets poses a significant challenge for research in this field. Most existing datasets are either focused on other industries or not specifically designed for hotel-related studies (Ngo et al., 2020). Applying ABSA in Vietnam not only addresses this research gap but also provides valuable insights for the tourism industry, especially as Huế City continues to develop as an attractive tourist destination.

This overview highlights that applying advanced language models like PhoBERT in ABSA, particularly in specific sectors such as hotels in Vietnam, is not only highly practical but also contributes significantly to the NLP research domain. It underscores the importance of the current study in addressing gaps in data and methodology.

Research Methodology

1. Research Process

The research process began with data collection, followed by data labeling to apply supervised learning algorithms. Next, the collected comments underwent preprocessing to meet data requirements before being vectorized for training sentiment classification models. The sentiment classification models were trained using ML algorithms combined with natural language processing. Finally, the classification results were analyzed and evaluated using metrics such as Accuracy, Precision, Recall, and F1-Score. This process was primarily implemented using Python programming language (Figure 1).

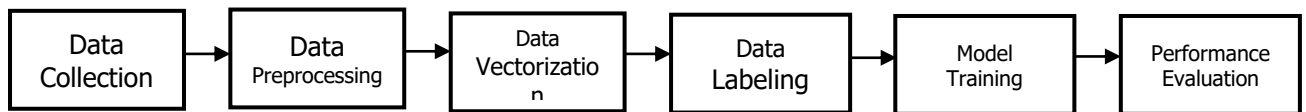


Figure 1. Research Process

2. Data Collection

Data was collected by crawling information from the TripAdvisor website (a popular platform for online reviews and feedback on travel and hotel services) using the scraper.plus tool and was stored as raw text. The initial dataset included 21 columns and 1,823 rows corresponding to 1,823 reviews and ratings in Vietnamese from travelers who had experienced services at hotels in Hue City. However, for the scope of this paper, which focuses on general sentiment classification and aspect-based sentiment analysis of traveler comments, only two columns were retained: review_text and ratings (Table 1).

Table 1. Illustration of the initial dataset

	review_text	rating
0	Dịch vụ ks rất tốt, chu đáo thân thiện .\nNhân...	5.0
1	Khách sạn ngay trung tâm, thuận tiện đi lại, n...	5.0
2	Mình chỉ ở 1 đêm nhưng rất ấn tượng vì tiện ng...	5.0
3	Khách sạn sạch sẽ, mặc dù 4 sao nhưng không qu...	5.0
4	Nhân viên phục vụ nhiệt tình, tắm khoáng nóng ...	5.0

3. Data Preprocessing and Data Vectorization

To ensure the quality of model training, data preprocessing was conducted. Besides removing rows with missing data, duplicate entries, and non-Vietnamese comments, the preprocessing process focused on normalizing the reviews. This process included procedures such as converting text to lowercase, removing special characters (non-alphabetic characters, hyperlinks, punctuation, etc.), tokenization, removing stopwords, and stemming words. These

procedures were implemented using text processing methods like `lower()`, `sub()`, `tokenize()`, and `stem()` from Python's NLTK library.

PhoBERT was used to extract features from the input review sentences and convert them into numerical representations (feature vectors) that machines and models could process. Each sentence was encoded into one or more feature vectors, called embeddings, to represent the contextual meaning of words or sentences.

The cleaned and normalized dataset comprised 1,749 rows (Table 2).

Table 2. Illustration of the cleaned and normalized dataset

	review_text	rating	comment_processed	tokenized_text	aspects	embedding	cls_embedding
0	Dịch vụ ks rất tốt, chu đáo thân thiện .nNhân...	5.0	dịch vụ ks rất tốt chu đáo thân thiện nhân viên...	dịch_vụ_ks_rất_tốt_chu_đáo_thân_thiện_nhân_viê...	['chất lượng dịch vụ', 'thái độ phục vụ của nh...	tensor([[[0.2020, 0.4847, -0.3504, ..., -0....	tensor([2.0202e-01, 4.8466e-01, -3.5044e-01...
1	Khách sạn ngay trung tâm, thuận tiên đi lại, n...	5.0	khách sạn ngay trung tâm thuận tiên đi lại nhâ...	khách_sạn_ngay_trung_tâm_thuận_tiên_đi_lại_nhâ...	['thái độ phục vụ của nhân viên', 'vị trí khác...	tensor([[[0.1311, 0.5251, -0.4069, ..., -0....	tensor([1.3110e-01, 5.2507e-01, -4.0686e-01...
2	Mình chỉ ở 1 đêm nhưng rất ấn tượng vì tiện ng...	5.0	mình chỉ ở đêm nhưng rất ấn tượng vì tiện nghi...	mình_chỉ_ở_đêm_nhưng_rất_ấn_tượng_vì_tiện_nghi...	['thái độ phục vụ của nhân viên']	tensor([[[0.2789, 0.6194, -0.4564, ..., -0....	tensor([2.7893e-01, 6.1942e-01, -4.5638e-01...
3	Khách sạn sạch sẽ, mặc dù 4 sao nhưng không qu...	5.0	khách sạn sạch sẽ mặc dù sao nhưng không quá l...	khách_sạn_sạch_sẽ_mặc_dù_sao_nhưng_không_quá_l...	['chất lượng dịch vụ', 'thái độ phục vụ của nh...	tensor([[[0.0641, 0.7954, -0.4120, ..., 0....	tensor([6.4076e-02, 7.9544e-01, -4.1200e-01...
4	Nhân viên phục vụ nhiệt tình, tắm khoáng nóng ...	5.0	nhân viên phục vụ nhiệt tình tắm khoáng nóng t...	nhân_viên_phục_vụ_nhiệt_tình_tắm_khoáng_nóng_t...	['thái độ phục vụ của nhân viên']	tensor([[[0.2773, 0.7033, -0.3591, ..., -0....	tensor([2.7726e-01, 7.0327e-01, -3.5910e-01...

4. Data Labeling

The data labeling process involves two main steps: mapping aspects to numerical values and assigning sentiment labels based on ratings (Figure 2).

- (1) **Aspect Mapping:** A dictionary (*aspect_mapping*) is created to convert specific aspects (e.g., "vị trí khách sạn" for hotel location) into numerical codes (0, 1, 2). A function (*convert_aspect*) iterates through the aspects in each review and maps them to their corresponding numerical values. If no matching aspect is found, a default value of -1 is assigned.
- (2) **Sentiment Labeling:** A separate function (*map_rating_to_sentiment*) maps review ratings to sentiment labels, where ratings of 1–3 correspond to negative sentiment (0), and ratings of 4–5 correspond to positive sentiment (1).

Finally, these functions are applied to the dataset, creating two new columns: *numerical_aspects* for aspect codes and *Sentiment* for sentiment labels. Table 3 illustrates 5 first rows from the dataset after labeling the data.

```
# Create a mapping dictionary
aspect_mapping = {
    "vị trí khách sạn": 0,
    "thái độ phục vụ của nhân viên": 1,
    "chất lượng dịch vụ": 2
}

# Function to convert aspect to numerical value
def convert_aspect(aspects):
    numerical_aspects = []
    for aspect in aspects:
        if aspect in aspect_mapping:
            numerical_aspects.append(aspect_mapping[aspect])
    return numerical_aspects if numerical_aspects else [-1] # Return -1 if no matching aspect is found

def map_rating_to_sentiment(rating):
    if 1 <= rating <= 3:
        return 0 # Negative sentiment
    else:
        return 1 # Positive sentiment

# Apply the function to the 'aspects' column
data['numerical_aspects'] = data['aspects'].apply(lambda x: convert_aspect(eval(x)))
data['sentiment'] = data['rating'].apply(map_rating_to_sentiment)
```

Figure 2. Python code for data labeling

Table 3. Illustration of the dataset after labeling

	review_text	aspects	rating	numerical_aspects	sentiment
0	Dịch vụ ks rất tốt, chu đáo thân thiện. .\nNhân...	['chất lượng dịch vụ', 'thái độ phục vụ của nh...	5.0	[2, 1, 0]	1
1	Khách sạn ngay trung tâm, thuận tiện đi lại, n...	['thái độ phục vụ của nhân viên', 'vị trí khác...	5.0	[1, 0]	1

	review_text	aspects	rating	numerical_aspects	sentiment
2	Mình chỉ ở 1 đêm nhưng rất ấn tượng vì tiện ng...	['thái độ phục vụ của nhân viên']	5.0	[1]	1
3	Khách sạn sạch sẽ, mặc dù 4 sao nhưng không qu...	['chất lượng dịch vụ', 'thái độ phục vụ của nh...']	5.0	[2, 1, 0]	1
4	Nhân viên phục vụ nhiệt tình, tắm khoáng nóng ...	['thái độ phục vụ của nhân viên']	5.0	[1]	1

5. Model Training

Before training the machine learning models, the review dataset was divided into three subsets: training (70%), testing (15%), and validation (15%).

Sentiment analysis was conducted at two primary levels: General Sentiment Classification and Aspect-Based Sentiment Analysis, focusing on specific aspects such as location, service quality, and staff attitude. The sentiment analysis was based on combining PhoBERT with machine learning models like SVM, Naïve Bayes, and LSTM to improve analytical performance. Specifically:

- PhoBERT combined with SVM and Naïve Bayes: PhoBERT was used to represent text as embeddings, which were then fed into SVM and Naïve Bayes models for sentiment classification.
- PhoBERT combined with LSTM: PhoBERT was integrated with the LSTM recurrent neural network to sequentially capture contextual information, enhancing the effectiveness of sentiment analysis.

The training process was conducted using PhoBERT-base-v2 in combination with SVM, Naïve Bayes, and LSTM models (Figure 3, Figure 4, and Figure 5).

```
class PhoBERT_SVM:
    def __init__(self, phoBERT_model):
        self.phoBERT = phoBERT_model
        self.sentiment_pipeline = Pipeline([
            ('scaler', StandardScaler()), # Chuẩn hóa embedding
            ('svm', SVC(kernel='linear', class_weight='balanced', probability=True)) # SVM cho sentiment
        ])
        self.aspect_pipeline = Pipeline([
            ('scaler', StandardScaler()), # Chuẩn hóa embedding
            ('svm', SVC(kernel='linear', class_weight='balanced', probability=True)) # SVM cho aspect
        ])

    def extract_embeddings(self, input_ids, attention_mask):
        self.phoBERT.eval() # Đặt PhoBERT ở chế độ eval
        with torch.no_grad():
            embeddings = self.phoBERT(input_ids=input_ids, attention_mask=attention_mask)
        return embeddings.cpu().numpy() # Chuyển sang numpy để dùng với sklearn

    def train(self, input_ids, attention_mask, sentiment_labels, aspect_labels):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        self.sentiment_pipeline.fit(embeddings, sentiment_labels)
        self.aspect_pipeline.fit(embeddings, aspect_labels)

    def predict(self, input_ids, attention_mask):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        sentiment_preds = self.sentiment_pipeline.predict(embeddings)
        aspect_preds = self.aspect_pipeline.predict(embeddings)
        return sentiment_preds, aspect_preds
```

Figure 3. Python code for building the PhoBERT combined with SVM model

```
class PhoBERT_NaiveBayes:
    def __init__(self, phoBERT_model):
        self.phoBERT = phoBERT_model
        self.sentiment_pipeline = Pipeline([
            ('scaler', MinMaxScaler()), # Scale embeddings to 0-1
            ('nb', MultinomialNB())      # Naive Bayes
        ])
        self.aspect_pipeline = Pipeline([
            ('scaler', MinMaxScaler()), # Add MinMaxScaler here as well
            ('nb', MultinomialNB())      # Naive Bayes cho aspect
        ])

    def extract_embeddings(self, input_ids, attention_mask):
        self.phoBERT.eval() # Đặt PhoBERT ở chế độ eval
        with torch.no_grad():
            embeddings = self.phoBERT(input_ids=input_ids, attention_mask=attention_mask)
        return embeddings.last_hidden_state[:, 0, :].cpu().numpy() # Lấy embedding của token [CLS]

    def train(self, input_ids, attention_mask, sentiment_labels, aspect_labels):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        self.sentiment_pipeline.fit(embeddings, sentiment_labels)
        self.aspect_pipeline.fit(embeddings, aspect_labels)

    def predict(self, input_ids, attention_mask):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        sentiment_preds = self.sentiment_pipeline.predict(embeddings)
        aspect_preds = self.aspect_pipeline.predict(embeddings)
        return sentiment_preds, aspect_preds
```

Figure 4. Python code for building the PhoBERT combined with Naïve Bayes model

```
class PhoBERT_LSTM(nn.Module):
    def __init__(self, embedding_dim, hidden_dim, sentiment_labels, aspect_labels, num_layers=1, bidirectional=False, dropout=0.5):
        super(PhoBERT_LSTM, self).__init__()
        self.lstm = nn.LSTM(
            input_size=embedding_dim,
            hidden_size=hidden_dim,
            num_layers=num_layers,
            bidirectional=bidirectional,
            batch_first=True
        )
        self.dropout = nn.Dropout(dropout)
        self.sentiment_fc = nn.Linear(hidden_dim * (2 if bidirectional else 1), sentiment_labels)
        self.aspect_fc = nn.Linear(hidden_dim * (2 if bidirectional else 1), aspect_labels)

    def extract_phobert_embeddings(self, text, tokenizer, model, max_length=256):
        encoded = tokenizer(text, padding=True, truncation=True, return_tensors="pt", max_length=max_length)
        # Mã hóa với PhoBERT và lấy embeddings
        with torch.no_grad():
            outputs = model(input_ids=encoded['input_ids'], attention_mask=encoded['attention_mask'])
            embeddings = outputs.last_hidden_state
        return embeddings

    def forward(self, x):
        # Chạy dữ liệu qua LSTM
        lstm_out, _ = self.lstm(x)
        lstm_out = lstm_out[:, -1, :]
        lstm_out = self.dropout(lstm_out)

        sentiment_out = self.sentiment_fc(lstm_out)
        aspect_out = self.aspect_fc(lstm_out)

        return sentiment_out, aspect_out

    def predict(self, input_ids, attention_mask):
        # Dự đoán cho một batch dữ liệu
        embeddings = self.extract_phobert_embeddings(input_ids, attention_mask)
        sentiment_preds, aspect_preds = self.forward(embeddings)
        sentiment_preds = sentiment_preds.argmax(dim=1).cpu()
        aspect_preds = aspect_preds.argmax(dim=1).cpu()
        return sentiment_preds, aspect_preds
```

Figure 5. Python code for building the PhoBERT combined with LSTM model

6. Performance Evaluation

The performance of the models was evaluated using key metrics in sentiment analysis, including:

- Accuracy: The proportion of correct predictions out of the total test data.
- Precision: The proportion of correct positive predictions out of all positive predictions.
- Recall: The proportion of correct positive predictions out of all actual positive instances.
- F1-Score: The harmonic mean of Precision and Recall, assessing the balance between these metrics.

Results Research

1. Exploratory Data Analysis (EDA)

Based on the WordCloud generated from tourist reviews (Figure 6), prominent terms such as "khách sạn" (hotel), "nhân viên" (staff), "nhiệt tình" (enthusiastic), "thân thiện" (friendly), "sạch sẽ" (clean), and "dịch vụ" (service) indicate that hotels in Hue are highly rated for their professionalism, friendliness, and dedication in service delivery. Words like "tôi" (I), "chúng tôi" (we), and "đã" (did) reveal that tourists tend to share personal experiences and positive feedback. Additionally, keywords related to cleanliness and the enthusiasm of the staff stand out as significant highlights. This reflects the service quality and the hotels' attentiveness to customer experiences.

Overall, the reviews demonstrate a high level of satisfaction among tourists with hotels in Hue, particularly regarding staff attitude and hygiene standards. This is further supported by the significant disparity in the number of 5-star ratings compared to ratings from 1 to 4 (Figure 7). Thus, it can be concluded that the majority of tourists are very satisfied with the quality of hotel services in Hue City.



Figure 6. WordCloud for All Reviews

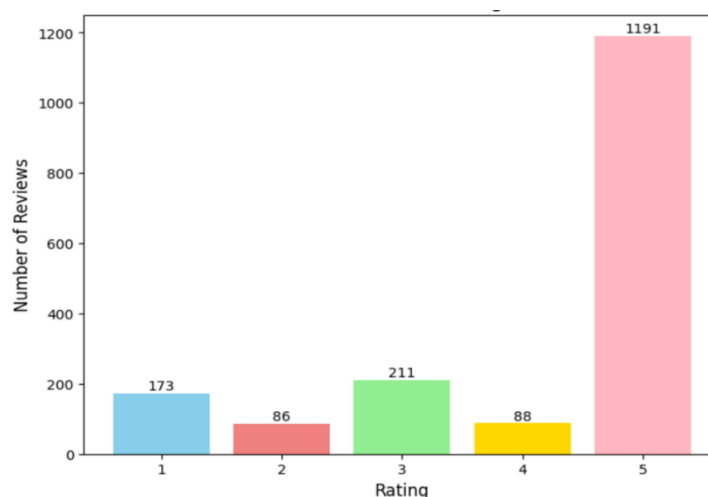


Figure 7. The bar chart illustrates the “Rating” evaluations of tourists

2. Model Performance

The evaluation results of the models for general sentiment classification and ABSA based on tourist reviews are presented in Table 4.

Table 4. Performance evaluation results of the models

Model	Precision		Recall		F1-score		Accuracy	
	Sentiment	Aspect	Sentiment	Aspect	Sentiment	Aspect	Sentiment	Aspect
SVM combined with PhoBERT	97%	64%	97%	59%	97%	61%	97%	59%
Naïve Bayes combined with PhoBERT	97%	52%	97%	58%	97%	48%	97%	58%
LSTM combined with PhoBERT	82%	57%	82%	52%	77.23%	38.87%	82.13%	52.47%

The analysis shows that the PhoBERT combined with SVM and Naïve Bayes models achieved outstanding performance in general sentiment classification, with an accuracy of 97%. Both models demonstrated high Precision, Recall, and F1-scores of 97% in general sentiment analysis, indicating stability and effectiveness in processing Vietnamese review data. However, for aspect-based analysis, accuracy dropped significantly to 59% and 58%, respectively, reflecting the challenges of extracting specific information from the reviews.

On the other hand, the PhoBERT combined with the LSTM model achieved an accuracy of 82.13% in general sentiment classification and 52.47% in aspect-based analysis. Although the overall accuracy was lower, this model demonstrated better contextual understanding for each aspect compared to traditional machine learning models. Nonetheless, its performance in aspect-based analysis remains limited, as evidenced by the significantly lower Precision and F1-scores. This underscores the need to enhance the model’s capability to analyze specific aspects.

3. Data Labeling

The data labeling process involves two main steps: mapping aspects to numerical values and assigning sentiment labels based on ratings (Figure 8).

Aspect Mapping: A dictionary (*aspect_mapping*) is created to convert specific aspects (e.g., "vị trí khách sạn" for hotel location) into numerical codes (0, 1, 2). A function (*convert_aspect*) iterates through the aspects in each review and maps them to their corresponding numerical values. If no matching aspect is found, a default value of -1 is assigned.

Sentiment Labeling: A separate function (*map_rating_to_sentiment*) maps review ratings to sentiment labels, where ratings of 1–3 correspond to negative sentiment (0), and ratings of 4–5 correspond to positive sentiment (1).

Finally, these functions are applied to the dataset, creating two new columns: *numerical_aspects* for aspect codes and *Sentiment* for sentiment labels. Table 3 illustrates 5 first rows from the dataset after labeling the data.

```
# Create a mapping dictionary
aspect_mapping = {
    "vị trí khách sạn": 0,
    "thái độ phục vụ của nhân viên": 1,
    "chất lượng dịch vụ": 2
}

# Function to convert aspect to numerical value
def convert_aspect(aspects):
    numerical_aspects = []
    for aspect in aspects:
        if aspect in aspect_mapping:
            numerical_aspects.append(aspect_mapping[aspect])
    return numerical_aspects if numerical_aspects else [-1] # Return -1 if no matching aspect is found

def map_rating_to_sentiment(rating):
    if 1 <= rating <= 3:
        return 0 # Negative sentiment
    else:
        return 1 # Positive sentiment

# Apply the function to the 'aspects' column
data['numerical_aspects'] = data['aspects'].apply(lambda x: convert_aspect(eval(x)))
data['sentiment'] = data['rating'].apply(map_rating_to_sentiment)
```

Figure 8. Python code for data labeling

Table 5. Illustration of the dataset after labeling

	review_text	aspects	rating	numerical_aspects	sentiment
0	Dịch vụ ks rất tốt, chu đáo thân thiện. .\nNhân...	['chất lượng dịch vụ', 'thái độ phục vụ của nh...]	5.0	[2, 1, 0]	1
1	Khách sạn ngay trung tâm, thuận tiện đi lại, n...	['thái độ phục vụ của nhân viên', 'vị trí khác...]	5.0	[1, 0]	1
2	Mình chỉ ở 1 đêm nhưng rất ấn tượng vì tiện ng...	['thái độ phục vụ của nhân viên']	5.0	[1]	1
3	Khách sạn sạch sẽ, mặc dù 4 sao nhưng không qu...	['chất lượng dịch vụ', 'thái độ phục vụ của nh...]	5.0	[2, 1, 0]	1

	review_text	aspects	rating	numerical_aspects	sentiment
4	Nhân viên phục vụ nhiệt tình, tắm khoáng nóng ...	['thái độ phục vụ của nhân viên']	5.0	[1]	1

4. Model Training

Before training the machine learning models, the review dataset was divided into three subsets: training (70%), testing (15%), and validation (15%).

Sentiment analysis was conducted at two primary levels: General Sentiment Classification and Aspect-Based Sentiment Analysis, focusing on specific aspects such as location, service quality, and staff attitude. The sentiment analysis was based on combining PhoBERT with machine learning models like SVM, Naïve Bayes, and LSTM to improve analytical performance. Specifically:

- PhoBERT combined with SVM and Naïve Bayes: PhoBERT was used to represent text as embeddings, which were then fed into SVM and Naïve Bayes models for sentiment classification.
- PhoBERT combined with LSTM: PhoBERT was integrated with the LSTM recurrent neural network to sequentially capture contextual information, enhancing the effectiveness of sentiment analysis.

The training process was conducted using PhoBERT-base-v2 in combination with SVM, Naïve Bayes, and LSTM models (Figure 9, Figure 10, and Figure 11).

```
class PhoBERT_SVM:
    def __init__(self, phoBERT_model):
        self.phoBERT = phoBERT_model
        self.sentiment_pipeline = Pipeline([
            ('scaler', StandardScaler()), # Chuẩn hóa embedding
            ('svm', SVC(kernel='linear', class_weight='balanced', probability=True)) # SVM cho sentiment
        ])
        self.aspect_pipeline = Pipeline([
            ('scaler', StandardScaler()), # Chuẩn hóa embedding
            ('svm', SVC(kernel='linear', class_weight='balanced', probability=True)) # SVM cho aspect
        ])

    def extract_embeddings(self, input_ids, attention_mask):
        self.phoBERT.eval() # Đặt PhoBERT ở chế độ eval
        with torch.no_grad():
            embeddings = self.phoBERT(input_ids=input_ids, attention_mask=attention_mask)
        return embeddings.cpu().numpy() # Chuyển sang numpy để dùng với sklearn

    def train(self, input_ids, attention_mask, sentiment_labels, aspect_labels):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        self.sentiment_pipeline.fit(embeddings, sentiment_labels)
        self.aspect_pipeline.fit(embeddings, aspect_labels)

    def predict(self, input_ids, attention_mask):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        sentiment_preds = self.sentiment_pipeline.predict(embeddings)
        aspect_preds = self.aspect_pipeline.predict(embeddings)
        return sentiment_preds, aspect_preds
```

Figure 9. Python code for building the PhoBERT combined with SVM model

```
class PhoBERT_NaiveBayes:
    def __init__(self, phoBERT_model):
        self.phoBERT = phoBERT_model
        self.sentiment_pipeline = Pipeline([
            ('scaler', MinMaxScaler()), # Scale embeddings to 0-1
            ('nb', MultinomialNB())     # Naive Bayes
        ])
        self.aspect_pipeline = Pipeline([
            ('scaler', MinMaxScaler()), # Add MinMaxScaler here as well
            ('nb', MultinomialNB())     # Naive Bayes cho aspect
        ])

    def extract_embeddings(self, input_ids, attention_mask):
        self.phoBERT.eval() # Đặt PhoBERT ở chế độ eval
        with torch.no_grad():
            embeddings = self.phoBERT(input_ids=input_ids, attention_mask=attention_mask)
        return embeddings.last_hidden_state[:, 0, :].cpu().numpy() # Lấy embedding của token [CLS]

    def train(self, input_ids, attention_mask, sentiment_labels, aspect_labels):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        self.sentiment_pipeline.fit(embeddings, sentiment_labels)
        self.aspect_pipeline.fit(embeddings, aspect_labels)

    def predict(self, input_ids, attention_mask):
        embeddings = self.extract_embeddings(input_ids, attention_mask)
        sentiment_preds = self.sentiment_pipeline.predict(embeddings)
        aspect_preds = self.aspect_pipeline.predict(embeddings)
        return sentiment_preds, aspect_preds
```

Figure 10. Python code for building the PhoBERT combined with Naïve Bayes model

```
class PhoBERT_LSTM(nn.Module):
    def __init__(self, embedding_dim, hidden_dim, sentiment_labels, aspect_labels, num_layers=1, bidirectional=False, dropout=0.5):
        super(PhoBERT_LSTM, self).__init__()
        self.lstm = nn.LSTM(
            input_size=embedding_dim,
            hidden_size=hidden_dim,
            num_layers=num_layers,
            bidirectional=bidirectional,
            batch_first=True
        )
        self.dropout = nn.Dropout(dropout)
        self.sentiment_fc = nn.Linear(hidden_dim * (2 if bidirectional else 1), sentiment_labels)
        self.aspect_fc = nn.Linear(hidden_dim * (2 if bidirectional else 1), aspect_labels)

    def extract_phobert_embeddings(self, text, tokenizer, model, max_length=256):
        encoded = tokenizer(text, padding=True, truncation=True, return_tensors="pt", max_length=max_length)
        # Mã hóa với PhoBERT và lấy embeddings
        with torch.no_grad():
            outputs = model(input_ids=encoded['input_ids'], attention_mask=encoded['attention_mask'])
            embeddings = outputs.last_hidden_state
        return embeddings

    def forward(self, x):
        # Chạy dữ liệu qua LSTM
        lstm_out, _ = self.lstm(x)
        lstm_out = lstm_out[:, -1, :]
        lstm_out = self.dropout(lstm_out)

        sentiment_out = self.sentiment_fc(lstm_out)
        aspect_out = self.aspect_fc(lstm_out)

        return sentiment_out, aspect_out

    def predict(self, input_ids, attention_mask):
        # Dự đoán cho một batch dữ liệu
        embeddings = self.extract_phobert_embeddings(input_ids, attention_mask)
        sentiment_preds, aspect_preds = self.forward(embeddings)
        sentiment_preds = sentiment_preds.argmax(dim=1).cpu()
        aspect_preds = aspect_preds.argmax(dim=1).cpu()
        return sentiment_preds, aspect_preds
```

Figure 11. Python code for building the PhoBERT combined with LSTM model

5. Performance Evaluation

The performance of the models was evaluated using key metrics in sentiment analysis, including:

- Accuracy: The proportion of correct predictions out of the total test data.
- Precision: The proportion of correct positive predictions out of all positive predictions.
- Recall: The proportion of correct positive predictions out of all actual positive instances.
- F1-Score: The harmonic mean of Precision and Recall, assessing the balance between these metrics.

Results Research

1. Exploratory Data Analysis (EDA)

Based on the WordCloud generated from tourist reviews (Figure 12), prominent terms such as "khách sạn" (hotel), "nhân viên" (staff), "nhiệt tình" (enthusiastic), "thân thiện" (friendly), "sạch sẽ" (clean), and "dịch vụ" (service) indicate that hotels in Hue are highly rated for their professionalism, friendliness, and dedication in service delivery. Words like "tôi" (I), "chúng tôi" (we), and "đã" (did) reveal that tourists tend to share personal experiences and positive feedback. Additionally, keywords related to cleanliness and the enthusiasm of the staff stand out as significant highlights. This reflects the service quality and the hotels' attentiveness to customer experiences.

Overall, the reviews demonstrate a high level of satisfaction among tourists with hotels in Hue, particularly regarding staff attitude and hygiene standards. This is further supported by the significant disparity in the number of 5-star ratings compared to ratings from 1 to 4 (Figure 13). Thus, it can be concluded that the majority of tourists are very satisfied with the quality of hotel services in Hue City.



Figure 12. WordCloud for All Reviews

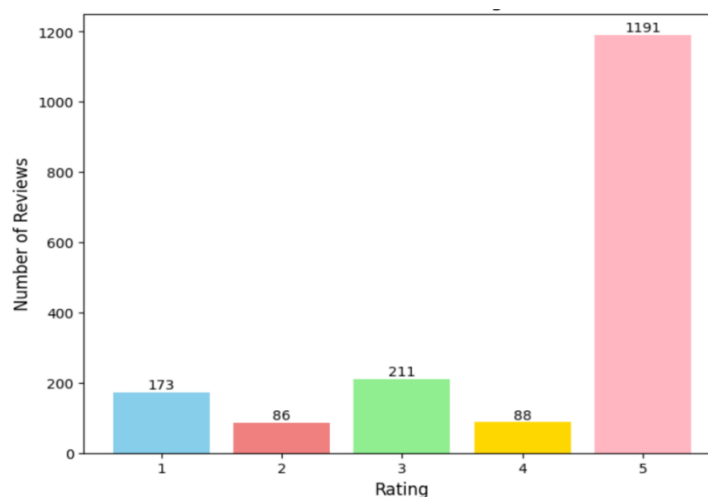


Figure 13. The bar chart illustrates the “Rating” evaluations of tourists

2. Model Performance

The evaluation results of the models for general sentiment classification and ABSA based on tourist reviews are presented in Table 4.

Table 4. Performance evaluation results of the models

Model	Precision		Recall		F1-score		Accuracy	
	Sentiment	Aspect	Sentiment	Aspect	Sentiment	Aspect	Sentiment	Aspect
SVM combined with PhoBERT	97%	64%	97%	59%	97%	61%	97%	59%
Naïve Bayes combined with PhoBERT	97%	52%	97%	58%	97%	48%	97%	58%
LSTM combined with PhoBERT	82%	57%	82%	52%	77.23%	38.87%	82.13%	52.47%

The analysis shows that the PhoBERT combined with SVM and Naïve Bayes models achieved outstanding performance in general sentiment classification, with an accuracy of 97%. Both models demonstrated high Precision, Recall, and F1-scores of 97% in general sentiment analysis, indicating stability and effectiveness in processing Vietnamese review data. However, for aspect-based analysis, accuracy dropped significantly to 59% and 58%, respectively, reflecting the challenges of extracting specific information from the reviews.

On the other hand, the PhoBERT combined with the LSTM model achieved an accuracy of 82.13% in general sentiment classification and 52.47% in aspect-based analysis. Although the overall accuracy was lower, this model demonstrated better contextual understanding for each aspect compared to traditional machine learning models. Nonetheless, its performance in aspect-based analysis remains limited, as evidenced by the significantly lower Precision and F1-scores. This underscores the need to enhance the model’s capability to analyze specific aspects.

Discussion

Significance of the results:

The research findings not only affirm the effectiveness of machine learning models and PhoBERT in analyzing Vietnamese sentiment but also provide significant strategic insights for the hotel management sector.

Firstly, the study highlights how specific aspects such as location, pricing, and service quality are evaluated by customers, offering reliable data for hotel managers to adjust their strategies. For instance, the results show that positive sentiments are often associated with hotel location, whereas pricing tends to elicit more negative feedback. This enables managers to

focus on improving weaker aspects or enhancing the hotel’s strengths. Furthermore, using Aspect-Based Sentiment Analysis (ABSA) allows for a deeper exploration of specific factors rather than relying solely on general sentiment, making service adjustment strategies more detailed and effective (Pang & Lee, 2008).

Secondly, the research emphasizes the superior benefits of using PhoBERT and machine learning models in Vietnamese sentiment analysis. PhoBERT, with its capability to handle the unique grammatical and semantic characteristics of Vietnamese, demonstrated high efficiency when combined with traditional machine learning models like SVM and Naïve Bayes, achieving 97% accuracy in general sentiment classification. Additionally, PhoBERT paired with LSTM achieved an overall classification accuracy of 82% and 52% for specific aspects, underlining its applicability to complex tasks like contextual analysis. These results not only showcase the strong application potential of PhoBERT but also pave the way for future research aimed at optimizing performance for imbalanced data (Nguyen et al., 2020).

In summary, this research contributes to both academic and practical domains. Theoretically, it underscores the capability of customized language models in natural language processing, particularly for under-researched languages like Vietnamese. Practically, the findings provide high application value, aiding hotel managers in enhancing service quality while extending the potential applications of sentiment analysis to other fields such as e-commerce and public services.

Comparison with previous studies:

The findings of this study align with previous research, especially regarding the application of BERT-based models in sentiment analysis. Studies by Devlin et al. (2019) and Sun et al. (2019) demonstrated that BERT and its variants deliver superior performance due to their ability to capture complex contextual and semantic structures. Our research confirms this by employing PhoBERT, a model optimized for Vietnamese, in combination with machine learning algorithms such as SVM and Naïve Bayes for general sentiment analysis, achieving an accuracy of 97%. This consistency with prior studies highlights the effectiveness of customizing language models for specific linguistic contexts (Nguyen & Tuan, 2020).

However, a key distinction of this study lies in extending the application of Aspect-Based Sentiment Analysis (ABSA) to the hotel sector, using a Vietnamese dataset comprising 1,749 reviews on Tripadvisor about hotels in Hue City. The results show that PhoBERT combined with LSTM achieved 82% accuracy in general sentiment analysis and 52% for specific aspects, highlighting LSTM’s contextual processing capabilities. Nonetheless, data imbalance significantly impacted the accuracy and predictive ability for negative sentiments, with 55 True Negatives but 208 False Positives. Compared to international studies that often use balanced and standardized datasets (Sun et al., 2019), these limitations reflect the unique challenges of Vietnamese data and aspect-based sentiment analysis in Vietnam.

These findings not only shed light on PhoBERT’s effectiveness in handling Vietnamese data but also contribute to a deeper understanding of the factors affecting model performance in real-world data contexts. This research lays a foundation for future studies, particularly in improving data quality and integrating advanced techniques like Transformer-based models (GPT, T5) to enhance predictive capabilities for specific aspects and negative sentiment labels while expanding sentiment analysis applications to other fields.

Conclusion

This study has affirmed the effectiveness of applying the PhoBERT model combined with machine learning algorithms such as SVM and Naïve Bayes in aspect-based sentiment analysis of Vietnamese online reviews. With an accuracy of 97%, these models not only demonstrate superior sentiment classification capabilities but also provide deep insights into specific aspects such as location, pricing, and service quality. These results highlight the immense potential of modern machine learning techniques and language models in extracting and analyzing Vietnamese natural language data.

In terms of practical applications, the study offers significant value to the hotel service industry. The analysis results can help managers gain a better understanding of travelers' experiences and expectations, enabling them to devise strategies to improve services effectively. Additionally, the proposed aspect-based sentiment analysis method can be extended to other fields such as retail, healthcare, and education, where user feedback is a critical foundation for enhancing service quality.

However, the study has certain limitations, particularly the impact of data imbalance on the models' performance for negative labels. Future research directions include balancing data to improve the models' predictive ability, especially for negative sentiments. Furthermore, the application of more advanced models such as GPT, T5, or other state-of-the-art Transformer models promises to enhance sentiment analysis efficiency and broaden the scope of applications. These advancements not only contribute to refining the research but also open opportunities for development in other fields, thereby advancing the utilization of natural language data in Vietnam.

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Driving factors of applying “economic-green” model in marine lobster farming in Vietnam

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Abstract

Marine cage lobster farming is a vital aquaculture activity in Vietnam, significantly contributing to the economy and supporting coastal livelihoods. This study examines the factors influencing farmers' choices of three farming models: ornate lobster monoculture, scalloped lobster monoculture, and mixed cultivation. Using multinomial logistic regression, we analyze data from 353 lobster farming households in the provinces of Khanh Hoa and Phu Yen.

Key findings reveal that factors such as the cultivation period at the same location, distance to neighboring farms, feed price, and fingerling price significantly influence the adoption of specific farming models. Scalloped lobster monoculture and mixed cultivation models exhibit higher profitability and environmental efficiency compared to ornate lobster monoculture. The study underscores the need for policies promoting sustainable practices, access to affordable inputs, and improved infrastructure, especially cage design. By addressing these factors, Vietnam can foster a more resilient and environmentally sustainable lobster farming sector, ensuring long-term economic benefits for coastal communities.

Keywords: lobster culture model, driving factors, Vietnam, multinomial logistic, economic-green

Introduction

Marine cage lobster farming is a high-value aquaculture activity that significantly contributes to Vietnam's economy, particularly in coastal regions. The provinces of Khanh Hoa and Phu Yen are national leaders in terms of farming area, production volume, and income generated from cage lobster farming. Each year, this sector produces around 2,000 tons of lobsters and provides employment for 8,000 to 10,000 coastal households across Vietnam (Minh *et al.*, 2016). However, the rapid expansion of this industry has imposed substantial pressure on the natural environment and coastal ecosystems (Minh *et al.*, 2016; Ton Nu Hai and Speelman, 2020a; Ton Nu Hai, Van Meensel and Speelman, 2020). Organic waste from excrement and excessive leftover feed (Tuan, 2011) adversely impacts local ecosystems and leads to eutrophication (Minh *et al.*, 2016). This accumulation of organic waste reduces farming productivity by impairing disease resistance, decreasing oxygen levels in the water, and causing stress in lobsters, ultimately resulting in high mortality rates (Minh *et al.*, 2016).

Existing research has explored opportunities and challenges (Tuan, 2011), factors influencing sustainable development (Ton Nu Hai and Speelman, 2020b), cost efficiency (Ton Nu Hai, Bui Dung and Speelman, 2018), environmental efficiency (Ton Nu Hai, Van Meensel and Speelman, 2020), and trade-offs between these factors (Ton Nu Hai and Speelman, 2020a) in Vietnam’s cage lobster farming sector. These studies highlight that two primary lobster species are farmed in Vietnam: the scalloped lobster (*Panulirus homarus*) and the ornate lobster (*Panulirus ornatus*). The ornate lobster is more economically valuable and preferred by consumers due to its bright coloration, larger size, and superior quality. In contrast, the scalloped lobster is characterized by its shorter farming cycle, faster growth rate, and quicker attainment of market size. With a relatively smaller size and lower economic value, scalloped lobsters are accessible to a wider range of market segments. Moreover, the cost of scalloped lobster juveniles is significantly lower than that of ornate lobster juveniles.

Furthermore, the majority of studies conclude that scalloped lobsters are more cost-effective and “greener” than ornate lobsters (Ton Nu Hai, Bui Dung and Speelman, 2018; Ton Nu Hai and Speelman, 2020a; Ton Nu Hai, Van Meensel and Speelman, 2020). Notably, scalloped lobsters are less susceptible to diseases compared to ornate lobsters (Ton Nu Hai, Bui Dung and Speelman, 2018; Ton Nu Hai, Van Meensel and Speelman, 2020; Ngọc Thúy, 2024). Recently, the number of households transitioning to monoculture of scalloped lobsters or adopting mixed farming models that prioritize scalloped lobsters has grown significantly, accounting for approximately 70% of farmers. However, no studies have yet examined the factors driving this transition. What influences farmers’ decisions regarding farming models in Vietnam’s cage lobster farming industry? Addressing this question is crucial to provide a scientific basis for developing policy recommendations that promote the sustainable growth of this sector. Therefore, besides providing a whole picture of lobster farming in Vietnam, this study aims to identify the factors influencing farmers’ choices of farming models in this area.

Research methodology

1. Multinomial logistic regression

To identify the factors influencing the choice of marine cage lobster farming models in Vietnam, this study employs a multinomial regression method with the following model:

$$\ln \left(\frac{p_i}{p_j} \right) = \alpha_{ij} + \beta_{ij}X_1 + \beta_{ij}X_2 + \cdots + \beta_{ij}X_k + \varepsilon_{ij}$$

where, p_i is lobster culture models which are commonly applied in the study area including p_0 represents the probability of farms practicing ornate lobster monoculture, p_1 represents the probability of farms cultivating scalloped lobsters mono-culture, and p_2 represents farms practicing mixed cultivation model. X_1, \dots, X_k are independent variables reflecting the characteristics of farmers, production features, and market attributes of marine cage lobster farming activities in Vietnam. β is a vector of coefficients on each of the independent variables X .

A positive/negative sign of the coefficient (β) in the multinomial logistic regression indicates that a farm was more/less likely to apply a certain lobster farming model. Because the relationship between the dependent variable and predictors is of logistic nature, the size of an effect cannot be directly interpreted from the regression coefficient. The odds ratio (OR) was therefore added in this study for interpretation, showing the change in the odds of an event resulting from a unit change of the predictors. Put differently, in our multinomial logistic

regressions an odds ratio (OR) larger/smaller than 1 shows how much more/less a farm was likely to apply a certain lobster farming model.

Multinomial logistic regression was used in this study because this is one of the common approaches in analyzing adaptation choice research (Hassan and Nhemachena, 2008; Linh and Bleys, 2024) which is well fit to the case of lobster farming with three common models. This approach has also been widely and successfully used in many previous scholars (Hassan and Nhemachena, 2008; Bryan *et al.*, 2009; Linh and Bleys, 2024). Moreover, multinomial logistic regression provides more precise results and easier computation (Cheng and Long, 2007; Kropko, 2008).

2. Data and variables

Marine cage lobster farming has been developed in Vietnam from Quang Binh to Binh Thuan provinces. Khanh Hoa and Phu Yen are the two top provinces with more than 94% of all lobster cages nationwide (Petersen and Phuong, 2010; Minh *et al.*, 2016). Hence, these two provinces were selected as the study areas. Initially, an in-depth expert interview was conducted in July 2016 to gather fundamental information about this activity. Based on this information, the research team developed a questionnaire and conducted a survey of 361 cage lobster farming households (approximately 4% of the estimated total households at the time of the study) from August to November 2016. During data processing, the study identified eight samples with notable discrepancies from the population and decided to exclude them from the dataset. Ultimately, the study processed and analyzed data from 353 households, consisting of 150 households farming ornate lobsters, 166 households farming green lobsters, and 37 households practicing mixed farming of both species.

In the study by Au Ton Nu Hai *et al.* (2018), age of farmer was found to have positive relationship with cost efficiencies for scalloped lobster and mixed cultivation models. Therefore, this study also expects to find out a significant relationship between this variable and probability to apply these two lobster culture models.

The cage size is associated with the volume of cultivation area. Larger volumes imply more space for the lobsters, greater capacity for dispersal of discharge, better flow rate inside the cages, less disease and thereby result in higher production. In contrast, the cultivation period at the current location might be related to water quality and disease resistance. Similarly, distance to the nearest farms might imply the probability of being impacted by water quality if the lobster of neighbor farms got disease. Moreover, these factors were found to have significant impacts on cost efficiency of lobster farms in Vietnam (Ton Nu Hai, Bui Dung and Speelman, 2018). Therefore, the total cage volume, the cultivation period at the same location, and distance from the nearest farms were expected to be correlated with model application of lobster farms in this study.

Moreover, this study also examines the impacts of some market characteristics such as feed and fingerling prices on the probability of applying lobster culture models in Vietnam. The description of these variables are shown in Table 1.

Table 1. Description of dependent and independent variables in the multinomial logistic regression

	Description	Mean	Min	Max
Dependent variables				
Lobster culture models				
-Ornate lobster mono-culture	Ornate lobster is the mere aquatic animal in this model	150	-	-
-Scalloped lobster mono-culture	Scalloped lobster is the mere aquatic animal in this model	166	-	-
-Mixed cultivation	Both ornate and scalloped lobster are cultivated in this model	37	-	-
Independent variables				
<i>Farmers' characteristics</i>				
Age	Age of household head in lobster farming	42.8	24	68
<i>Farm's characteristics</i>				
Volume	Total volume of farming cages	844.5	2.3	8,000.0
Nearest farm	Distance from the nearest farms	26.7	0.5	500.0
Years in location	Cultivation period at the current location	10.4	1.0	27.0
<i>Market characteristics</i>				
Fingerling price	Price of fingerling	196.1	34.0	600.0
Feed price	Price of feed	20.6	5.5	60.2

Results and discussion

1. Overview of lobster culture models in the study areas

In Vietnam, lobster fingerlings are either captured by fishers or imported from other countries. They are then sold to middlemen or dealers before being distributed to farmers. These fingerlings are typically nursed in submerged cages with small mesh sizes for 3 to 4 months before being transferred to grow-out farms. Lobster stocking densities are adjusted 3-5 times throughout the production process, depending on the species and size of the lobster. For ornate lobster monoculture, the stocking density ranges from 3-7 units per square meter. In contrast, scalloped lobsters are stocked at 30-50 units per square meter for the 50-100 gram size and 20-30 units per square meter at larger sizes. These densities vary not only by farming model but also among individual farms. Mixed cultivation farms stock the highest number of fingerlings, averaging 4,044 units per farm, while ornate lobster monoculture farms stock the least, averaging 1,028 units (Table 2). The cost of fingerlings accounts for 42-51% of total production costs, with mixed cultivation farms incurring the highest costs and ornate lobster monoculture farms the lowest (Table 3).

Currently, lobster farming in Vietnam relies heavily on trash fish as feed. The quantity, size, and composition of feed vary throughout the production cycle. Small lobsters are fed 2-3 times daily with shrimp, crab, or high-quality fish, while larger lobsters (over 200 grams) are fed 1-2 times daily with fish and mollusks. Feed quantities increase before molting, and lobsters are provided more mollusks during the final months before harvest. Ornate lobsters, due to their selective feeding behavior and higher production costs, are typically given higher-quality feed compared to scalloped lobsters. On average, farms practicing ornate and scalloped lobster monoculture use 13.6 tons and 12.4 tons of feed per cycle, respectively, while mixed cultivation farms use 22.6 tons (Table 2). Feed costs range from 36% to 48% of total production costs, with ornate lobster monoculture farms spending the most (48%) and mixed cultivation farms the least (36%) (Table 3).

Most lobster farms in Vietnam are family-operated, employing an average of 1 to 2 labor units per farm. These workers are responsible for preparing and distributing feed, diving to inspect lobster health, cleaning cages, and making necessary adjustments to farming practices. They also collect uneaten feed, mollusk shells, and lobster shells. Larger farms often hire additional labor for these tasks and may employ night guards to prevent theft. On average, ornate lobster monoculture and mixed cultivation farms require nearly 3,400 labor hours per cycle, while scalloped lobster monoculture farms require only 2,000 hours (Table 2).

A scalloped lobster monoculture farm typically harvests over 780 kilograms of output from 15 cages, earning approximately 250 million VND in profit, which accounts for more than 37% of its revenue (Table 3). However, this farming model releases around 138 kilograms of nitrogen emissions into the marine environment per cycle (Table 4).

Mixed cultivation farms generate the highest revenue (1,485 million VND) and profit (731 million VND) among all models due to their higher production output, averaging more than 1.5 tons and 20 cages per farm (Table 2). The profit from mixed cultivation accounts for nearly 50% of total revenue, but these farms also release the highest nitrogen emissions, averaging 248 kilograms per cycle (Table 4).

Ornate lobster monoculture farms generate the lowest profit, averaging only 240 million VND or 23% of total revenue (Table 3). These farms produce approximately 737 kilograms of output from 16 cages (Table 2) and emit an average of 155 kilograms of nitrogen into the marine environment per cycle (Table 4).

These above information seem to be in line with other previous studies on the differences among lobster culture models such as studies by Ton Nu Hai, Bui Dung, Speelman (2018), Ton Nu Hai, Van Meensel and Speelman (2020), and Ton Nu Hai and Speelman (2020a).

Table 2. Inputs and output information of lobster culture models (per farm per cultivation cycle)

	Unit	Ornate lobster mono-culture	Scalloped lobster mono-culture	Mixed cultivation
Production	Kg	736.7	783.9	1,532.0
Inputs				
Feed	Ton	13.6	12.4	22.6
Fingerling	Unit	1,028	2,793	4,044.0
Labor	Working hours	3,355	2,009	3,466
Number of cages	Cage	16.5	15.0	20.2
Equipment	Million VND	69.8	16.1	32.9

Table 3. The cost and benefit of lobster culture models (per farm per cultivation cycle)

	Ornate lobster mono-culture		Scalloped lobster mono-culture		Mixed cultivation	
	Million VND	%	Million VND	%	Million VND	%
Revenue	1,051.3	100.0	662.8	100.0	1,485.3	100.0
Production costs	810.3	77.0	414.5	62.5	745.0	50.2
Feed	388.5	47.9	155.2	37.4	265.9	35.7
Fingerling	341.5	42.1	193.0	46.6	378.4	50.8
Labor	55.0	6.8	57.0	13.8	97.6	13.1
Depreciation	25.2	3.1	9.3	2.2	12.0	1.6
Profit	241.1	23.0	248.3	37.5	731.2	49.8

Table 4. Nitrogen emission of lobster culture models (per farm per cultivation cycle)

	Ornate lobster mono-culture		Scalloped lobster mono-culture		Mixed cultivation	
					Unit: kilogram	
<i>Mean</i>		155.5		138.2		247.9
<i>Min</i>		15.9		5.9		46.3
<i>Max</i>		599.9		689.7		745.6

2. Driving factors of applying lobster culture models

The driving factors of applying lobster aquaculture models and their estimated coefficients of the multinomial logistic model, along with their levels of significance, are presented in Table 2. The Chi-square statistic and Pseudo R² values indicate that the model possesses strong explanatory power. As noted earlier, the estimated coefficients of the multinomial logistic model do not provide information about the actual magnitude of changes or probabilities, they only reveal the direction of the impact of explanatory variables on the dependent variables.

The results in Table 2 show that the variable of cultivation period at the current location has positive relationship with probability of applying scalloped lobster mono-culture and mixed cultivation while feed price have negative relationship. The distance from the nearest farm impacted on both lobster culture model but in different side. It has positive relationship with scalloped lobster mono-culture but negative relationship with mixed cultivation model.

Besides these three above variables, probability of applying scalloped lobster mono-culture was also negative impacted by the age of famers and fingerling price. Meanwhile probability of applying mixed cultivation was negative impacted by the total cage volume.

In details, the coefficient linked to age for the scalloped lobster mono-culture (-0,126) shows that the older the farmers are, the more likely to apply ornate than scalloped lobster mono-culture. Its odd ratio of (- 0.881) implies that a years-old decrease in age of farmer would yield 11,9% increase in the probability of applying scalloped lobster mono-culture. This can be explained by the good experience of old farmers in the past decades when the farming environment and condition were very well, and the occurrence of lobster disease was less (Minh *et al.*, 2016). Moreover, the ornate lobster is preferred by consumers and more economically valuable and thereby earn high return.

The coefficients of cultivation period at the current location (0,434 for scalloped lobster mono-culture and 0,204 for mixed cultivation model) show that if lobster farmers have cultivated at the same location for a long time, they tend to apply scalloped lobster mono-culture or mixed cultivation model rather than ornate mono-culture. One-year increase in

cultivation period at the current location (OR=1.544 for scalloped lobster mono-culture and OR=1.226 for mixed cultivation model) would yield 55.4% and 22.6% increase in probability of applying scalloped lobster mono-culture and mixed cultivation model respectively. An explanation for these relationships may be due to differences in susceptibility to disease between these two type of lobster (Ton Nu Hai, Van Meensel and Speelman, 2020) and the link between risks of spreading diseases and cultivating at the same location for a long time. With lower susceptibility to disease, scalloped lobster mono-culture or mixed cultivation model seem to be good choices for lobster farmers to switch to when they have cultivated ornate lobster mono-culture for a long period at the same location.

On the contrary, feed price has negative impacts on probability of applying both scalloped lobster mono-culture (-0.283) and mixed cultivation model (-0.344). They imply that the higher the feed price is, the more likely to apply ornate mono-culture instead. The odd ratios of 0.754 for scalloped lobster mono-culture and 0.670 for mixed cultivation show that a one thousand increase in the feed price would result in 24.6% and 33.0% decrease in probability of applying those two models respectively. This is maybe because of the high market value of ornate lobster. Moreover, this type of lobster was known as grumpy aquatic animal. Its appetite fluctuates significantly (Ton Nu Hai, Bui Dung and Speelman, 2018). Therefore, farmers cultivating ornate lobster mono-culture seem to feed them high quality and more “delicious” trash fish, which is associated with high price.

Besides that, probability of applying scalloped lobster mono-culture was negative impacted by fingerling price (-0.223). This shows that scalloped lobster mono-culture is often associated with lower price of fingerling. Its odd ratio of 0.800 indicates that a one thousand increase in fingerling price would yield 20% increase in applying ornate lobster mono-culture.

The coefficient of total cage volume of (-0.003) shows that farms with larger cage volume tends to cultivate ornate lobster mono-culture. A one cubic meter decrease in total cage volume would result in 0.3% increase in the probability of applying mixed cultivation model (OR=0.997). It is understandable because cage volume is often associated with the living space for aquatic animal. Larger volume implies more space for moving, discharging, and less able to get disease, especially in the marine environment. Meanwhile ornate lobster is known as grumpier than scalloped lobster.

Table 5. Driving factors of applying lobster culture models

	Scalloped lobster mono-culture		Mixed cultivation	
	B	Exp(B)	B	Exp(B)
Intercept	27.105***		6.2***	
<i>Farmers' characteristics</i>				
Age	-0.126**	0.881***	-0.022	0.979
<i>Farm's characteristics</i>				
Total cage volume	-0.002	0.998	-0.003***	0.997***
Distance from the nearest farm	0.094***	1.099	-0.062**	0.940
Cultivation period at the current location	0.434***	1.544**	0.204*	1.226*
<i>Market characteristics</i>				
Fingerling price	-0.223***	0.800***	0.001	1.001
Feed price	-0.283***	0.754	-0.344***	0.6709***
Base Category	Ornate lobster mono-culture			
Number of Observation	353			
Chi-square	571***			

	Scalloped lobster mono-culture		Mixed cultivation	
	B	Exp(B)	B	Exp(B)
Pseudo R ²	0.802			

- *, **, *** indicate significance at 10, 5 and 1 %

Conclusion

Ornate lobster monoculture, scalloped lobster monoculture, and mixed cultivation are typical models in Vietnam. Scalloped lobster monoculture and mixed cultivation models demonstrated higher profitability and environmental efficiency compared to ornate lobster monoculture, making them attractive options for sustainable aquaculture. However, ornate lobster remains a preferred choice for many farmers due to its higher market value and consumer preference.

The results of this study underscore the complexity and diversity of marine cage lobster farming in Vietnam. The findings highlight the critical factors influencing the adoption of various farming models, including farmer characteristics, farm-specific features, and market dynamics. Notably, the cultivation period at the same location, distance to neighboring farms, feed price, and fingerling price were key determinants in the choice between ornate lobster monoculture, scalloped lobster monoculture, and mixed cultivation models. This study also confirms the importance of balancing economic returns with environmental impacts, as nitrogen emissions varied significantly across farming models.

This paper is a solid contribution to the field of sustainable aquaculture and offers valuable insights into Vietnam's lobster farming industry. Due to the “economic-green” nature of scalloped lobster monoculture and mixed cultivation, policymakers should promote these models by addressing cost constraints, particularly for feed and fingerlings. Subsidies or financial incentives for affordable, high-quality feed and fingerling supplies could encourage adoption. Moreover, given the positive correlation between cultivation period and model adoption, investments in disease prevention and monitoring systems, especially in long-term farming areas, are critical. Training programs on biosecurity measures and early disease detection would benefit farmers. Enhancing cage designs and encouraging farmers to adopt larger cage volumes could improve production efficiency and reduce environmental stress. Because younger farmers are more likely to adopt scalloped lobster monoculture, policies should focus on knowledge-sharing, technology transfer, and financial incentives for young farmers could foster a generational shift toward sustainable practices.

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Poster Presentation

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Improving the binding affinity of cross-reactive dengue antibody using computational methods

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Abstract

Dengue virus (DENV) remains a significant global health concern, with no approved vaccine or broadly effective therapeutic options available. The cross-reactive 1B3B9 antibody, which targets the envelope (E) proteins of DENV, has demonstrated strong neutralizing activity against all four DENV serotypes. However, its binding affinity varies across serotypes, potentially reducing overall neutralization efficacy and increasing the risk of antibody-dependent enhancement (ADE) in serotypes with weaker binding. This study aims to improve the binding affinity of 1B3B9 against all four DENV serotypes. The MutaBind2 tool was used to screen antibody candidates for improved binding affinity, followed by characterization of the final candidates using the HADDOCK molecular docking tool, which confirmed enhanced binding affinity and cross-reactivity. Interestingly, binding affinity analysis revealed that the D3M22 mutant antibody increased the affinities of 1B3B9 toward the E dimer proteins of DENV-1, DENV-3, and DENV-4, while slightly decreasing the affinity for DENV-2. However, the overall binding affinity remained well-balanced, potentially addressing the challenge of ADE in dengue. Further characterization showed that the amino acid substitutions R31S, R273N, and T274M in D3M22 improved affinities by introducing hydrogen bonding, hydrophobic interactions, and shape complementarity. These substitutions also reduced the distances between D3M22 and the E dimer proteins of all four DENV serotypes compared to the template antibody. Notably, the same antibody mutant sites interacted with different residues across the various serotypes. In summary, computational methods were employed to enhance the binding affinity of an antibody against all four DENV serotypes, showcasing their potential to achieve cross-reactivity while mitigating ADE. These methods provide an efficient and cost-effective approach to improving antibodies, advancing the broader goal of developing next-generation therapeutics.

Keywords: Dengue, Antibody improvement, Computational methods, Molecular docking

Introduction

Dengue virus (DENV) is the most rapidly spreading mosquito-borne disease, posing a significant public health threat, particularly in tropical and subtropical regions such as Southeast Asia and Thailand. Existing in four distinct serotypes (DENV-1, DENV-2, DENV-3, and DENV-4), DENV can cause a wide range of diseases, including dengue fever, dengue hemorrhagic fever, and dengue shock syndrome. A major challenge in developing dengue vaccines and therapeutic agents is antibody-dependent enhancement (ADE), a phenomenon where antibodies generated against one serotype facilitate the entry of a different serotype into

host cells, potentially leading to more severe disease upon subsequent infection. Currently, no specific drug has been approved for the treatment of dengue virus infections. Therefore, designing therapeutic antibodies capable of effectively neutralizing all four serotypes without inducing ADE is crucial (Harapan et al., 2020).

Traditional antibody development methods, including *in vitro* and *in vivo* assays, identify desirable biophysical properties but are often limited in accuracy and efficiency. Their development remains time-consuming and heavily reliant on empirical methods (Kuroda et al., 2012). In contrast, computational approaches provide faster and more precise, using sequence- and structure-based algorithms to detect problematic regions that may impact antibody properties (Sormanni et al., 2017). Studies have demonstrated that even minimal amino acid substitutions within the complementarity-determining regions (CDRs) can significantly enhance antibody properties, such as binding affinity and physicochemical stability. For instance, Rathore et al. (2019) reported that targeted mutations in CDRs improved antibody-antigen interactions, offering a rational strategy to guide experimental optimization. These findings highlight the critical role of precise CDR modifications in the developing more effective antibodies.

In previous work, we presented a machine learning (ML)-based framework for rapid identification of human neutralizing antibodies (HuNAbs) against DENV. This approach combined sequence-based ML models and molecular dynamics (MD) simulations, identifying candidates such as 1B3B9_V21, a mutated derivative of the 1B3B9 antibody at CDR-H3. However, mutating only the CDR-H3 region limited the enhancement of binding (Natsrita et al., 2024). To address this limitation, we have designed a new computational method that enables mutations across various CDRs to further improve antibody affinity.

This study aims to improve the binding affinity of antibody candidates against all four DENV serotypes. Specific objectives include: (i) constructing antibody model and analyzing antibody-antigen interactions, (ii) identifying interfacial residues and designing mutations, (iii) screening high-affinity antibody candidates, (iv) characterizing selected candidates, and (v) identifying key residues influencing affinity. The 1B3B9 antibody sequence was used to construct a structural model using SWISS-MODEL. Then, HADDOCK molecular docking tool was used to assess interactions with the DENV antigen, and the MutaBind2 tool was employed to screen CDR mutations aimed at improving binding affinity. The resulting improved candidates were further analyzed using HADDOCK to identify those with the highest affinities. This computational approach accelerates the development of therapeutic antibodies, offering a cost-effective solution for combatting DENV and other viral infections.

1. Research Objectives

- 1.1 To construct the antibody model and analyze antibody-antigen interactions
- 1.2 To identify the interfacial residues and design mutations
- 1.3 To screen for improved affinity antibody candidates
- 1.4 To characterize the screened antibody candidates
- 1.5 To identify key amino acid residues influencing binding affinities

2. Review of Related Literatures

Setthapramote et al. (2012) generated the human monoclonal antibody (1B3B9), which targets the first domain II of the E protein and exhibits strong neutralizing activity against all four DENV serotypes. However, at sub-neutralizing concentrations, 1B3B9 demonstrated ADE activity *in vitro*, limiting its potential as a therapeutic candidate.

Rathore et al. (2019) developed a single-chain variable fragment (scFv) antibody targeting the E protein of DENV. Using computational methods, they identified two conserved

regions to guide the construction of an scFv mutant library for improved binding efficiency. By mutating the CDRs and evaluating binding through simulations, the study demonstrated the effectiveness of computational methods in accelerating antibody development. Homology modeling, molecular docking, and MD simulations were utilized, demonstrating their potential to advance therapeutic strategies against the dengue virus.

Natsrita et al., (2024) introduced a novel framework that combines ML with MD simulations to predict potent and stabilized cross-neutralizing antibody candidates. Their approach focused exclusively on the CDR-H3 region, a key determinant of antigen recognition. The study utilized ML for high-throughput mutation generation, while MD simulations evaluated binding affinity and stability, confirming that computational methods can effectively identify promising antibody candidates with enhanced properties.

Collectively, several studies have advanced the development of antibodies against DENV through innovative computational approaches. Mutating various CDRs has emerged as a key strategy for improving antibody efficacy. By integrating techniques such as molecular docking, researchers can efficiently design and optimize antibodies. Molecular docking, in particular, proves to be a simple yet effective tool for fine-tuning antibody-antigen interactions, offering a promising avenue for overcoming existing challenges and generating novel therapeutic strategies.

Research Methodology

1. Antibody modeling and binding interaction analysis

To construct the 1B3B9 antibody structure and analyze the interaction of 1B3B9 antibody on the E dimer proteins of DENV-1 to DENV 4. Firstly, the SWISS-MODEL web server was used to construct the 3D structure of antibody. Then, the antibody structure was assessed for the structure quality using SWISS-ExpASY web server. After that, the 1B3B9 antibody was docked to the E dimer proteins of DENV-1 to DENV 4 (PDB ID: 4CCT, 5A1Z, 3J6T, and 4CBF) through HADDOCK molecular docking tool and further examining the binding affinity (ΔG) using PRODIGY web server.

2. Identification of interfacial residues and generation of antibody mutants

To identify the interfacial residues of the 1B3B9 antibody and generate mutations, residues within 5 Å of the interface of the interaction with the E dimer proteins of DENV-1 to DENV-4 were selected. The interaction analysis was performed using the ChimeraX tool. The antibody mutant library was then constructed for further affinity enhancement prediction. Single, double, and triple amino acid mutations were introduced in the CDR regions using Python 3.9. Each interfacial residue was mutated to 19 different natural amino acids to create single mutations, which were then combined to form double mutations. Finally, all double mutations were combined to generate the triple mutations.

3. Screening of improved antibodies using MutaBind2

The MutaBind2 web server was used to screen affinity improvement, with results indicating changes in binding free energy ($\Delta\Delta G$; kcal/mol). MutaBind2 calculates $\Delta\Delta G$ as the difference between the wild type and mutant free energy ($\Delta\Delta G_{\text{MutaBind2}} = \Delta G_{\text{wt}} - \Delta G_{\text{mut}}$), where a reduced free energy indicates a more stable complex structure and increased affinity. Triple mutations with $\Delta\Delta G < -3$ were then selected to ensure the enhancement of binding affinity for the antibody candidates.

4. Construction of mutant antibody structures

The screened antibody candidates were constructed using SWISS-MODEL web server, with the 1B3B9 wildtype as a template. The structural quality of the antibodies was assessed using the SWISS-ExPASy web server, where the structures were compared to the template using the local distance difference test (IDDT score), template modeling (TM)-score, and root mean square deviation (RMSD). These scores were used to measure structural similarity, overall alignment, and average deviation between the predicted and template structures.

5. Identification of binding affinity and key amino acid residues

To characterize the binding affinity of the mutant antibodies, the antibodies were docked with the E dimer proteins of DENV-1 to DENV-4 using the HADDOCK molecular docking tool. The binding affinity score (ΔG) was then assessed using the PRODIGY tool. Key amino acid residues influencing binding affinities were identified through structural analysis using the PyMOL tool.

Results

1. Structural modeling and molecular docking analysis of 1B3B9 antibody

To construct and assess the structure of 1B3B9 antibody, the amino acid sequences of 1B3B9 antibody were used to model the 3D structure via the SWISS-MODEL web server. The resulting structure was then docked with E dimer proteins of DENV-1 to DENV-4 (PDB ID: 4CCT, 5A1Z, 3J6T, 4CBF) using the HADDOCK molecular docking tool. As shown in Figure 1, the human monoclonal antibody HEPC46 (PDB ID: 6meg.1) was found to be suitable for making homology modeling of 1B3B9 with 76.58 % identity. The modeled structure of the 1B3B9 antibody was depicted in Figure 1A. Additionally, Figure 1B shows that 95.56% of the residues fall within the Ramachandran favored region (green), and 0.93% are classified as Ramachandran outliers (white).

From Table 1, the results of molecular docking analysis of 1B3B9 antibody with E dimer proteins of DENV-1 to DENV-4 revealed binding affinities (ΔG) of -13.1, -16.8, -11.0, and -12.0 kcal/mol, respectively. The 1B3B9 antibody with DENV-3 shown the largest gap in binding affinity improvement and may serve as a promising candidate for further antibody enhancement due to its weakest binding affinity ($\Delta G = -11.0$ kcal/mol) compared to other serotypes.

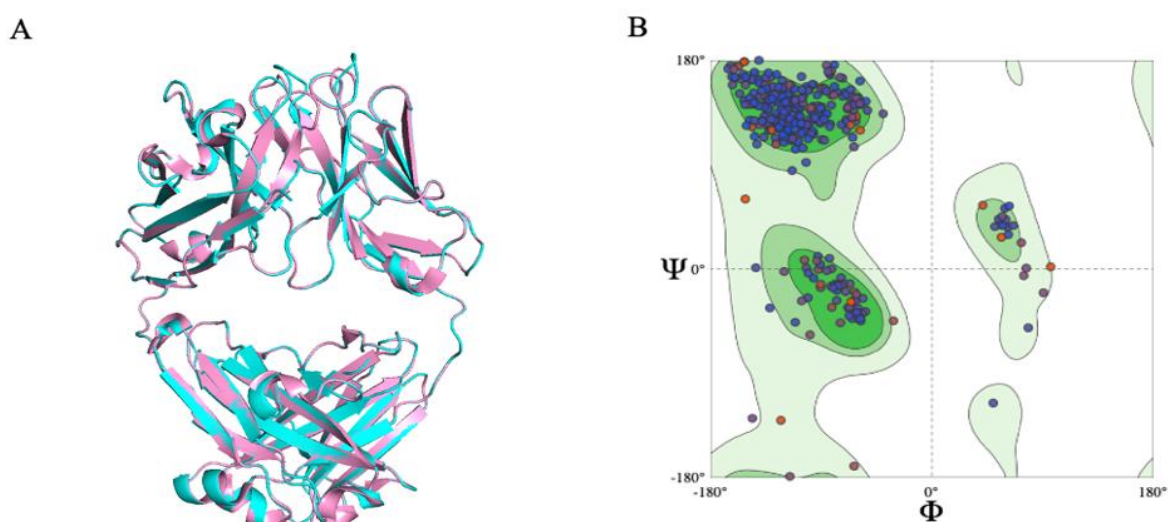


Figure 1. Modeling quality validation of the 1B3B9 antibody. (A) Superposition of the homology-modeled 1B3B9 antibody (Cyan) and HEPC46 antibody (PDB ID: 6meg.1) (Pink) (B) Ramachandran plot of 13BB9

Table 1. Molecular docking analysis of 1B3B9 antibody with E dimer proteins.

Parameter	1B3B9 Fab with E dimer DV1	1B3B9 Fab with E dimer DV2	1B3B9 Fab with E dimer DV3	1B3B9 Fab with E dimer DV4
HADDOCK score	-89.2 +/- 1.7	-107.8 ± 12.4	-91.4 +/- 3.3	-85.8 +/- 6.2
RMSD	16.9 +/- 0.2	0.8 ± 0.5	12.2 +/- 0.4	14.1 +/- 1.0
Van der Waals energy	-73.4 +/- 3.0	-92.9 ± 6.3	-55.5 +/- 7.2	-68.9 +/- 6.2
Electrostatic energy	-203.3 +/- 37.6	-262.2 ± 50.8	-347.9 +/- 22.8	-206.8 +/- 26.8
Desolvation energy	-14.7 +/- 0.9	-11.8 ± 4.2	-1.3 +/- 1.9	-2.5 +/- 1.3
Restraints violation	395.4 +/- 88.1	-441.2 ± 22.6	349.1 +/- 48.4	269.4 +/- 41.3
Buried surface area (Å ²)	2400.2 +/- 100.2	2991.2 ± 163.4	2275.2 +/- 64.2	2408.0 +/- 131.2
Z-score	-1.7	-1.4	-1.1	-1.2
Binding affinity (ΔG) (kcal/mol)	-13.1	-16.8	-11.0	-12.0
Dissociation constant (K _d) (M)	2.6e-10	4.5e-13	9.1e-09	1.6e-09

2. Identification of interfacial residues and triple mutation screening for affinity enhancement

Interfacial residues within 5.0 Å of the CDRs between the 1B3B9 antibody and the E dimer protein of DENV-3 were identified using ChimeraX tool, with the results summarized in Table 2. The analysis revealed 23 interfacial residues located in the CDRs of the 1B3B9 antibody, providing key insights into the molecular interactions and aiding the design of broadly neutralizing antibodies. Additionally, the results of triple mutation screening for 1B3B9 binding to the E dimer protein of DENV-3 are presented in Table 3. A total of 48 triple mutants were generated, all showing improved affinity for the DENV-3 E protein compared to the wildtype antibody. Nine of these mutants demonstrated significant affinity improvement ($\Delta\Delta G < -3$) and were selected for further evaluation as potential final antibody candidates.

Table 2. Interfacial residues of the 1B3B9 antibody with the E dimer protein of DENV-3.

Residue positions	Residue names	Residue positions	Residue names
28	PRO (P)	104	ALA (A)
29	PHE (F)	105	ASP (D)
30	THR (T)	106	TRP (W)
31	ARG (R)	247	THR (T)
32	TYR (Y)	248	GLY (G)
33	ILE (I)	249	ALA (A)
52	ASP (D)	251	THR (T)
53	THR (T)	252	SER (S)
54	LYS (K)	253	GLY (G)
55	THR (T)	254	HIS(H)
57	ASN (N)	255	TYR (Y)
58	PRO (P)	314	TYR (Y)
101	GLY (G)	315	ARG (R)
102	TYR (Y)	316	ASP (D)
103	SER (S)	317	GLY (G)

Table 3. Beneficial triple mutations for 1B3B9 binding to E dimer protein of DENV-3.

Mutation	Mutation Energy
R31S;S252G;R273N	-3.91
R31S;D105S;S252G	-3.41
R31S;S103F;S252G	-3.78
R31S;D105S;R273N	-3.62
R31S;H254Q;R273N	-3.13
R31S;S103F;R273N	-3.06
S252G;R273N;T274M	-3.28
R31S;T251M;R273N	-3.29
R31S;R273N;T274M	-3.29

3. Structural modeling and quality assessment of screened antibodies

To construct the mutant antibodies after screening with MutaBind2, the 3D structures of nine antibody candidates were modeled using the SWISS-MODEL web server, with the 1B3B9 wildtype as a template. These mutants combined mutations in the CDRs of both heavy chains (CDR-H1 or CDR-H3) and light chains (CDR-L1 or CDR-L2), except for D3M19, which included mutations only in CDR-L1 and CDR-L2. The structural quality of the antibody candidates was assessed, and the results are presented in Table 4. From Table 4, the evaluation using the SWISS-MODEL web server showed that over 95.00% of the residues were in the Ramachandran favored region. The QMEAN score was within 1 standard deviation of the mean (Z score 0-1), and further analysis of the IDDT score, (TM)-score, and RMSD values confirmed that all antibody candidates displayed reliable predictive models with a high degree of structural similarity to the template.

Table 4. Mutation sites and structural quality assessment of nine antibody candidates.

Antibody name	Mutation	Structure assessment				
		Ramachandran favoured	QMEAN score	IDDT	TM-score	RMSD
1B3B9	Template	95.56%	0.54	ND	ND	ND
D3M4	R31S;S252G;R273N (H1; L1; L2)	95.33%	0.43	0.99	1.00	0.03
D3M5	R31S;D105S;S252G (H1; H3; L1)	95.33%	0.30	1.00	1.00	0.03
D3M10	R31S;S103F;S252G (H1; H3; L1)	95.33%	0.46	1.00	1.00	0.03
D3M11	R31S;D105S;R273N (H1; H3; L2)	95.33%	0.26	0.99	1.00	0.03
D3M12	R31S;H254Q;R273N (H1; L1; L2)	95.33%	0.24	0.99	1.00	0.03
D3M13	R31S;S103F;R273N (H1; H3; L2)	95.33%	0.36	0.99	1.00	0.03
D3M19	S252G;R273N;T274M (L1; L2; L2)	95.33%	0.32	1.00	1.00	0.03
D3M21	R31S;T251M;R273N (H1; L2; L2)	95.33%	0.59	0.99	1.00	0.03
D3M22	R31S;R273N;T274M (H1; L2; L2)	95.33%	0.37	0.99	1.00	0.03

The parentheses indicate the CDRs region for mutational analysis.

4. Identification and evaluation of final antibody candidate

To identify the final antibody candidates with high binding affinity and key amino acid residues influencing binding, the selected antibodies were docked with E dimer proteins of DENV-1 to 4 using the HADDOCK molecular docking tool. Their binding affinities were evaluated using the PRODIGY tool, as shown in Figure 2. Key amino acid residues influencing binding affinities were identified using PyMOL, as illustrated in Figure 3. Figure 2 presents the binding affinity results of nine mutant antibodies from heat map analysis, highlighting D3M22 as a promising candidate. D3M22 demonstrated consistently strong binding affinity and stability across all four DENV serotypes, with ΔG values ranging from -13.1 to -14.1 kcal/mol, indicating high binding affinity. It exhibited excellent binding to DENV-1, with slightly weaker binding to DENV-2, DENV-3, and DENV-4, respectively, though still within acceptable limits for cross-reactivity. Compared to the wild-type antibody, it demonstrated improved binding to three serotypes while exhibiting slightly lower binding to DENV-2. These findings suggest that D3M22 enhances binding to three serotypes while maintaining a balanced interaction across all four DENV serotypes.

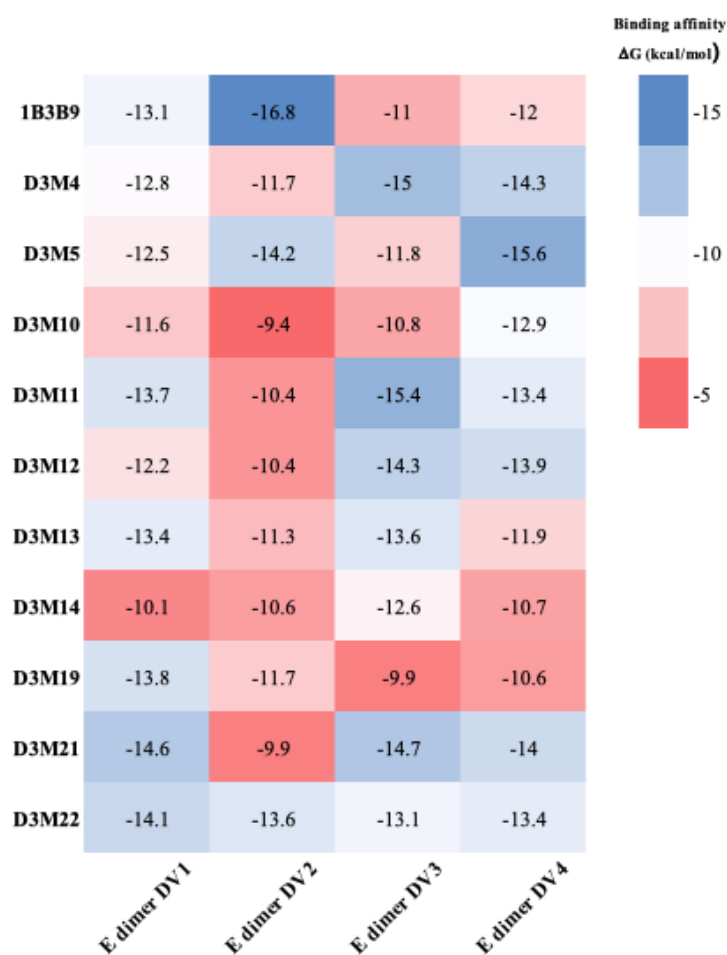


Figure 2. Comparative binding affinity analysis of nine antibody candidates and template against DENV-1 to DENV-4.

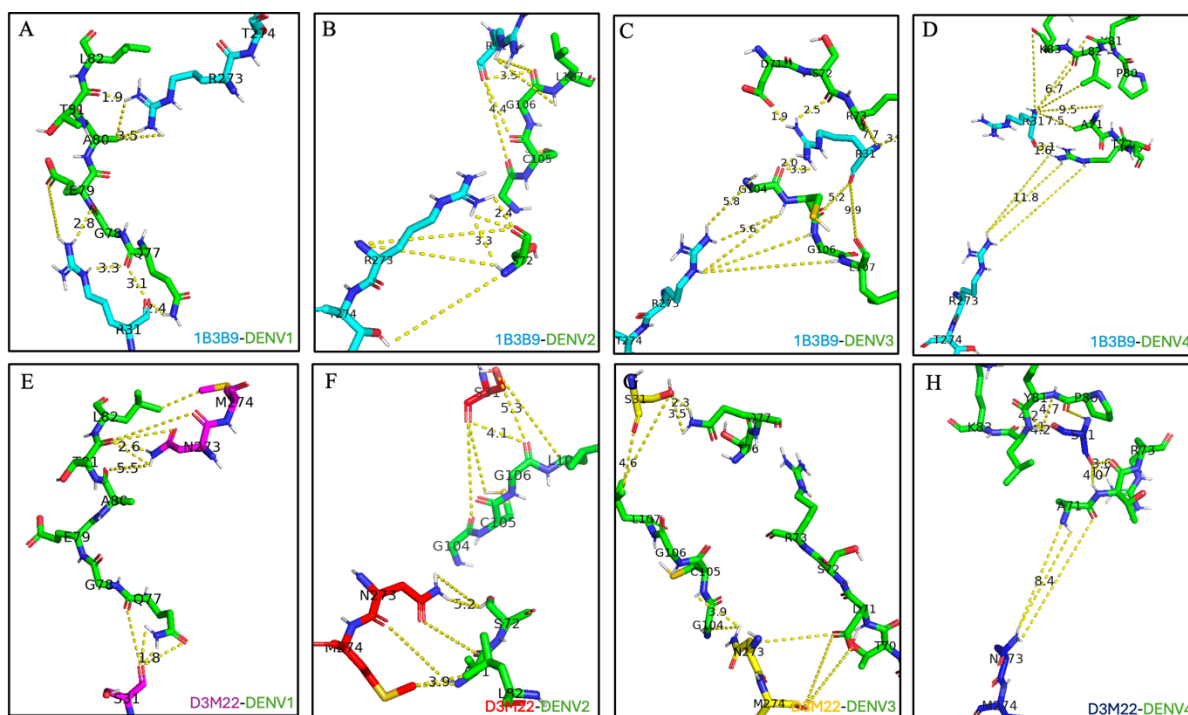


Figure 3. Comparative analysis of key binding residues in nine antibody candidates and template against DENV-1 to DENV-4.

Figure 3 illustrates the key amino acid residues that significantly influence binding affinities when comparing the wild type 1B3B9 antibody to its mutants. The R31S mutation replaces the positively charged arginine (R31) with the polar, uncharged amino acid serine (S31), which contains a hydroxyl (-OH) group. This structural change may enhance binding affinity by forming hydrogen bonds with amide groups, such as glutamine (Q77) in DENV-1, cysteine (C105) in DENV-2, glutamine (Q77) in DENV-3, and arginine (R73) in DENV-4. These interactions also reduced the distances between D3M22 and E dimer proteins of all four DENV serotypes compared to the template antibody, potentially improving binding efficiency. The R273N mutation replaces the positively charged arginine (R273) with the polar, uncharged amino acid serine (N273), which contains amide group. This structural change may enhance binding affinity by reducing steric hindrance and removing the positive charge, facilitating closer proximity and potential hydrogen bonding with nearby residues, such as threonine (T81) in DENV-1, serine (S72) in DENV-2, aspartic acid (D71) in DENV-3, and alanine (A71) in DENV-4. The T274M mutation, which replaces threonine (T274) with methionine (M274), introduces hydrophobic characteristics that promote van der Waals interactions with hydrophobic regions of the E dimer proteins, such as leucine (L82) in DENV-1, leucine (L82) in DENV -2, aspartic acid (D71) in DENV-3, and alanine (A71) in DENV-4. These changes enhance hydrophobic packing, bringing the interacting residues closer together and strengthening the binding affinity.

Discussion and conclusions

This study successfully demonstrates the effectiveness of computational methods in enhancing the binding affinity of the 1B3B9 antibody against all four DENV serotypes while preserving its cross-reactivity. By employing MutaBind2 tool for affinity screening and HADDOCK for molecular docking characterization, the D3M22 mutant emerged as a

promising candidate with improved and balanced binding affinities. The introduction of key amino acid substitutions (R31S, R273N, and T274M) led to enhanced interactions with DENV-1 to DENV-4 envelope proteins. Key amino acid substitutions (R31S, R273N, and T274M) facilitated enhanced interactions with DENV-1 to DENV-4 envelope proteins. These modifications promoted hydrogen bonding, hydrophobic interactions, and better shape complementarity at the DENV interface, leading to increased binding efficiency, consistent with previous studies (Wei et al., 2022). Furthermore, the study illustrated how these mutations interacted with different residues across serotypes, providing a mechanistic explanation for the observed improvements, in line with earlier research (Wong et al., 2018).

The computational methods employed, which rely on a single antibody template and allow for mutation of various CDRs, showed improved accuracy, particularly when using a complete envelope dimer for prediction, differing from previous studies (Natsrita et al., 2024; Rathore et al., 2019). Improving and balancing antibody binding affinities to reduce the risk of ADE is a major challenge in dengue therapy, and this method addresses it effectively.

Overall, the success of these computational strategies highlights their efficiency and cost-effectiveness in pre-screening candidates before experimental studies, making them valuable tools for future antibody optimization efforts. These findings contribute to the development of broadly neutralizing therapeutics for dengue and other viral infections.

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Identification of Banana Cultivars Using *rbcL* Gene as a DNA Barcode for Accurate Species Differentiation

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Abstract

Accurate identification of banana cultivars is essential for biodiversity conservation and agricultural production. Traditional methods based on morphological traits often fail due to environmental influences and phenotypic variability in bananas. To address this challenge, the ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (*rbcL*) gene has emerged as a promising molecular marker for plant species identification. However, its effectiveness for cultivar-level discrimination remains underexplored. This study aimed to evaluate the potential of the *rbcL* gene as a DNA barcode for identifying banana cultivars from Kalasin Province, Thailand. Twenty banana cultivars were analyzed through DNA extraction using a modified CTAB method, followed by PCR amplification and sequencing of the *rbcL* gene. Phylogenetic relationships were inferred using the unweighted pair group method with arithmetic mean (UPGMA), and reliability was assessed with bootstrap analysis. The *rbcL* gene sequences showed high conservation across cultivars, with sequence identity percentages ranging from 96.89% to 99.82% when aligned with GenBank sequences. However, inconsistencies in cultivar grouping were observed, particularly among closely related cultivars, underscoring the limitations of *rbcL* as a sole marker for phylogenetic analysis. The results indicate that while *rbcL* is useful for broad species identification, its limited resolution at the cultivar level suggests the need for a multi-locus approach. Combining *rbcL* with other markers, such as *matK* or nuclear markers like ITS, could improve the discriminatory power. Future research should focus on integrating these markers to enhance the accuracy of banana cultivar identification and explore more comprehensive phylogenetic frameworks.

Keywords: Banana cultivars, DNA barcoding, *rbcL* gene, Chloroplast DNA

Introduction

In the realm of biodiversity conservation, genetic resource management, and agricultural production, the accurate identification of plant species and cultivars is of paramount importance. Traditional methods relying on morphological characteristics often fall short due to environmental factors, developmental stages, and subjective interpretation. This challenge is particularly evident in the case of bananas (*Musa* spp.), where high phenotypic

plasticity, local naming conventions, and somaclonal variation complicate cultivar classification efforts (Čížková et al., 2015).

To address these challenges, researchers have turned to molecular tools, with DNA barcoding emerging as a promising approach. Among the various genetic markers used in DNA barcoding, the *rbcL* gene has gained prominence as one of the most widely utilized for plant species identification (Kress & Erickson, 2007; CBOL Plant Working Group, 2009; Hollingsworth, 2011). The ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (*rbcL*) gene, which encodes the large subunit of ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO), is located within the chloroplast genome. Its popularity in DNA barcoding studies stems from several advantageous characteristics. The gene is highly conserved across plant taxa, making it suitable for broad-scale species identification. Additionally, it can be easily amplified using universal primers, resulting in high amplification success rates and relatively simple analysis procedures (CBOL Plant Working Group, 2009; Hollingsworth, 2011).

Numerous studies have demonstrated the effectiveness of *rbcL* in distinguishing plant species across a wide range of taxa (CBOL Plant Working Group, 2009; Hollingsworth, 2011; Saarela et al., 2013). For instance, research on tropical trees showed that *rbcL* provided sufficient variation for species-level identification in over 90% of cases (Newmaster et al., 2008; Lahaye et al., 2008). Despite its advantages, the *rbcL* gene is not without limitations, particularly when it comes to differentiating between closely related species or cultivars within the same genus. This shortcoming is especially evident in the case of bananas, where cultivars often display minor genetic differences but considerable phenotypic variation (Christelová et al., 2011).

The highly conserved nature of the *rbcL* gene, while beneficial for broad species identification, poses challenges for intra-species discrimination. Several studies have highlighted inconsistencies in phylogenetic analyses based solely on *rbcL* sequences, especially when dealing with closely related cultivars (Kress & Erickson, 2007; Hollingsworth et al., 2011). The primary reason for this inconsistency lies in the nature of the *rbcL* gene itself. As a chloroplast gene, it is inherited maternally and represents only a small fraction of the plant's total genome. Consequently, it may not capture the full genomic complexity of the organism or provide enough genetic variation to resolve relationships between closely related cultivars. Moreover, maternal inheritance patterns can obscure phylogenetic signals in cases of hybridization or introgression, which are not uncommon in bananas (Christelová et al., 2011; Li et al., 2013).

1. Research Objectives

1.1 To assess the effectiveness of the *rbcL* gene as a DNA barcode for distinguishing banana cultivars.

1.2 To analyze 15 banana cultivars collected from Kalasin Province, Thailand, for species differentiation.

1.3 To explore the use of the *rbcL* gene in the context of genetic resource management and plant taxonomy.

2. Review of Related Literatures

To overcome the limitations of *rbcL* as a sole marker, researchers have explored alternative and complementary molecular markers. The maturase K (*matK*) gene, also located within the chloroplast genome, has been proposed as a complementary barcode to *rbcL* due to its higher rate of nucleotide substitution, offering better resolution at the species and subspecies

levels (Kress & Erickson, 2007; CBOL Plant Working Group, 2009; Hollingsworth et al., 2011). However, *matK*'s lower amplification success rates compared to *rbcL* make it less universally applicable across different plant taxa (CBOL Plant Working Group, 2009; Fazekas et al., 2009; Hollingsworth et al., 2011). A multi-locus approach, combining *rbcL* with *matK* or other nuclear markers such as the internal transcribed spacer (ITS) region, has been suggested as a way to improve the resolution of phylogenetic relationships in plants (Fazekas et al., 2009; Chen et al., 2010; Hollingsworth et al., 2011). In bananas, studies incorporating both chloroplast and nuclear markers have demonstrated improved cultivar resolution compared to using *rbcL* alone (Christelová et al., 2011; Li et al., 2013; Sardos et al., 2016). Furthermore, next-generation sequencing (NGS) techniques, such as genome skimming, provide an opportunity to capture more extensive genomic data, which can improve the resolution of cultivar-level identification (Dodsworth, 2015; Coissac et al., 2016).

Despite advancements in DNA barcoding and molecular phylogenetics, several research gaps remain. More studies are needed to evaluate the performance of *rbcL* in combination with other markers across a broader range of banana cultivars. Future research should focus on integrating multi-locus approaches and high-throughput sequencing technologies to improve the accuracy of cultivar identification. Additionally, while chloroplast markers like *rbcL* and *matK* have been extensively studied, the role of nuclear markers in complementing chloroplast data in bananas is still underexplored (Christelová et al., 2011; Sardos et al., 2016). There is also a need for more comprehensive studies that consider the genetic diversity of bananas across different geographical regions, which could provide insights into the evolutionary history and diversification of this important crop (Hippolyte et al., 2010; Perrier et al., 2019).

The *rbcL* gene remains a valuable tool in plant species identification, offering broad applicability and ease of use. However, its limitations in resolving relationships between closely related cultivars, particularly in complex taxa like bananas, highlight the need for more comprehensive approaches.

This study seeks to address the gap in existing research by assessing the effectiveness of the *rbcL* gene as a DNA barcode for differentiating banana cultivars. Specifically, the study focuses on 15 banana cultivars collected from Kalasin Province, Thailand. While the utility of the *rbcL* gene in broader plant identification has been established, its application for cultivar-level discrimination in bananas has not been extensively studied. By analyzing sequence variation and constructing phylogenetic relationships, this research explores the *rbcL* gene's potential for accurate banana cultivar identification. Furthermore, the study contributes to the ongoing discourse on molecular tools for plant taxonomy, suggesting that the *rbcL* gene could play a key role in cultivar identification and genetic resource management. Additionally, the limitations of using *rbcL* for evolutionary proximity studies are highlighted, reinforcing the need for more comprehensive barcoding strategies when dealing with closely related cultivars. Ultimately, this research offers a practical solution to the challenges of banana cultivar identification, presenting a more reliable, efficient, and cost-effective method that could significantly enhance molecular identification efforts.

Research Methodology

1. Plant Material

Twenty banana cultivars were collected from Kalasin Province, Thailand, and planted at Kalasin University to preserve germplasm. The common names and genome groups of the cultivars were classified following the taxonomy proposed by Silayoi (2015).

2. DNA Extraction

Young, fresh leaves from each cultivar were harvested in the field, sealed in plastic bags, and stored in iceboxes for transportation. DNA was extracted using a modified cetyltrimethylammonium bromide (CTAB) method (Chanaeng et al., 2017). A 300 mg sample of leaves was ground in liquid nitrogen and transferred into a sterile 1.5 mL reaction tube. This was followed by the addition of 1000 μ L of CTAB extraction buffer (20 g/L CTAB; 1.4 M NaCl; 0.1 M Tris-HCl; 20 mM Na₂EDTA) and 20 μ L of Proteinase K (20 mg/mL). The sample was vortexed and incubated at 65°C for 60 minutes. Subsequently, 20 μ L of RNase A (10 mg/mL) was added, and the sample was incubated at 37°C for 30 minutes. Debris was removed via centrifugation, and the supernatant was extracted twice with phenol–chloroform–isoamyl alcohol (25:24:1). DNA was precipitated with ice-cold isopropanol and centrifuged again. The supernatant was discarded, and the DNA pellet was washed twice with 70% ethanol, air-dried, and resuspended in 50 μ L of TE buffer (10 mM Tris-HCl; 1 mM EDTA, pH 8.0). DNA quality and concentration were evaluated using 0.8% agarose gel electrophoresis and spectrophotometric measurements at 260 and 280 nm.

3. Polymerase Chain Reaction (PCR) Amplification

Partial amplification of the *rbcl* gene was performed using PCR amplification on a Biometra T-GRADIENT thermocycler. Each 25 μ L PCR reaction contained 1X PCR buffer, 0.4 mM dNTP, 2.0 mM MgCl₂, 0.25 μ M of forward primer (5'-ATG TCA CCA CAA ACA GAG ACT AAA GC-3'), 0.25 μ M of reverse primer (5'-GTA AAA TCA AGT CCA CCR CG-3') (Costion et al., 2011), 0.5 units of Taq polymerase (Vivantis), and 20 ng of template DNA. The thermocycling conditions were as follows: initial denaturation at 94°C for 3 minutes, followed by 35 cycles of denaturation at 94°C for 30 seconds, annealing at 53°C for 30 seconds, and extension at 72°C for 50 seconds, with a final extension step at 72°C for 5 minutes. PCR products were visualized on a 1.5% agarose gel stained with ethidium bromide and were stored at -20°C for further analysis.

4. DNA Sequencing and Sequence Analysis

The PCR products were separated using 2% agarose gel electrophoresis in 1× TAE buffer and stained with ethidium bromide for 30 minutes. DNA fragments were purified using the PureLink Quick Gel Extraction Kit (Invitrogen) and sent for sequencing at Gibthai Co., Ltd. The *rbcl* gene sequences were aligned and compared with sequences in the GenBank database using the BLASTn tool to verify identity. The dendrogram was constructed using the unweighted pair group method with arithmetic means (UPGMA) in the MEGA11 software (Tamura et al., 2021). To ensure reliability, bootstrap analysis with 1000 replicates was performed to assess the robustness of the dendrogram. Additionally, sequence divergence was analyzed using the maximum likelihood method to further confirm the phylogenetic relationships among the cultivars.

Results and discussion

1. DNA Extraction

The DNA extraction from banana leaves using the modified CTAB method resulted in high-quality genomic DNA, as indicated by the presence of clear bands at the same position as the Lambda/HinDIII marker on a 0.8% agarose gel (data not shown). This demonstrates the efficacy of cetyltrimethylammonium bromide in eliminating proteins and polysaccharides, which often interfere with DNA isolation from plant tissues. The extracted DNA was suitable for PCR amplification of the *rbcl* gene.

2. The Nucleotide Sequences of the *rbcL* Gene

All cultivars successfully amplified using specific primers, producing clear bands of the expected size on a 1.5% agarose gel. The *rbcL* fragments varied between 567 and 633 base pairs across cultivars, with the average fragment size being 587.2 base pairs (Table 1). Due to the limitations of agarose gel electrophoresis, fragments with less than 20 base pair differences appeared indistinguishable, highlighting the need for more sensitive techniques such as polyacrylamide gel electrophoresis for finer resolution (Lee et al., 2012).

The nucleotide sequences of the *rbcL* gene for each cultivar (Figure 1) were obtained through three independent sequencing operations, resulting in consistent sequences across replicates. The sequence characteristics, including length variation, base composition, and GenBank accession numbers, are presented in Table 1. The average GC content of the *rbcL* gene was 44.03%, consistent with the characteristics of chloroplast genomes, which typically have lower GC content (Smith, 2009; Guisinger et al., 2010). The highest GC content was observed in the cultivar Kluai Krang (47.80%), while the lowest was found in Kluai Sao Kratueb Ho (40.35%). Regions with higher GC content are associated with greater gene density and compactness, as well as higher recombination rates (Glémin et al., 2014).

Table 1. Plant materials and their genome group used in this study together with the length, base composition and identical GenBank Accession number of the *rbcL* gene.

No.	Taxon	Genome group	Length (bp)	Base Content					Identical GenBank No.	% Identical	Acc. Length (bp)
				A	C	G	T	%GC			
1	Kluai Hak Muk Som	ABB	578	159	114	136	169	43.25	KJ506060.1	99.64%	604
2	Kluai Hin	ABB	580	158	114	135	173	42.93	NC_039815.1	99.64%	169458
3	Kluai Hom Karen	AAA	585	158	116	138	173	43.42	MT555128.1	98.92%	558
4	Kluai Hom Khieo	AAA	580	154	115	137	174	43.45	MT555128.1	99.82%	558
5	Kluai Khai Boran	AAB	583	159	115	134	175	42.71	MT555128.1	99.82%	558
6	Kluai Hom Thong Thai	AAA	567	156	115	129	167	47.8	XR_010508677.1	99.65%	1744
7	Kluai Khai Boran	AAB	583	159	115	134	175	47	NC_058956.1	99.30%	169808
8	Kluai Khai Pratabong	AAA	580	159	113	133	175	42.41	MT555128.1	99.46%	558
9	Kluai Krang	AAA	577	160	114	133	170	42.81	MT555125.1	99.82%	559
10	Kluai Leb Mu Nang	AA	587	160	118	134	175	42.93	MT555125.1	98.74%	559
11	Kluai Ma Hoi	AAA	577	155	113	135	174	42.98	NC_042874.1	99.82%	169989
12	Kluai Namwa Dam	ABB	579	157	115	134	173	43.01	JN114824.1	99.47%	614
13	Kluai Namwa Kom	ABB	577	155	115	136	171	43.5	KJ506057.1	99.82%	610
14	Kluai Nark Sai Nampung	AAA	580	160	116	134	170	47.59	XR_010508677.1	98.78%	1744
15	Kluai Ngachang	AAB	633	179	130	135	189	41.86	MN555794.1	97.99%	555
16	Kluai Phama Haek Khuk	ABB	578	158	114	136	170	47.06	NC_058956.1	99.12%	169808
17	Kluai Roipli	Unclear	584	162	114	135	173	47.26	NC_058956.1	99.12%	169808
18	Kluai Sao Kratueb Ho	AAB	627	184	135	118	190	40.35	NC_042874.1	98.18%	169989
19	Kluai Tani Dam	BB	582	159	120	130	173	42.96	KY442786.1	99.63%	565
20	Kluai Tip Khu	ABB	627	166	152	132	177	45.3	MK238285.1	96.89%	676
Average			587.2	160.85	118.65	133.4	174.3	44.03		99.18%	

The alignment of the *rbcl* gene sequences with the GenBank database using BLASTn revealed identity percentages ranging from 96.89% to 99.82%, demonstrating the high conservation of this gene across banana species. The highest sequence identity (99.82%) was observed in four cultivars corresponding to GenBank accession numbers MT555128.1, NC_042874.1, and KJ506057.1. This high degree of similarity confirms the conserved nature of the *rbcl* gene, which is consistent with previous studies highlighting its role as a reliable DNA barcode for plant species identification (Kress & Erickson, 2007; CBOL Plant Working Group, 2009).

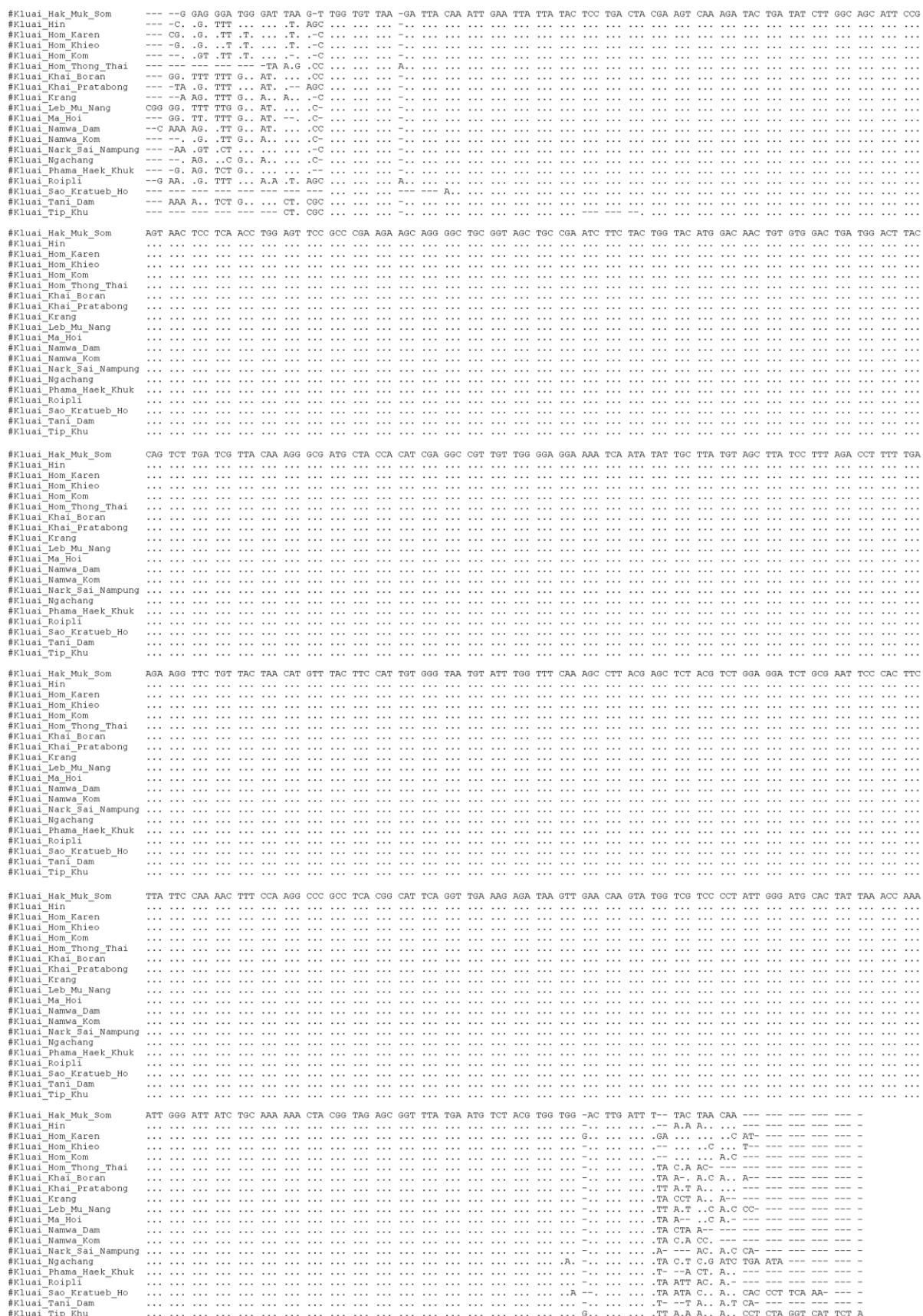


Figure 1. Sequence comparisons of *rbcL* gene from 20 banana cultivars. Dots (.) indicate the nucleotides and dashes (-) are introduced to the gap.

The identical sequences found between two cultivars (Kluai Ma Hoi and Kluai Sao Kratueb Ho) and the complete plastid genome NC_042874.1, which includes the entire *rbcL* gene, can be attributed to the fact that *rbcL* is a highly conserved region in plastid genomes across land plants. This result aligns with earlier research, which has demonstrated that plastid genes, especially *rbcL*, are evolutionarily conserved, making them effective markers for distinguishing between species but with limitations in resolving closely related cultivars (Hollingsworth et al., 2011; Li et al., 2011).

The average sequence identity of 99.18% with other *Musa* species further validates the accuracy of the sequencing and suggests that *rbcL* can be reliably used to identify banana cultivars. However, the high conservation of the *rbcL* gene across species also underscores its limitations in differentiating between closely related taxa or cultivars. Studies have suggested that, while *rbcL* is an effective barcode at the species level, its discriminatory power decreases when used to distinguish within-species variation, making it necessary to incorporate additional markers, such as *matK* or nuclear regions, to improve resolution (Fazekas et al., 2008; Saarela et al., 2013).

3. The UPGMA dendrogram

The phylogenetic analysis was performed using the unweighted pair group method with arithmetic mean (UPGMA) to construct a dendrogram, with evolutionary distances calculated using the p-distance method. Although the dendrogram successfully clustered the 20 banana cultivars (Figure 2), certain inconsistencies in grouping were observed, particularly among closely related cultivars. For instance, Kluai Ma Hoi (AAA genome), Kluai Khai Boran (AAB genome), and Kluai Leb Mu Nang (AA genome) were grouped together despite having differing genome types. These discrepancies suggest limitations in using *rbcL* as a sole marker for phylogenetic analysis in bananas. Such inconsistencies may be attributed to the maternal inheritance of chloroplast DNA, which does not account for hybridization or introgression events—both common in banana evolution (Christelová et al., 2017). As a result, the *rbcL* gene alone may not accurately represent evolutionary relationships, particularly at the cultivar level.

To enhance the discriminatory power for banana cultivar identification, combining *rbcL* with other molecular markers, such as *matK* or nuclear markers like the ITS region, is essential. The *matK* gene, located within the chloroplast genome, has a higher rate of nucleotide substitution compared to *rbcL*, making it a more variable marker that can resolve closely related taxa more effectively (Hollingsworth et al., 2011; CBOL Plant Working Group, 2009). The ITS region, located in the nuclear genome, complements chloroplast markers by providing information on biparental inheritance, which is especially useful in species with complex hybridization and introgression histories, such as bananas (Sass et al., 2007). Using a multi-locus approach can mitigate the limitations of *rbcL*, which, due to its high conservation, sometimes fails to distinguish between closely related cultivars (Li et al., 2013).

The need for additional markers is further emphasized by the observed inconsistencies in the phylogenetic grouping of closely related banana cultivars. In this study, bootstrap analysis with 1000 replicates was performed to assess the reliability of the inferred phylogenetic tree. While some branches were well-supported, others remained unresolved, indicating insufficient phylogenetic signal from the *rbcL* gene alone. Bootstrap analysis is a crucial method for testing the robustness of phylogenetic trees, providing confidence intervals for branching points; values above 70% generally indicate strong support (Felsenstein, 1985; Tamura et al., 2021). The unresolved branches in this analysis suggest that relying solely on *rbcL* may lead to incomplete or misleading phylogenetic relationships, particularly at the cultivar level.

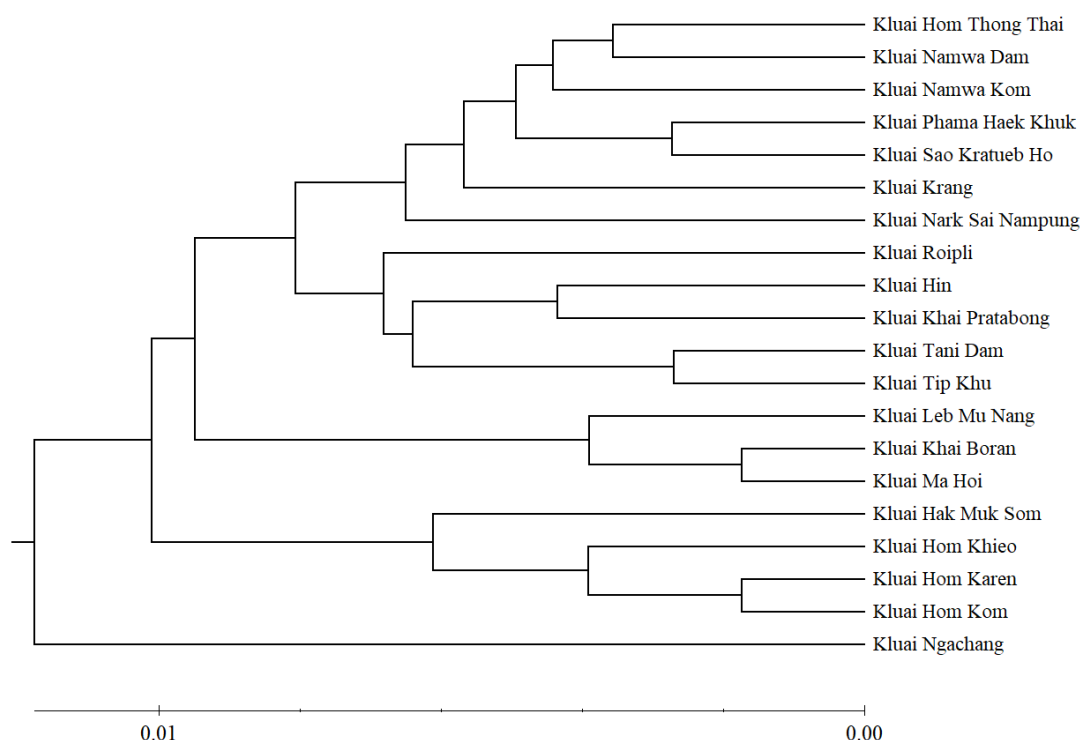


Figure 2. A dendrogram of the 20 banana cultivars constructed from sequence comparisons of the *rbcL* gene using the UPGMA method on MEGA11 software.

Studies on other plant species have demonstrated the efficacy of combining *rbcL* and *matK*, or *rbcL* and ITS, to improve resolution. For example, in angiosperms, the use of a dual-marker system with *rbcL* and *matK* has been shown to achieve high success rates in species-level identification (Chase et al., 2007). In *Musa* species, the addition of nuclear markers such as ITS has proven effective in resolving complex evolutionary histories and providing a clearer picture of genetic diversity (Li et al., 2013; Christelová et al., 2017). Thus, adopting a multi-locus strategy in future studies could significantly improve the resolution and reliability of phylogenetic analyses in banana cultivars.

Conclusion

The identification of banana cultivars is crucial for biodiversity conservation, agricultural production, and genetic resource management. Traditional morphological methods often fail to provide accurate classification due to environmental influences and the phenotypic plasticity of bananas. This research was undertaken to evaluate the effectiveness of the *rbcL* gene as a DNA barcode for identifying banana cultivars, addressing the limitations of morphological methods and contributing to the development of molecular tools for plant taxonomy.

In this study, 20 banana cultivars from Kalasin Province, Thailand, were analyzed using the *rbcL* gene. DNA extraction was performed using a modified CTAB method, and the *rbcL* gene was successfully amplified and sequenced for all cultivars. Phylogenetic analysis was conducted using the UPGMA method, and the reliability of the dendrogram was assessed through bootstrap analysis with 1000 replicates. Sequence alignment with the GenBank

database showed high identity percentages, ranging from 96.89% to 99.82%, confirming the conserved nature of the *rbcL* gene across banana species. However, despite the high conservation of the *rbcL* gene, certain inconsistencies in cultivar grouping were observed, particularly among closely related cultivars with different genome types.

The findings of this research indicate that while *rbcL* provides sufficient resolution for banana cultivar identification, it has limitations in resolving evolutionary proximity, especially among closely related cultivars. The maternal inheritance of chloroplast DNA and the highly conserved nature of the *rbcL* gene likely contribute to these inconsistencies. The results underscore the need for a multi-locus approach, combining *rbcL* with additional markers such as *matK* or nuclear markers like the internal transcribed spacer (ITS) region, to improve phylogenetic resolution and accuracy. The inclusion of bootstrap analysis confirmed that certain branches in the phylogenetic tree were well-supported, while others remained unresolved, further emphasizing the limitations of relying solely on *rbcL* for cultivar identification.

Future research should focus on incorporating additional molecular markers to complement *rbcL*, providing a more robust framework for banana cultivar identification and phylogenetic analysis. Additionally, studies using next-generation sequencing (NGS) techniques, such as genome skimming, could capture more extensive genomic data, offering improved resolution at the cultivar level. Expanding the geographical scope of the research to include more diverse banana populations may also provide insights into the evolutionary history and diversification of this important crop.

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