2nd - 3rd April 2026

Innovative & Appropriate Sustainable Development in the digital Era

Proceeding Book

The 3rd International Conference on ASEAN Sustainable Development

ICASD 2026

International College
Thaksin University

Co-Host

Faculty of Economics and Business Administration
Faculty of Multidisciplinary Science and Entrepreneurship
Faculty of Law
Faculty of Agro-and Bio-Industry
Faculty of Engineering
Hi-SCooL
Scientists Engineers Without Borders Korea
Myanmar Creative University
KATS 한국태국학회 Korean Association of Thai Studies

Partners

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Title: Proceedings of the 3rd International Conference on ASEAN Sustainable Development (ICASD2026)

Theme: Innovative & Appropriate Sustainable Development in the digital Era

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Dr. Muhammad Hassan Arshad

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Acknowledgements

The organizing committee of the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026)would like to express our sincere appreciation to all individuals and institutions who have contributed to making this conference possible. Under the theme, “Innovative & Appropriate Sustainable Development in the Digital Era”, this conference reflects our shared commitment to promoting meaningful dialogue, research, and practical solutions for sustainable development in a rapidly changing world.

We would also like to acknowledge the educational philosophy of Thaksin University, which greatly inspires this conference: “Thaksin University focuses on learning outcomes of learners towards social innovation competence and entrepreneurship with wisdom, ethics, leading development through active learning management”. This philosophy serves as an important foundation for ICASD 2026, guiding our efforts to create a platform that encourages knowledge creation, ethical leadership, innovation, and active engagement among participants.

In particular, we would like to extend our heartfelt appreciation for the participation of young researchers, including undergraduate students and high school students, whose enthusiasm, creativity, and academic potential bring special value to this conference. Their involvement reflects our strong belief that the future of sustainable development depends on empowering the next generation of scholars and change-makers.

We are equally grateful to our co-hosts, partners, keynote speakers, reviewers, presenters, and participants from various institutions and countries for their academic support, collaboration, and trust. The international nature of this conference demonstrates the strength of cooperation across borders and highlights the importance of exchanging diverse perspectives in addressing sustainable development challenges.

Finally, we sincerely hope that the 3rd ICASD will serve not only as a venue for academic exchange, but also as a meaningful starting point for future collaborations, including joint research, publications, student development, and long-term institutional partnerships. We deeply appreciate everyone’s contribution and look forward to continuing this valuable journey together.

Conference Organizers

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Dr. Pittayatorn Kaewkong

- **Co-Chairperson**

Mr. Abdunfatah Masamae
Dr. Ye Jin Kim

- **Advisory Committee**

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2. Vice President for Research and Innovation
3. Dean of the International College
4. Dean of the Faculty of Economics and Business Administration
5. Dean of the Faculty of Law
6. Dean of the Faculty of Agro-and-Bio Industry
7. Dean of the Faculty of Multidisciplinary Sciences and Entrepreneurship
8. Dean of the Faculty of Engineering

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Conference Organizers

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1. Dr. Pittayatorn Kaewkong, Dean of the International College
2. Mr. Abdunfatah Masamae, Vice Dean of the International College
3. Dr. Nattanant Thongmak, Assistant to the Dean of the International College
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6. Dr. Min Liu
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8. Ms. Siriporn Petmanee, Head of the International College Office
9. Ms. Paweena Junpradit
10. Mrs. Chatpavee Ruppradit
11. Ms. Fontip Kaewsuwan

- **Abstract and Proceeding:**

1. Dr. Pittayatorn Kaewkong
2. Mr. Abdunfatah Masamae
3. Dr. YeJin Kim
4. Dr. Muhammad Hassan Arshad
5. Dr. Min Liu
6. Ms. Paweena Junpradit
7. Ms. Fontip Kaewsuwan

Message from the President
Thaksin University

It is my great pleasure to extend a warm welcome to all distinguished scholars, researchers, practitioners, and students attending the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026). On behalf of Thaksin University, I would like to express our sincere appreciation to everyone who has contributed to and participated in this important academic gathering.

This conference provides a valuable platform for scholars and professionals from diverse disciplines and countries to exchange knowledge, share research findings, and engage in meaningful dialogue on issues related to sustainable development. Under the theme "Innovation & Appropriate Sustainable Development in the Digital Era," the conference highlights the importance of integrating innovation, technology, and collaborative approaches in addressing the complex challenges facing our societies today.

In the context of the ASEAN region and the wider global community, sustainable development requires not only academic insight but also practical cooperation among universities, research institutions, governments, and communities. International conferences such as ICASD play a vital role in fostering these connections and encouraging the exchange of ideas that can lead to practical and sustainable solutions.

Thaksin University remains committed to supporting academic excellence, international collaboration, and the advancement of knowledge that contributes to sustainable and inclusive development. We hope that this conference will inspire new perspectives, strengthen academic networks, and encourage future collaborations among participants.

I would like to thank the organizing committee, partners, and contributors for their dedication and hard work in making this conference possible. I wish all participants a fruitful conference and an enjoyable stay in Hatyai, Songkhla.

N. Chitniratna

Associate Professor Dr. Nathapong Chitniratna
President of Thaksin University

Message from the Vice President
Research and Innovation, Thaksin University

Research and innovation play an essential role in addressing the complex challenges faced by societies around the world today. The 3rd International Conference on ASEAN Sustainable Development (ICASD 2026), therefore, serves as an important academic forum for scholars, researchers, practitioners, and students to share knowledge, present research findings, and strengthen international research collaboration.

In recent years, rapid technological advancement and digital transformation have created both opportunities and challenges for sustainable development. The integration of innovation, interdisciplinary research, and responsible application of digital technologies is increasingly necessary in order to develop practical and sustainable solutions that respond to the needs of society.

The theme of this conference, “Innovation & Appropriate Sustainable Development in the Digital Era,” highlights the importance of promoting research that not only advances academic knowledge but also contributes to social, economic, and environmental sustainability. Through scholarly exchange and collaboration, conferences such as ICASD provide a valuable platform for researchers to explore new perspectives and foster meaningful partnerships across institutions and countries.

Thaksin University remains committed to supporting research and innovation that contribute to sustainable development at both regional and global levels. It is hoped that this conference will encourage productive discussion, inspire new research initiatives, and strengthen academic networks among participants.

I would like to express my sincere appreciation to the organizing committee, co-host institutions, keynote speakers, reviewers, and all contributors whose efforts have made this conference possible.

I wish all participants a fruitful conference and a pleasant stay in Thailand.

Samak K.

Associate Professor Dr. Samak Kaewsuksaeng
Vice President Research and Innovation
Thaksin University

Message from the Dean
International College, Thaksin University

On behalf of the International College, Thaksin University, it is my great pleasure to welcome all participants to the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026). This conference provides an important platform for scholars, researchers, policymakers, and practitioners to exchange ideas and share research that contributes to sustainable development within the ASEAN region and beyond.

In an era marked by rapid social, economic, and environmental changes, sustainable development has become a shared responsibility for nations, institutions, and communities. The ASEAN region, with its diverse cultures, dynamic economies, and unique environmental challenges, offers both opportunities and responsibilities for collaborative solutions. ICASD 2026 brings together interdisciplinary perspectives to address these challenges and explore innovative approaches to achieving sustainable and inclusive growth.

At Thaksin University International College, we strongly believe that higher education institutions play a crucial role in promoting knowledge creation, international collaboration, and responsible global citizenship. Conferences such as ICASD not only provide opportunities for academic dialogue but also help strengthen networks that support research, innovation, and sustainable practices across borders.

I would like to express my sincere appreciation to all authors, reviewers, keynote speakers, and organizing committee members whose contributions have made this conference possible. Your participation and commitment to advancing knowledge are invaluable to the success of this event.

I wish you all a productive conference and a rewarding exchange of ideas.

Dr. Pittayatorn Kaewkong
Dean, International College Thaksin University, Thailand

Message from the Dean
Faculty of Law, Thaksin University

The Faculty of Law at Thaksin University is deeply honored to serve as a co-host for the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026). This esteemed conference convenes distinguished scholars, researchers, and practitioners across multidisciplinary fields to engage in intellectual discourse and chart strategic trajectories toward sustainable development within the ASEAN region and beyond.

Sustainable development transcends mere economic prosperity and technological innovation; it is intrinsically intertwined with the rule of law, robust institutional frameworks, and equitable access to justice. Comprehensive legal structures and sound governance are indispensable pillars in fostering sustainable societies, protecting fundamental rights, ensuring egalitarianism, and enforcing accountability.

The thematic symposia of this conference—most notably those dedicated to Peace, Justice, and Strong Institutions—profoundly emphasize the critical function of legal architectures in fortifying governance and propelling sustainable progress. Rigorous legal scholarship and constructive policy dialogues are instrumental in architecting institutional frameworks that champion inclusive and conscientious development.

In our capacity as a co-host of ICASD 2026, the Faculty of Law takes immense pride in facilitating this academic nexus, which fosters interdisciplinary synergy and substantive deliberation among global experts. Such dynamic exchanges are pivotal in bridging the gap between empirical research, policymaking, and pragmatic application to effectively mitigate the multifaceted challenges confronting contemporary society.

On behalf of the Faculty of Law, I extend my profound gratitude to the organizing committee, esteemed keynote speakers, diligent reviewers, and all participants whose invaluable contributions have actualized this conference.

I wish you all a highly productive, intellectually stimulating, and inspiring conference.

Assistant Professor Dr.Krisda Apinawatawornkul
Dean of the Faculty of Law
Thaksin University

Message from the Dean
Faculty of Economics and Business Administration, Thaksin University

It is my distinct honor and privilege to welcome all distinguished delegates, scholars, and practitioners to the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026).

This year's theme, "Innovative & Appropriate Sustainable Development in the Digital Era," arrives at a critical juncture for the ASEAN community. As we navigate the complexities of rapid digital transformation, we must remain steadfast in our commitment to development that is not only technologically advanced but also ecologically resilient and socially inclusive.

At the Faculty of Economics and Business Administration, Thaksin University, our vision is to be a leading institution that fosters innovation and serves as a center of excellence in business education, dedicated to creating tangible value for both the economy and society. In this capacity, we recognize that the digital era provides us with sophisticated tools to accelerate the transition toward a Circular Economy. By optimizing resource life cycles and minimizing waste through digital intelligence, we can significantly bolster Energy Security across our region—reducing our dependence on finite resources and building a more self-reliant, sustainable energy landscape.

The concept of "appropriateness" remains at the heart of our discussions. It serves as a reminder that innovation must be strategically tailored to the unique environmental and socioeconomic contexts of ASEAN nations. ICASD 2026 stands as a premier platform for intellectual exchange, where we can bridge the gap between theoretical research and practical application, ensuring that our collective efforts lead to sustainable prosperity.

On behalf of the Faculty and the organizing committee, I would like to express my sincere gratitude to our sponsors, partners, and most importantly, the participants for their invaluable contributions. Your insights are the catalysts for the transformative change our region requires.
I wish you all an intellectually stimulating conference and a memorable stay in the historic province of Songkhla.
Warm Regards,

P. Duangchinda.

(Dr. Pinit Duangchinda)
Dean of Economics business and administration
Co-Chair, ICASD 2026

Message from the Dean
Faculty of Engineering, Thaksin University

On behalf of the Faculty of Engineering, Thaksin University, it is my great pleasure to extend a warm welcome to all participants of The 3rd International Conference on ASEAN Sustainable Development (ICASD 2026) under the theme “Innovation & Appropriate Sustainable Development in the Digital Era.”

The Faculty of Engineering is honored to co-host this important international conference. Our faculty is committed to the mission of producing professional engineers and creating innovations for society, with a strong emphasis on applying engineering knowledge and technology to address real-world challenges and support sustainable development.

In today’s rapidly evolving digital era, innovation, engineering solutions, and interdisciplinary collaboration play a crucial role in advancing sustainable development across economic, environmental, and social dimensions. This conference provides an excellent platform for scholars, researchers, and practitioners from around the world to share research findings, exchange ideas, and build international collaboration that contributes to sustainable development in the ASEAN region and beyond.

We sincerely hope that ICASD 2026 will foster meaningful academic exchange, inspire innovative ideas, and strengthen networks among global scholars and institutions.

I would like to express my appreciation to the International College and all partners involved in organizing this conference, and I wish the conference every success.

J. KAEW-ON

Assoc. Prof. Dr. Jatuporn Kaew-On
Dean, Faculty of Engineering
Thaksin University

Message from Dean
Faculty of Agro- and Bio-Industry, Thaksin University

It is with great pride and pleasure that the Faculty of Agro- and Bio-Industry, Thaksin University, extends a warm welcome to all distinguished participants of the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026).

This important academic platform brings together researchers, educators, practitioners, and policymakers from across ASEAN and beyond to exchange knowledge, share innovations, and discuss practical approaches to advancing sustainable development. The conference theme strongly aligns with the United Nations Sustainable Development Goals (SDGs) and reflects our collective commitment to addressing global challenges through regional cooperation and scientific progress.

As one of the co-hosting institutions, the Faculty of Agro- and Bio-Industry is honoured to support this international forum, which promotes collaboration and knowledge exchange across agriculture, biotechnology, food systems, environmental management, and sustainable socio-economic development.

We sincerely believe that the discussions and outcomes of this conference will encourage new partnerships, stimulate future research, and contribute meaningfully to sustainable development within the ASEAN region and beyond.

On behalf of the Faculty Agro- and Bio Industry, we would like to express our sincere appreciation to the organising committee, keynote speakers, presenters, and all participants for their valuable contributions. We wish everyone a productive and inspiring experience at ICASD 2026.

Assistant Prof. Dr. Rutrada Theppradit
Dean of Faculty of Agro- and Bio-Industry
Thaksin University

Message from Dean
Faculty of Multidisciplinary Sciences and Entrepreneurship, Thaksin University

On behalf of the Faculty of Multidisciplinary Sciences and Entrepreneurship, Thaksin University, it is my great honor and pleasure to welcome you to the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026). We are truly privileged to serve as a co-host of this important international academic gathering.

This conference provides a valuable global platform for scholars, practitioners, and policy contributors to exchange ideas and research findings that advance sustainable development in ASEAN and beyond. In particular, the discussions today reflect the shared commitment to the five key dimensions of the Sustainable Development Goals: People, Prosperity, Planet, Peace, and Partnership. These pillars remind us that sustainable development requires not only knowledge and innovation but also collaboration across institutions, disciplines, and nations.

The Faculty of Multidisciplinary Sciences and Entrepreneurship is proud to actively contribute to this conference in several important roles. As a co-hosting institution, our faculty has supported the organizational and coordination processes that help connect partners and ensure the smooth implementation of this academic event. In addition, members of our faculty have been invited to serve as expert reviewers and academic contributors in the peer-review process, helping to maintain the scholarly quality and rigor of the conference proceedings.

Furthermore, we are pleased to share that the Faculty has encouraged and supported active academic participation from our members. In this conference, our faculty contributed research papers, reviewers involved in the development and preparation of these studies. This reflects our strong commitment to fostering research collaboration, interdisciplinary learning, and knowledge dissemination within the international academic community.

Beyond this year's event, the Faculty of Multidisciplinary Sciences and Entrepreneurship remains committed to continuously supporting international academic conferences such as ICASD through collaboration, academic networking, and institutional support. We believe that such partnerships are essential for strengthening sustainable academic ecosystems and ensuring the long-term sustainability of international scholarly engagement.

Finally, I would like to extend my sincere appreciation to the organizing committee, our international partners, reviewers, presenters, and participants for your dedication and contributions. Your engagement makes this conference a meaningful space for dialogue, innovation, and collective progress toward a sustainable future.

Rungrawee Jitpakdee.

Assoc. Prof. Dr. Rungrawee Jitpakdee
Dean, Faculty of Multidisciplinary Sciences and Entrepreneurship
Thaksin University

Welcome Message from the President of the Korean Association of Thai Studies

On behalf of the Korean Association of Thai Studies, I would like to extend a warm welcome to all participants, scholars, and distinguished guests.

The Korean Association of Thai Studies has long been dedicated to promoting mutual understanding between Korea and Thailand through interdisciplinary research and academic exchange, thereby strengthening the scholarly foundation of bilateral relations. In the context of a rapidly changing international order and structural transformations across Asia, academic reflection on regional studies and inter-state cooperation has become more important than ever. In response to these evolving challenges, we have gathered here today to further deepen scholarly communication and collaboration.

This conference will provide a meaningful platform for in-depth discussions on the social, cultural, political, and economic transformations taking place in Korea, Thailand, and the broader Southeast Asian region. By bringing together researchers from diverse academic backgrounds and experiences, we hope to facilitate the exchange of knowledge and the expansion of perspectives, contributing to a more comprehensive and balanced understanding of the region.

In particular, this occasion goes beyond a simple forum for research presentations; it serves as a starting point for building a sustainable academic community and laying the groundwork for future collaboration among the next generation of scholars. The Korean Association of Thai Studies remains fully committed to strengthening academic networks, promoting joint research, and expanding people-to-people exchange between our two countries.

I sincerely thank all of you for your participation despite your busy schedules, and I hope this conference will lead to meaningful discussions and productive cooperation.

Thank you.

Bongchul Kim

Prof. Bongchul Kim
President
Korean Association of Thai Studies

Message from the Co-Host :
China–Laos–Thailand High-Speed Railway Impact Research Centre

On behalf of the research project “The Hi-SCooL Project: Impact of the China–Laos–Thailand High-Speed Railway Impact Research Centre,” supported by the Lancang-Mekong Cooperation Special Fund, I would like to express my sincere appreciation to the Thaksin University International College for generously providing our research project center with the opportunity to be part of this distinguished international conference.

Along the academic journey, a platform for presenting research findings is not merely a venue for reporting what research we have conducted and what results we have obtained. Rather, it serves as an open space for mutual learning and intellectual exchange among scholars who stand together in the shared position of seekers of knowledge. It also offers valuable opportunities to cultivate academic collaboration among scholars, researchers, teachers, and students from different institutions. Such exchanges ultimately nurture scholarly growth that will contribute to building a better and more enlightened society in the future.

I sincerely hope that everyone will enjoy the opportunity to exchange ideas and learn from one another, and perhaps even find “new friends” through participation in the 3rd International Conference on ASEAN Sustainable Development (ICASD 2026).

With respectful regards.

Associate Professor Dr. Thanapauge Chamaratana
Head of The Hi-SCooL Project
Faculty of Humanities and Social Sciences
Khon Kaen University

Message from President
Scientists and Engineers Without Borders (SEWB), Korea

On behalf of Scientists and Engineers Without Borders (SEWB), Korea, I would like to express my sincere congratulations on the 3rd International Conference on ASEAN Sustainable Development (ICASD).

It is a great honor for SEWB to serve as a co-host of this meaningful conference. We are truly pleased to join Thaksin University and our partners in ASEAN in promoting collaboration for a sustainable future.

SEWB is a non-profit organization that brings together scientists and engineers who wish to use science, technology, and education to support communities and contribute to solving global challenges. Through partnerships with universities, researchers, and students, we aim to promote practical solutions related to the Sustainable Development Goals (SDGs).

We believe that ICASD provides an important platform for sharing knowledge, building networks, and developing collaborative solutions for our shared future. SEWB is honored to take part in this initiative, and we look forward to continuing our cooperation with friends across ASEAN.

Thank you, and we wish the conference great success.

Kwanwoo Shin
President
Scientists and Engineers Without Borders (SEWB), Korea
www.sewb.org

Message from the Partner of ICASD 2026
CEO Shenzhen LIMON Technology Co., Ltd.

On behalf of Shenzhen LIMON Technology Co., Ltd., it is my greatpleasure to express our appreciation for the opportunity to participate in the 3rd International Conference on ASEAN Sustainable Development (ICASD). This conference provides an important platform for scholars, institutions, and industry leaders to exchange ideas and explore collaborative solutions for sustainable development.

As global communities continue to face challenges related to environmental sustainability, economic development, and social progress, international cooperation and knowledge sharing have become increasingly important.ICASD plays a valuable role in bringing together diverse perspectives to address these complex issues and promote innovative approaches for a sustainable future.

We are honored to support the conference and to take part in the nomination process for a partner to support the academic contribution, as well as discussions regarding the Sustainable Development (SD) Association, especially on the theme “Innovative and Appropriate Sustainable Development in the Digital Era”. We believe these initiatives will strengthen academic collaboration and contribute to long-term sustainable development across the ASEAN region.

We look forward to meaningful discussions, knowledge exchange, and future cooperation through this importantinternational platform.

Warm regards,

Zhang Jingran
Legal Representative
Shenzhen Lingmou Wisdom Technology Co., Ltd.

Message from President
Myanmar Creative University (MCU)

First and foremost, I would like to extend my sincere congratulations on the successful organization of the 3rd International Conference on Sustainable Development 2026 (ICASD 2026).

On behalf of Myanmar Creative University (MCU), I would also like to express our deepest appreciation to Thaksin University, TSU for your continued friendship and partnership, and for kindly granting
MCU the opportunity to participate as a Co-Host in the 1st, 2nd, and now the 3rd ICASD.

Among the many remarkable achievements of Thaksin University, ICASD stands out as a highly valuable initiative that contributes not only to regional and institutional development but also to partner universities. The conference provides an excellent platform for scholars from various international universities to present their research, exchange perspectives, and gain valuable global academic experience. It is indeed a meaningful and beneficial program for all participants.

We sincerely wish Thaksin University continued success and growth, and hope that it will carry on organizing impactful international conferences such as ICASD 2026 in the years to come.
Please accept my highest regards and congratulations.

Prof. Dr. Saw Htay Myint
(Co - Host, Conference Chair and Reviewer ICASD-2026)
President
Myanmar Creative University (MCU)

3RD ICASD 2026 AGENDA

The 3rd ICASD PresThe 3rd International Conference ASEAN Sustainable Development (ICASD 2026)

THEME: "Innovative & Appropriate Sustainable Development in the Digital Era"

- **Day 1: Academic Conference (April 2, 2026; Thursday)**

Time	Agenda
08:00 – 08:30	Preparing Poster Presentations
08:30 – 09:00	Registration
09:00 – 09:30	**Opening Ceremony (MC: Mr. Budy Prastyo)**
	• TSU Video • Cultural Performance • Welcoming by Dr. Pittayatorn Kaewkong, the chair of ICASD Committee, the Dean of International College, Thaksin University • Reporting by Dr. Yejin Kim, the co-chairperson of ICASD Committee, the Dean of International College, Thaksin University • Opening by Assoc. Prof. Dr. Nathapong Chitniratna, the President of Thaksin University • Photo session
09:40 – 10:20	**Keynote Lecture 1**: **Prof. Bongchul Kim**
	• **Topic:** *Middle Power countries in the Digital Age: Korea and Thailand*
10:20 – 11:00	**Refreshment**
11:00 – 11:40	**Keynote Lecture 2: Mr. Mohd Hairulnlzam Ibrahim**
	• **Topic:** *Coral Sustainability and Restoration Innovation in Coral Reef: Connectivity Between Marine Biology and Marine Engineering*
11:40 – 13:00	**Lunch**
13:00 – 15:00	**Oral Presentations by Participants 1:** Session 1-1, 1-2, 1-3, 1-4, and 1-5
15:00 – 15:15	**Refreshment**
15:15 – 17:00	**Oral Presentations by Participants 2 and 3:** • Sessions 2-1, 2-2, and 2-3 / Online Sessions: 3-1, 3-2, 3-3 and 3-4 **Poster Presentations by Participants (Parallel Session)**
17:00 – 17:30	**Closing Ceremony (MC: Mr. Budy Prastyo)** • Awards and Announcement: Outstanding Presentation and Honorable Presentation • Closing by Mr. Abdunfatah Masamae, the Vice Dean of International College, Thaksin University

- **Day 2 : n Sustainable Development Field Visit (April 3, 2026; Friday- Optional)**

Time	Agenda
08:30 – 09:00	**Meeting at the lobby of The Crystal Hotel** (Please register through QR code. Frist come, first served. Only 50 seats are available.)
09:00 – 12:00	**This offers participants an opportunity to explore local cultural heritage, community-based learning, and place-based sustainability practices in Songkhla.** • Visit to the Folklore Museum at the Institute for Southern Thai Studies, Thaksin University • Exploring Songkhla Old Town • Return to The Crystal Hotel

Important Notes :

1. Thank you for joining and contributing to the 3rd ICASD 2026.
Your participation makes this event meaningful and impactful.

2. Oral Presentations

• Each presenter is allotted 15 minutes, including time for questions and reflections.

• All presenters in the oral presentation sessions are kindly requested to arrive at their presentation room at least 10 minutes before the session starts to ensure smooth operation.

• Please prepare your presentation in PDF format and submit it to your session room during lunch and refreshment time.

3. Poster Presentations

• Each poster presenter will be given 5–8 minutes to present when the Chair and Co-chair arrive at the designated poster area.

LIST OF CHAIRS AND CO-CHAIRS OF THE 3RD ICASD

Sessions	Chair and Co-Chairs
Oral Presentations 1: 13:00 – 15:00	
Session 1-1 (Crystal Grand Ballroom)	**People** • **Chair**: Asst. Prof. Dr. Saw Htay Myint • **Co-chair**: Dr. Wasin Praditsilp
Session 1-2 (ChanManee Room: 3rd floor)	**People 2** • **Chair**: Assoc. Prof. Dr. Thanapauge Chamaratana • **Co-chair**: Mr. Thura Swe
Session 1-3 (Sorapong Room**:** 3rd floor**)**	**Planet 1** • **Chair**: Prof. Dr. Min-Soo Maeng • **Co-chair:** Assoc. Prof. Dr. Phanat Kittiphattanabawon
Session 1-4 (ChanNapha Room:3rd floor)	**Planet 2** • **Chair**: Assoc. Prof. Dr. Jompob Waewsak • **Co-chair**: Dr. Hyung Woo Lee
Session 1-5 (Sirirat Room: 3rd floor)	**Prosperity 1** • **Chair**: Assoc. Prof. Papontee Teeraphan • **Co-chair**: Assoc. Prof. Dr. Nazlina Zakaria
Oral Presentations 2 (Onsite): 15:15 – 17:00	
Session 2-1 (ChanManee Room: 3rd floor)	**Planet 3, Peace and Partnership** • **Chair**: Asst. Prof. Dr. Sanit Srichookiat • **Co-chair**: Asst. Prof. Dr. Morakot Ditta–Apichai
Session 2-2 (Sorapong Room: 3rd floor)	**People 3** • **Chair**: Asst. Prof. Dr. Muhammad Zulqarnain Arshad • **Co-chair**: Dr. Kanyanit Wichianrat
Session 2-3 (ChanNapha Room:3rd floor)	**People 4 and Prosperity 2** • **Chair**: Assoc. Prof. Dr. Darwina Arshad • **Co-chair**: Assoc. Prof. Dr. Puttharak Prabnok
Oral Presentations 3 (Online): 15:15 – 17:00: Links will be updated soon	
Session 3-1 (Sirirat Room: 3rd floor)	**Multidisciplinary** • **Chair**: Dr. Min Liu
Session 3-2 (Sirirat Room: 3rd floor)	**Multidisciplinary** • **Chair**: Dr. Muhammad Hassan Arshad
Session 3-3 (Sirirat Room: 3rd floor)	**Multidisciplinary** • **Chair**: Mr. Md Ahbabur Rahman
Session 3-4 (Sirirat Room: 3rd floor)	**Multidisciplinary** • **Chair**: Ms. Phyu Phyu • **Co-chair**: Ms. Hera Liu
Poster Presentations: 15:15 – 17:00 (Parallel with Oral Presentations 2 and 3)	
Session 4-1 (Crystal Grand Ballroom)	**People and Prosperity** • **Chair**: Assoc. Prof. Dr. Hendrik Bin Lamsali • **Co-chair**: Dr. Sattra Keawphang
Session 4-2 (Crystal Grand Ballroom)	**Planet** • **Chair**: Prof. Dr. Seok Dockko • **Co-chair**: Asst. Prof. Dr. Niramol Juntarachat

Awards and Evaluation Criteria for the 3rd ICASD

1. For each oral presentation session at the 3rd ICASD, two awards will be selected by the Chair and Co-chair: **Outstanding Presentation** and **Honorable Presentation**. These awards will be presented during the **Closing Ceremony (17:00–17:30).**

2. For the **Poster Session for high school students, Gold, Silver, and Bronze Awards** will be given based on the total scores: **90% and above for Gold, 80% and above for Silver, and 70% and above for Bronze.** The poster presentations will be evaluated based on five criteria: originality and significance, methodology, results and findings, discussion and conclusions, and overall presentation and understanding. Certificates for the awardees will be provided after the conference in **PDF format.**

Table of Content

PROCEEDING ARTICLES

GROUP 1
PEOPLE

English Education Reform Policy in Thai Secondary Schools: Policy Formulation, Implementation, and Outcomes

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Abstract: This study examines the formulation and implementation of the English language teaching reform policy in secondary schools under the Office of the Basic Education Commission (OBEC). Using document analysis, it draws on key theoretical frameworks, including the Common European Framework of Reference for Languages (CEFR), Communicative Language Teaching (CLT), Van Meter and Van Horn's (1975) Policy Implementation Theory, and the critical policy analysis model of Chung and Cheung (1995). The purposes are: (1) to analyze the policy formulation process, (2) to investigate the mechanisms and processes of policy implementation, and (3) to evaluate the outcomes of policy enactment. The findings show that (1) in terms of formulation, the policy aims to enhance educational quality and develop human resources by reforming English teaching, curriculum, and assessment, and by setting CEFR-based targets for teacher training and testing; (2) in terms of implementation, it follows a hierarchical structure through Human Capital Excellence Centers (HCECs), covering curriculum and instructional development (CEFR, CLT), continuous teacher professional development, learner support through special programs, and technology use/CEFR testing; and (3) in terms of outcomes, students' English proficiency has improved but remains largely at basic levels (Pre-A1 to A2), while teacher development has been highly successful and has exceeded the original targets. Nevertheless, challenges remain regarding resources, teacher readiness, and diverse local contexts. The study recommends developing integrated policy mechanisms and providing ongoing professional development for teachers to ensure effective and sustainable English language teaching.

Keywords: English language teaching reform policy, CEFR, Policy implementation, Thai secondary schools

1. Introduction

English proficiency is critical for global integration and serves as the official working language of ASEAN (Onwimon, 2011). To enhance national competitiveness, the Thai Ministry of Education enacted an English language teaching reform in 2014.

The Office of the Basic Education Commission (OBEC) was tasked with integrating the Common European Framework of Reference for Languages (CEFR) and Communicative Language Teaching (CLT) into secondary education (Jeerawut, 2014; Ministry of Education, 2014).

Despite these systemic efforts, student outcomes remain persistently low. Thailand ranked 101st out of 113 nations in the 2023 EF English Proficiency Index (EF Education First, 2023), and national O-NET scores for secondary students remain critical (NIETS, 2024). Concurrently, official reports indicate that teacher upskilling initiatives missed targets due to budget constraints, ambiguous guidelines, and inadequate supervision (OBEC, 2021). These discrepancies highlight the limitations of top-down educational policies that lack context-sensitive execution mechanisms (Cahyono & Widodo, 2018; Fullan, 2015; Honig, 2006; Spillane et al., 2002).

Consequently, this research systematically analyzes the formulation, implementation mechanisms, and outcomes of this reform in OBEC secondary schools. Ultimately, the study aims to propose an evidence-based, context-aligned implementation model to sustainably bridge the gap between centralized policy intentions and local classroom realities.

2. Materials and Methods

This study employs document analysis as the primary qualitative method to systematically examine the formulation, implementation, and outcomes of the English language teaching reform policy. To ensure a comprehensive and critical analysis, the research integrates pedagogical concepts with educational policy implementation models. The following theoretical frameworks form the analytical foundation of this study.

2.1. Theoretical Framework

2.1.1. The Common European Framework of Reference for Languages (CEFR) and its Application in Thailand

The Common European Framework of Reference for Languages (CEFR) is an internationally recognized standard for measuring and describing language proficiency (Council of Europe, 2001). It comprises six levels, from A1 to C2, each detailing linguistic abilities across various skills such as listening, speaking, reading, and writing (Council of Europe, 2020). Developed by the Council of Europe and first published in 2001, the CEFR offers a transparent and systematic framework for curriculum development, language teaching, and assessment worldwide (Council of Europe, 2001; Little, 2007). The CEFR proficiency levels are structured as per Appendix (Table 1).

Implementation of CEFR in Thailand

In 2014, the Thai Ministry of Education adopted the CEFR to standardize and elevate English language proficiency for students and teachers (Ministry of Education, 2014). This integration involves curriculum design, assessment, and teacher training, with specific proficiency targets: A2 for lower secondary and B1 for upper secondary students. The CEFR also guides national and school-level English assessment, including test design, teacher professional development, and overall national proficiency objectives.

2.1.2. Communicative Language Teaching (CLT)

Communicative Language Teaching (CLT) aims to develop genuine communicative competence in real-world situations, building on Hymes' (1972) concept of appropriate language use within social contexts. Canale and Swain (1980) expanded this to include grammatical, sociolinguistic, discourse, and strategic competencies, allowing learners to use language flexibly (Richards & Rodgers, 2014). Therefore, CLT activities emphasize authentic interaction, group work, and meaning conveyance over rote memorization (Richards & Rodgers, 2014)

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2.1.3. Policy Implementation Theory

Policy Implementation Theory, specifically the model by Van Meter and Van Horn (1975), is employed to analyze and evaluate how established policies are translated into practice. This framework posits that policy implementation is a complex process influenced by six key variables: (1) Policy Goals, which must be clear and consistent; (2) Available Resources, encompassing budget, personnel, and equipment; (3) Organizational Communication, including clarity and communication channels; (4) Characteristics of the Implementing Agency, such as organizational structure and culture; (5) External Conditions, like economic, social, and political factors; and (6) Attitudes of Implementers, or the willingness of stakeholders to apply the policy. This model facilitates the examination both systemic and stakeholder-related factors that impact the success or failure of policy implementation.

2.1.4. Critical Policy Analysis by Chung and Cheung (1995)

Cheng and Cheung (1995) proposed a framework for educational policy analysis emphasizing comprehensiveness and the interrelationship between policy stages. This can be applied to research as follows:

1.Policy Formulation Analysis: Examines the origins, principles, and influential factors in policy formulation, such as analyzing announcements or guidelines from the Ministry of Education.

1.Policy Implementation Analysis: Investigates the mechanisms and approaches for translating policy into actual practice at the regional educational office and school levels, including interpretation and adaptation to each school's context.
2.Policy Effects Analysis: Evaluates the outcomes of policy implementation, particularly regarding students' English proficiency and teacher development, to assess policy effectiveness or unintended impacts.

2.2. Research Methodology

This study primarily employs Document Analysis to gather fundamental information, principles, concepts, and relevant theories. This approach aims to foster a deep understanding of the policy implementation for English language teaching reform in secondary schools under the Office of the Basic Education Commission (OBEC). Document analysis is a qualitative research method that involves systematically examining existing documents—such as policies, manuals, and reports—to extract key issues and establish a framework for in-depth analysis (Bowen, 2009; Corbin & Strauss, 2015). The document analysis process involves:

1.Categorization: Grouping documents by content (e.g., policies, regulations, operational reports).
2.Close Reading: Detailed examination of document content to identify key themes.
3.Thematic Extraction: Summarizing main points that reflect critical factors or issues related to policy implementation.
4.Data Comparison: Comparing information from various documents to identify similarities and differences.
5.Critical Policy Analysis: Analyzing policy formulation, implementation, and outcomes.

2.3. Data Sources

Data for this study will be drawn from the following sources:
1.Policy and Plan Documents: Including policies on English language teaching reform, guidelines for English language instruction in Thailand, policies for promoting and developing teachers' English competence, educational development plans, English language teaching operational manuals, and related regulations.
2.Performance Reports: Such as evaluation reports on policy implementation in schools.
3.Academic Documents: Relevant research, academic articles, and published analyses.

Documents will be selected based on the following criteria:

1.Credibility: Information must originate from reliable academic or recognized institutional sources (Student CAS Blog, 2024).
2.Official Documents: Government documents are prioritized for their high reliability and formal status for research referencing, aligning with established research standards (National Research Council of Thailand, 2024).
3.Relevance: Clear criteria will guide the selection of information directly pertinent to the research objectives, consistent with systematic literature review practices (BMC Medical Research Methodology, 2018).
4.Recency: Documents will primarily be less than 10 years old to ensure the data reflects the current context of English language education in secondary schools (Hiebl, 2023).
5.Comparability: Data from multiple sources will be compared to identify connections and consistency in content, as is standard in systematic literature reviews (ResearchGate, 2023).

3. Results and Discussion

The document analysis of the English language teaching reform policy in Thai secondary schools revealed critical insights across three core dimensions: policy formulation, implementation mechanisms, and outcome evaluation. By applying Policy Implementation Theory and Critical Policy Analysis, the findings highlight both the structural strengths of the reform and the practical challenges encountered during its execution. The results are detailed as follows:

3.1. Policy Formulation Analysis

3.1.1. Background and Context of Policy Formulation

The English language teaching reform policy for secondary schools under the Office of the Basic Education Commission (OBEC) stems from Thailand's strategic focus on enhancing educational quality and human resource development. This initiative aims to boost global competitiveness by systematically improving English proficiency among both students and teachers. English proficiency is recognized as a crucial skill for meeting international demands and enhancing Thailand's position in the global marketplace.

3.1.2. Objectives and Goals of the Policy

The primary objective of this policy is to comprehensively reform English language teaching through systematic changes in teaching methodologies, curriculum design, and assessment practices.

The overarching goal is to enable learners to effectively use English for authentic communication purposes. Specific quantitative targets include training and testing a substantial number of English teachers, reflecting the government's commitment to developing a capable teaching force aligned with international standards, particularly the Common European Framework of Reference for Languages (CEFR).

3.2. Policy Implementation Process and Mechanisms

3.2.1. Key Driving Mechanisms

The reform of English language teaching in Thailand, implemented under the Ministry of Education's policy framework, operates through a hierarchical structure with the Human Capital Excellence Center (HCEC) serving as the central coordinating mechanism. The HCEC aims to establish a comprehensive 21st-century educational ecosystem through the strategic integration of HCEC initiatives, the Digital Education Excellence Platform (DEEP), and the Excellence Individual Development Plan (EIDP). Administrative responsibilities are distributed across four distinct levels:

1.Ministry of Education

Establishes the overarching policy direction and provides strategic support for HCEC policies, budget allocation, and staff development initiatives.

2.Office of the Basic Education Commission (OBEC)

Issues operational guidelines and, through the Human Capital Excellence Management Center (HCEMC), establishes and oversees HCECs while managing resource allocation, personnel training, and systematic monitoring procedures.

3.Provincial Level

HCEC centers function as primary operational hubs, conducting teacher training programs, administering CEFR assessments, and serving as crucial links between central policies and local implementation. Provincial committees coordinate and manage HCECs while procuring necessary resources.

4.School Level

HCEC school directors oversee daily implementation activities, supported by a Center Operating Committee that manages strategic planning and facilitates both educational activities and technology integration.

3.2.2. Operational Processes

Policy Dissemination: Core policies are initially announced by the Ministry of Education, then systematically detailed by OBEC into comprehensive operational guidelines, demonstrating a structured top-down, centralized implementation approach.

1.Curriculum and Teaching Methodology: English curricula are aligned with CEFR standards and prioritize Communicative Language Teaching (CLT) approaches. Educational institutions receive detailed guidelines and ongoing support to effectively adapt these teaching models to their specific contexts.
2.Teacher Development: Teachers' English proficiency levels and CLT competencies are systematically assessed to identify areas requiring targeted professional development. HCEC centers provide comprehensive ongoing training through both online and virtual platforms including programs such as “Level Up Your English Webinar” and “English ReBoot”, supplemented by recruitment of qualified instructors and targeted interventions addressing specific pedagogical challenges.
3.Learner Proficiency Enhancement: Specialized programs (English Program - EP, Mini English Program - MEP, Intensive Program - IP) and structured activities (English camps, English Zones) significantly expand learning opportunities for students. Continuous CEFR-aligned assessments systematically monitor and document student progress.
4.Technology Integration: The policy actively encourages the development and acquisition of digital educational content and interactive learning applications. HCEC centers are equipped with essential information technology infrastructure to support both training delivery and assessment administration.
5.CEFR Assessment Implementation: HCEC centers conduct comprehensive four-skill, computer-based CEFR assessments (approximately 90 minutes duration). These assessment scores can also assist teachers in reducing the time requirements for academic advancement procedures.

3.3. Policy Outcome Evaluation

During fiscal years 2021-2024, the Ministry of Education and OBEC systematically implemented various projects and activities to advance the English language teaching reform policy. The outcomes can be comprehensively assessed across several key dimensions:

3.3.1. Results of Student English Proficiency Development

Implementation results indicate measurable improvement in student English proficiency through various targeted projects, although most participants remain at basic proficiency levels (A1-A2). The 2024 CEFR-aligned English speaking proficiency assessment for secondary students revealed that more than 91% of participants remained at Pre-A1 to A2 levels, highlighting the continued need for enhanced development in practical communication competencies. However, this assessment project enables individualized learner evaluation and the design of personalized learning pathways (see Appendix, Table 2).

Furthermore, the 2024 CEFR Placement Test (A1-A2) for English proficiency assessment included 49,754 student participants, with the majority (65.7%) achieving A2 level proficiency, reflecting their ability to understand and communicate effectively in familiar situational contexts. This assessment project assists students in accurately determining their current proficiency levels. For Matthayom 3 and 6 students assessed in 2023 (totaling 2,100 participants), results consistently demonstrated that most students (more than 70%) achieved A1-A2 proficiency levels (see Appendix, Table 3).

3.3.2. Results of Teacher and Educational Personnel Teaching Competency Development

Significant progress has been achieved in developing teachers' English proficiency and pedagogical capabilities. Professional development programs such as the "Level Up Your English Webinar" (2023) reached more than 18,000 teachers, substantially enhancing their CEFR-aligned communicative competencies and instructional confidence. The "Anywhere Anytime" project (2023) further provided flexible professional learning opportunities for 6,000 teachers through three comprehensive courses and 100 instructional video resources.

Overall, the CEFR-aligned E-Learning Platform (2022-2024) has successfully engaged more than 113,000 participants, effectively supporting self-paced learning initiatives and sustained professional growth. This institutional commitment to continuous improvement is further evidenced by the 2024 assessment results, in which 35,776 teachers and educational personnel were evaluated, exceeding the established target by 176.63% (see Appendix,Table 4).

3.3.3. Excellence in Education through English Special Programs

The establishment of regional centers for English special programs (2022-2023) has proven instrumental in providing localized curricular support, pedagogical guidance, and assessment coordination. This strategic initiative, combined with the 2023 National Academic Exhibition for English Special Programs, which attracted more than 12,548 participants, demonstrates substantial interest and sustained engagement in CEFR-aligned English language development across educational institutions nationwide.

4. Conclusions and Recommendations

The findings of this research demonstrate substantial academic importance across multiple dimensions, contributing to both theoretical understanding and practical applications in educational policy studies.

4.1. Enhancing Policy Process Understanding

This study provides a comprehensive analysis of English language teaching reform policy encompassing formulation, implementation, and outcomes within Thailand's centralized education system (Hill & Hupe, 2014). Through the systematic application of Howlett and Ramesh's (2003) policy cycle framework and Pressman and Wildavsky's (1984) implementation theories, the research offers empirical insights into the inherent complexities of educational policy translation from conception to practice. The analysis reveals the multifaceted challenges that emerge when ambitious policy objectives encounter institutional constraints and contextual realities.

4.2. Application and Extension of Theoretical Frameworks

The research conducts an in-depth analysis of the Thai educational context by integrating multiple theoretical perspectives, including the Common European Framework of Reference for Languages (CEFR) (Council of Europe, 2001), Communicative Language Teaching (CLT) pedagogical concepts (Richards & Rodgers, 2014), Van Meter and Van Horn's (1975) implementation theory, and Fischer's (2003) critical policy analysis framework. This multi-theoretical approach not only validates these established frameworks within a Southeast Asian context but also prompts further theoretical discourse on the factors that influence policy success and failure in developing nations (Grindle, 2004). The synthesis of these frameworks provides a robust analytical foundation for understanding complex policy dynamics in non-Western educational settings.

4.3. Revealing Policy-Context Imbalances

Through critical policy analysis, this study interrogates power dynamics and stakeholder perceptions (Ball et al., 2012), revealing a significant disconnect between centralized policy aspirations and local implementation realities. The research highlights persistent challenges,including resource limitations, insufficient teacher preparedness, and educational inequities that create substantial barriers to effective policy implementation. These findings contribute crucial knowledge to the theoretical understanding of implementation gaps and provide insights for developing more nuanced theories regarding policy equity and social justice in educational reform initiatives.

4.4. Generating Knowledge in English as a Foreign Language (EFL) Contexts

This research makes a significant contribution to the academic literature on English language education policy within English as a Foreign Language (EFL) environments. The study emphasizes the complex interplay between bureaucratic structures and practitioner agency (Kachru,1992), addressing a notable gap in the existing academic literature. Furthermore, the findings underscore the critical importance of developing flexible policy frameworks that are responsive to local social, cultural, and linguistic realities (Phillipson, 2009). This contribution is particularly valuable for scholars and policymakers working in similar EFL contexts where international educational standards must be adapted to local conditions and constraints.

4.5. Recommendations for Policy Implementation and Adaptation

Based on the analytical findings, to ensure that the effect of the reform becomes visible in actual student performance, the following recommendations are proposed regarding what could be done differently:

1.Decentralization and Contextual Adaptation: Policy implementation should move away from rigid, top-down mandates. HCECs should be empowered to adapt CEFR guidelines and CLT expectations to fit the specific constraints of different school sizes and regional contexts, allowing for flexible milestones rather than national blanket targets.
2.Transition from Training to Sustained Coaching: The current model heavily relies on mass webinars and standardized CEFR testing for teachers. Future policies must shift funds toward establishing ongoing, localized Professional Learning Communities (PLCs) where teachers receive in-classroom coaching and constructive feedback on executing CLT methodologies.
3.Resource Equity: To address the gap in student outcomes, policymakers must address the unequal distribution of resources. Rather than uniform funding, targeted resource allocation—such as reducing class sizes in critical areas and providing specialized teaching materials—must be prioritized for schools lacking the infrastructure of elite “Special Programs.”

5. Limitations of the Study

This study relies primarily on the document analysis of official government policies and performance reports, which may inherently reflect institutional perspectives and emphasize quantitative targets. Furthermore, the findings are contextually bound to Thai secondary schools under OBEC. Future research should incorporate empirical data, such as field observations and stakeholder interviews, to provide a more holistic understanding of the ground-level challenges and qualitative impacts of the policy implementation.

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Appendix

Table 1: CEFR proficiency levels

Level	Description	Characteristics of User
A1	Beginner (Breakthrough)	Understands and uses simple everyday expressions. Can introduce themselves and ask/answer basic personal information.
A2	Elementary (Waystage)	Understands sentences and frequently used expressions related to everyday life. Can communicate in simple situations.
B1	Intermediate (Threshold)	Understands the main points in general situations. Can communicate continuously on familiar topics.
B2	Upper-Intermediate (Vantage)	Understands more complex content. Can communicate fluently on a variety of topics.
C1	Advanced	Uses language effectively in complex social, academic, and professional situations.
C2	Proficient (Mastery)	Understands and communicates fully in all contexts. Can distinguish fine shades of meaning.

Table 2: Results of CEFR-aligned English speaking skill assessment for secondary school students under OBEC (2024)

CEFR Level	Number of Students (People)	Approximate Percentage
Pre A1	189	9.6 %
A1	815	41.5 %
A2	800	40.8 %
B1	141	7.2 %
B2	16	0.8 %
C1	1	0.05 %
Total	1,962	100.00%

Table 3: Results of assessment for Matthayom 3 and Matthayom 6 students in 2023

CEFR Level	Number of Students (People)	Approximate Percentage
A1	635	30.2
A2	875	41.6
B1	415	19.7
B2	175	8.3
Total	2,100	99.80%

Table 4: Percentage of English teachers tested for English language proficiency according to CEFR or other standards (2024)

Agency/Project	Target (People)	Actual Performance (People)	Percentage
Total	20,255	35,776	176.63
Office of the Basic Education Commission (Teacher and Student English Proficiency Development Project)	20,000	35,640	-
Office of the Vocational Education Commission (Vocational Education Teaching Skills and Potential Development Project)	250	130	-
Mahidol Wittayanusorn School (English Teacher English Proficiency Test)	5	6	-

Inner Development Goals in Higher Education: Deepening SDG Practice Beyond Awareness

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Abstract: Higher education institutions (HEIs) have increasingly engaged with the Sustainable Development Goals (SDGs) through curriculum integration, campus campaigns, and "green" initiatives. Yet, in many contexts, SDG practice remains weighted toward awareness and curricula inclusion, with less consistently documented evidence of durable, student-led sustainability practice. Grounded in a narrative review of recent peer-reviewed literature, this perspective paper argues that a key under-addressed limitation is insufficient attention to cultivating inner human capacities—understood as intrapersonal competencies, socio-emotional skills, and reflective capacities—that help sustain SDG-aligned action over time. Drawing on the Inner Development Goals (IDG) framework (a science-based model comprising five dimensions and 23 skills developed to complement the SDGs), we examine why prevailing HEI approaches may fall short and how an IDG-informed lens can deepen SDG practice beyond awareness-oriented approaches. The review highlights recurrent concerns about superficiality in implementation, suggests that inner-dimension approaches may be most feasible when embedded into existing courses, and indicates that the IDG-in-HEI evidence base remains emergent—offering promising implementation pathways while robust outcome evaluation is still limited.

Keywords: Inner development goals, SDGs, Higher education, Sustainability education, Transformative learning

1. Introduction

There are now fewer than 5 years to meet the 2030 deadline for the Sustainable Development Goals (SDGs), yet the SDGs are significantly off-track (United Nations, 2025). The latest SDG report by the UN indicated that only 17% of the targets are on track, with almost half with minimal or moderate progress, while over one-third are stalled or going backward (United Nations, 2024).

For higher education institutions (HEIs), this message carries a direct implication that SDG-targeted efforts should be considered to ensure deeper and more durable sustainability practices across all initiatives and operations. HEIs have played as frontliners in advancing the SDGs. In response to the SDG goals, HEIs across diverse global contexts have pursued curriculum integrations, organized awareness campaigns, implemented green campus initiatives, secured certifications, and embedded sustainability in various research agendas (Fia et al., 2022; Leal Filho et al., 2025).

However, empirical evidence indicates that SDG practice and engagement in many HEI settings are mostly prioritized for awareness and knowledge level, with less evidence toward more durable and consistent student-led sustainability practices (Maoela et al., 2024). In this paper, the author points out that the key reason for failures to have sustained sustainability actions is due to a critical gap in cultivating inner human capacities, which can strengthen people's efforts to engage in sustainability practices more sustainably. In this regard, the inner development goals (IDG) framework offers a systematic and science-based approach to empowering these capacities, emphasizing five dimensions and 23 inner skills developed to complement the SDGs (Ankrah et al., 2023).

Grounded in a narrative review of previous peer-reviewed literature, this paper adopts a perspective paper approach and responds to the critical implementation gap by examining how IDGs with inner capacities can bring outer change for sustained sustainability practices.

2. Materials and Methods

This paper employs a perspective paper format, which is designed to present an evidence-informed argument or viewpoint on an important issue. Previous peer-reviewed literature was reviewed, synthesized, and an original argument was constructed. No empirical data were collected and analyzed.

The review of literature was focused on three interconnected areas: (1) SDG achievement and HEI roles in sustainability education, (2) critiques of education for sustainable development (ESD approaches in higher education, and (3) applications of IDG framework in HEI contexts.

Peer-reviewed literature was searched through academic databases such as Google Scholar, Scopus, and Web of science. The search also extended to the reference list of foundational references, and relevant ones were further assessed. Key terms used in the search included "Inner Development Goals," "sustainability education in higher education," "education for sustainable development," and "sustainable development goals".

Literature was selected based on their direct relevance to the paper's argument, publication quality, and recency. References between 2021 and 2026 were favored while keeping foundational and authoritative references were included regardless of their date of publication. The selected references were then categorized, thematized, and synthesized around the paper's 3 core inquiries. Sources in languages other than English were excluded.

3. Argument and Discussion

3.1. The Limits of Current SDG Practice in Higher Education

HEIs' efforts for SDGs show their genuine institutional commitments toward SDG achievement. However, their ESD efforts have been criticized to be superficial.Based on the conceptual analysis and ESD policy reviews, Wals and Benavot (2017) argued that ESD must go beyond knowledge transmission to cultivate deeper values, competencies, and agency. Evidence suggests that a gap persists between ESD aspirations and practice. Although there have been theoretical advancements, HEI sustainability education often remains superficial. They often struggle to go deep to achieve systemic shifts or equip learners with emotional resilience and inner skills to effectively engage with complex global challenges. In most HEI contexts, knowledge dissemination remains dominant, and the gap between ESD's transformative aspirations and institutional implementations remains a recurring concern in the literature (Fagerholm et al., 2026).

3.2. The Underaddressed Gap: Inner Human Capacities

The recent emerging body of sustainability science literature highlights a persistent neglect of inner human capacities, such as intrapersonal competencies, socio-emotional skills, and reflective capacities that shape individual engagement with sustainability challenges. As argued in a peer-reviewed study published in Climatic Change, sustainability crises are partly rooted in a disconnection from ourselves, from others, and from the natural world—a disconnection that knowledge transmission alone is unlikely to address. Methods targeting these inner dimensions have so far been rarely applied or adapted in sustainability leadership and education (Wamsler et al., 2023). Complementing this, Ives et al. (2023) also identified a growing body of research that increasingly recognises inner dimensions as essential to sustainability education, yet note that their integration into mainstream HEI practice remains limited. Considered together, these suggest that the missing or weak ingredient in HEI sustainability contexts is not more knowledge, but the cultivation of inner capacities that empower students to translate knowledge into sustained sustainability practices.

3.3. The Inner Development Goals: A Structured Framework for Deepening SDG Practice

3.3.1. Origin and Core Premise

The Inner Development Goals emerged in 2021 as a science-based, non-profit, open-source initiative co-created by a global network of researchers, educators, and practitioners. Their foundational premise is that the slow pace of SDG progress reflects not only insufficient policy or technology, but also insufficient cultivation of the inner human capacities needed to drive change. IDGs do not replace the SDGs or ESD—they are intended as a complementary inner developmental layer, where the SDGs define what the world needs to achieve, IDGs map the inner qualities that may help individuals sustain SDG-aligned action. This will bridge the gap between personal growth and global transformation by means of the shared framework for the inner qualities, which contribute to a sustainable world (Ankrah et al., 2023).

3.3.2. The Five Dimensions and 23 Skills

The IDG framework organises inner development into five interconnected dimensions comprising 23 skills (Ankrah et al., 2023) :

1.Being — Relationship with Self: Intrapersonal competencies including values alignment, presence, and self-awareness.
2.Thinking — Cognitive Capacities: Critical thinking, systems thinking, and long-term orientation.
3.Relating — Care for Others and the World: Empathy, compassion, and connectedness to nature—socio-emotional capacities that can support intrinsic motivation for collective sustainability action.
4.Collaborating — Social Capacities: Co-creation, inclusive leadership, and trust-building—capacities central to collective sustainability practice.
5.Acting — Drive to Create Change: Courage, creativity, optimism, and perseverance—capacities that help translate inner development into outer SDG-aligned action.

3.4. IDGs Within a Growing Academic Field

The IDG framework is part of a broader and rapidly growing field of research on the inner dimensions of sustainability. Ives et al. (2023) describe a recent proliferation of research on interior dimensions of sustainability—including values, beliefs, worldviews, and inner capacities—and position IDGs as one of several emerging communities of practice within this field recognising the interdependence of inner and outer dimensions of sustainability transformation recognising the interdependence of inner and outer dimensions of sustainability transformation. Despite this growing recognition, Wamsler et al. (2023) suggest that inner dimensions remain a significant and underutilised area in sustainability leadership and education.

3.5. Emerging Pedagogical Evidence

Empirical studies in this field are still growing. Early studies and scholarly contributions indicate a coherent and encouraging signal that IDG-informed pedagogy is both conceptually sound and practically implementable. It can also have meaningful shifts in students' inner capacities.

In a case study at Lund University, Libertson (2023) explored barriers and enablers of inner transitions, with a focus on intra-personal skills training and mindfulness practices within a university training. Although ESD already includes informal introspection elements, there are some challenges, such as staff resistance and evaluation against formal embedding. The author recommends having student-led informal activities together with curriculum integration to build support. This integration of standalone modules suggests that IDG cultivation does not need to reform curricula as a whole, but rather a deliberate reorientation of existing pedagogical approaches through informal and supported approaches.

This type of reorientation can be seen in the study of Engel and Janssen (2024). The authors conducted an experimental seminar at Osnabrück University, where they systematically addressed all 5 IDG dimensions and 23 skills. In the seminar, the cocoa-chocolate value chain was used to see IDG-SDG linkages. The student outcomes showed gains in their self-awareness, inner compass, complexity awareness, perspective-taking, appreciation, and optimism. This indicates that structured, multi-dimensional experiential engagement can produce tangible shifts not only in students' self-perception but also in their capacity to engage with complex sustainability challenges.

The potential of IDG integration goes beyond individual courses. Nordén (2024) examined how teachers in training integrated IDG dimensions and future-oriented methodologies such as design thinking and didactic modeling. The study found that their engagement with IDGs enabled students to connect inner transition and sustainability commitment. This indicates that cultivating IDGs can bring about durable sustainability commitment.

In addition to these course-level and program-level contributions, scholars also indicate that instiutional and conceptual conditions make IDG integration viable at scale. Wood (2024) argues that the IDG framework provides a response to systemic failures in education. The author positions the IDG framework as a driver of transformation, not just a pedagogical add-on. This will help students prepare for human-generated global crises. Building on this, Keshishi (2025) highlights that universities are key drivers for the IDGs. To cultivate the necessary inner development for the next generation of sustainability leaders, the author points out the need to embed inner development practices into everyday academic programs, student support structures, and everyday campus routines.

Evaluating the IDGs from a psychospritual and relational perspectives, Briciu et al. (2026) examined how integral trasformative pdagogies impact student well-being. Their analysis of a 15-student community of practice reveals that transformative pedagogies actively shaped the IDG dimensions of Being and Relating. Ultimately, the authors argue that inner capacities should not be treated as a secondary layer to academic skills. They argued that cultivating them is an urgent need for the academic and higher education environment, which is increasingly characterized by loneliness and mental health challenges.

Collectively, this preliminary evidence indicates an encouraging direction that IDG-informed pedagogy offers a significantly impactful, multifaceted approach to sustainable education. These initial finidngs demonstrate that inner capacity developments shall not be treated as a supplementary layer, as the integration of cognitive, emotional, and relational dimensions of the IDGs fundamentally make changes in how students conceptualize and engage with sustainability practices. Ulitmately, HEIs can better equip a generation of sustainability leaders of resilience, connectedness, and sustained commitment.

4. Conclusions

As the 2030 deadline approaches, HEIs need to ensure deeper and more durable sustainability practices. While HEIs have implemented green campus initiatives and curriculum integration, empirical evidence indicates that these efforts mostly remain at the awareness and knowledge level. This paper points out that achieving sustained sustainability actions requires the cultivation of inner human capacities.

The inner development goals (IDG) framework offers a systematic and science-based approach to fill this critical gap. Early empirical studies show that integrating the IDGs into HEI settings is well-supported and practically implementable. It can bring meaningful shifts in students' inner skills and help them engage in sustainability practices more consistently. Since cultivating these inner capacities is a gradual process, HEIs should consider embedding IDG practices into their academic programs and student support structures now rather than later.

This approach also carries a direct implication for HEIs in Thailand and the ASEAN region. Several IDG dimensions naturally align with the regional values of mindfulness, collectivism, and community orientation. Grounded in the review of previous literature, this paper highlights that to bring outer change for the SDGs, HEIs need to shift their focus to empower the inner development of their students.

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A Qualitative Case Study of Student Absenteeism among Undergraduate Students at Fatoni University

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Abstract: Student absenteeism is a persistent challenge in higher education and has significant implications for academic engagement, learning outcomes, and institutional effectiveness. This study investigates patterns of absenteeism among undergraduate students at Fatoni University in Thailand and explores strategies to improve attendance through a collaborative action research approach. Drawing on Self-Determination Theory, Student Engagement Theory, and Self-Regulation Theory, the research examines the motivational, instructional, and contextual factors influencing students' decisions to attend or miss classes. The study employs qualitative methods including semi-structured interviews with students, interviews with lecturers, and reflective journals. The findings aim to provide a contextualized understanding of absenteeism and to co-develop practical strategies for improving student attendance and engagement. The study contributes to institutional policy development, student engagement practices, and the broader scholarship on attendance and learning in higher education.

Keywords: Student engagement theory, Self-regulation theory, Absenteeism

1. Introduction

Regular class attendance is widely recognized as a key factor in academic success in higher education. Attendance allows students to actively engage with course content, interact with peers and instructors, and participate in learning activities that support deeper understanding (Moores et al., 2019). Conversely, absenteeism has been linked to reduced academic performance, lower engagement levels, and increased likelihood of course failure or withdrawal (Gubbels et al., 2019)

Research consistently demonstrates that students who attend classes regularly tend to achieve better academic outcomes compared to those who frequently miss classes. Attendance not only facilitates knowledge acquisition but also strengthens students' sense of belonging and connection within the learning environment. In higher education settings, where learning is often collaborative and discussion-based, absenteeism can significantly disrupt both individual learning and collective classroom dynamics.

Despite its importance, absenteeism remains a widespread issue across universities worldwide. Many students struggle to maintain consistent attendance due to competing demands such as employment, family responsibilities, financial pressures, and mental health challenges. Furthermore, some students may perceive lectures as less valuable when course materials are available online or when teaching methods rely heavily on passive learning approaches (García & Weiss, 2018)

At Fatoni University, lecturers have reported recurring concerns regarding irregular attendance among undergraduate students. While institutional policies exist to monitor attendance, these measures often emphasize compliance rather than understanding the underlying reasons for students' absence. As a result, interventions may fail to address the complex factors influencing student attendance behaviour.

This study seeks to explore patterns of absenteeism among undergraduate students at Fatoni University and to collaboratively develop strategies for improving attendance and engagement. By adopting an action research approach, the study integrates theoretical insights with student experiences and reflective practice. The aim is not only to understand the problem but also to generate practical solutions that are responsive to the institutional context.

1.1. Problem Statement

Although class attendance is widely acknowledged as essential for effective learning, absenteeism remains a persistent issue among undergraduate students in Thailand. Lecturers frequently report that a significant number of students miss classes, arrive late, or attend inconsistently throughout the semester. There is research on patterns of school absenteeism among primary school students in Bangkok but there is no such study as far as higher education is concerned (Taweeseneepitch et al., 2018)

Absenteeism is often influenced by multiple interacting factors, including motivation, teaching practices, course relevance, personal circumstances, and students' ability to manage academic responsibilities (Demir & Karabeyoglu, 2015). Furthermore, students' voices are rarely included in discussions about attendance policies or strategies for improvement. Without student perspectives, efforts to address absenteeism may fail to consider the lived experiences and challenges that shape students' academic participation (Kahne et al., 2022)

Therefore, there is a need for context-sensitive research that examines absenteeism from the perspectives of both students and lecturers. A participatory research approach can help identify practical strategies that address the root causes of absenteeism rather than merely its symptoms.

1.2. Purpose of the Study

The purpose of this study is to explore and understand patterns of absenteeism among undergraduate students at Fatoni University and to collaboratively develop strategies that support improved student attendance and engagement.

1.3. Research Objectives

This study aims to:

1.Identify patterns of absenteeism among undergraduate students at Fatoni University.
2.Explore students' perceptions of factors contributing to absenteeism.
3.Examine the impact of absenteeism on students' academic engagement and motivation.
4.Collaboratively design and implement strategies to improve attendance.
5.Evaluate the effectiveness of the implemented strategies through reflective action research.

1.4. Research Questions

The study is guided by the following research questions:

1.What patterns of absenteeism are evident among undergraduate students at Fatoni University?
2.What factors do students perceive as contributing to their absenteeism?
3.How does absenteeism affect students' academic engagement and learning experiences?
4.What strategies can students and lecturers collaboratively develop to improve attendance?
5.How effective are these strategies in supporting improved attendance and engagement?

2. Literature Review

2.1. Absenteeism in Higher Education

Student absenteeism has been widely studied in educational research due to its strong relationship with academic performance. Studies indicate that attendance is one of the most consistent predictors of student achievement in higher education. A meta-analysis by Credé, Roch, and Kieszczynka (2010) found a strong correlation between class attendance and academic performance, highlighting attendance as a critical component of student success. (khan, 2022)

Lukkarinen, Koivukangas, and Seppälä (2016) investigated the effect of attendance on performance of students in an advanced methodological course in a Finnish university. They found that attendance was strongly positively related to performance.

Researchers increasingly emphasize that absenteeism should not be viewed solely as a disciplinary problem. Instead, it reflects a complex interaction of individual, institutional, and contextual factors influencing student behaviour. (Childs & Lofton, 2021)

Fatoni university is an institution based in rural Pattani and cater largely for the rural students of provinces in the deep south especially Yala, Pattani and Narathiwat. The factors, therefore, responsible for absenteeism range from social to cultural to economic.

2.2. Motivation and Student Attendance

Motivation plays a central role in shaping students' decisions to attend classes. According to Self-Determination Theory, students are more likely to engage in learning activities when they experience autonomy, competence, and relatedness in their educational environment (Deci & Ryan, 2000).

2.3. Student Engagement

Student engagement refers to the degree to which students actively participate in their learning processes. Fredricks, Blumenfeld, and Paris (2004) conceptualize engagement as comprising three dimensions: behavioural, emotional, and cognitive engagement.

Attendance represents a form of behavioural engagement, reflecting students' physical participation in learning activities. Emotional engagement involves students' interest and enthusiasm toward learning, while cognitive engagement relates to their willingness to invest effort in understanding complex ideas (King, 2020)

2.4. Self-Regulation and Attendance

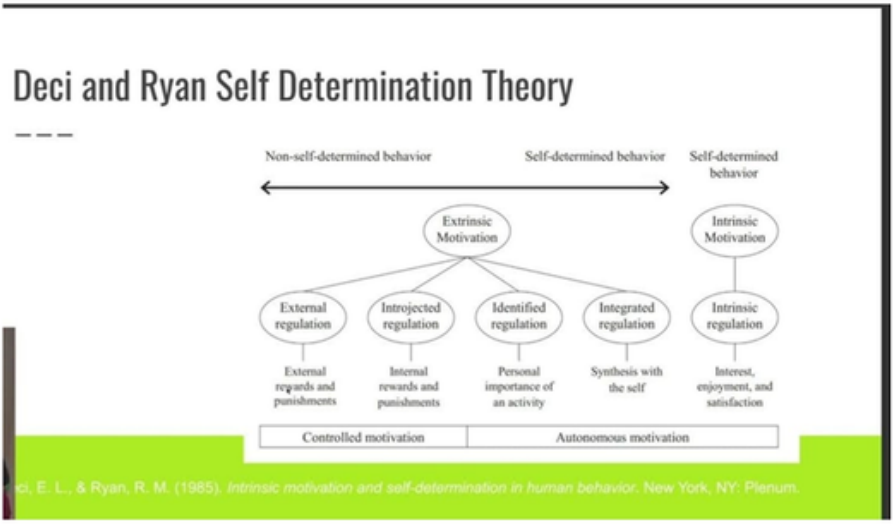
Self-regulation refers to students' ability to manage their learning behaviors, including time management, goal setting, and self-monitoring. According to Zimmerman (2002), self-regulated learners actively plan, monitor, and evaluate their learning processes.

In higher education contexts, students often face competing demands such as part-time work, family responsibilities, and social commitments. Students with strong self-regulation skills are better able to balance these responsibilities while maintaining consistent attendance. (Balkis et al., 2009)

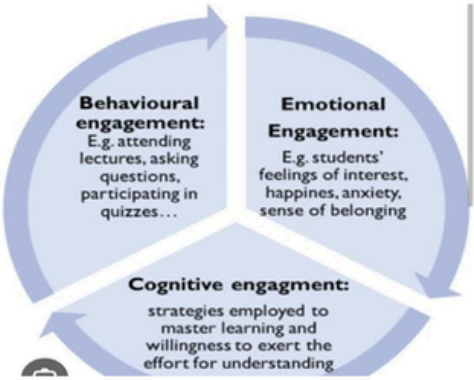
3. Theoretical and Conceptual Framework

This study was guided by an integrated theoretical framework combining three complementary perspectives:

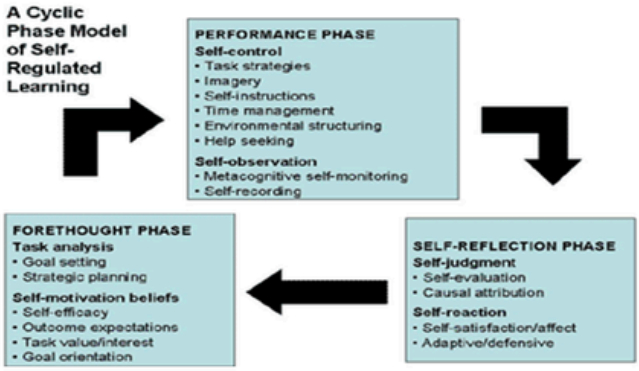
1.Self-determination theory explains how students' motivation influences their willingness to attend classes.



2. *Student engagement theory* conceptualizes attendance as a form of behavioral engagement that reflects students' participation in learning activities.



3. *Self-regulation theory* focuses on students' capacity to manage time, responsibilities, and learning behaviors.



Together, these theories suggest that absenteeism is not caused by a single factor but results from interactions among motivational, instructional, and personal influences. Within the context of Fatoni University, these factors operate within broader institutional and sociocultural environments that shape students' educational experiences.

4. Methodology

4.1. Research Design

This study adopts a qualitative case study research design to explore patterns of absenteeism among undergraduate students at Fatoni University. A case study approach is appropriate because it enables an in-depth, context-specific investigation of a complex phenomenon within its real-life setting.

The “case” in this study is defined as student absenteeism among undergraduate students at Fatoni University, examined through the perspectives of both students and lecturers. This design allows the researcher to gain a holistic understanding of the issue by exploring the interplay between personal, instructional, and contextual factors.

Unlike action research, which focuses on intervention and cyclical change, this case study emphasizes understanding, interpretation, and rich description of participants lived experiences.

4.2. Participants and Sampling

Participants were selected using purposive sampling to ensure they can provide relevant insights into absenteeism. The participants included:
·4 undergraduate students who reported frequent absenteeism
·2 lecturers who regularly taught undergraduate courses

4.3. Data Collection Methods

Multiple qualitative data sources were used to enhance the credibility and depth of the findings.

1.Semi-structured interviews (students). Interviews with students explored their experiences, motivations, and challenges related to attendance.
1.1.Explore students’ personal experiences, motivations, and challenges related to absenteeism
1.2.Provide insight into emotional, behavioural, and contextual factors
2.Semi-structured interviews (lecturers). Lecturers provided perspectives on classroom attendance patterns and potential instructional factors influencing absenteeism.
2.1.Examine lecturers’ perspectives on attendance patterns
2.2.Identify instructional and institutional influences
3.Classroom observations. The researcher noted observations regarding attendance patterns and classroom dynamics.
3.1.Document attendance patterns and classroom dynamics
3.2.Provide contextual understanding of student engagement

4.4. Data Analysis

Data was analysed using thematic analysis. This approach involves identifying recurring patterns and themes across interview transcripts, focus group discussions, and reflective journals. The analysis will follow several stages:
1.Data familiarization
2.Initial coding
3.Theme development
4.Theme review and refinement
5.Interpretation

5. Findings of the study

Teacher 1 observation

There are still a small number of students—approximately two to three individuals—who are frequently absent. This absenteeism may be attributed to several factors:

1.Some students may realize, after attending the class, that they are not interested in the subject. They may not wish to pursue a career related to the airline industry, which leads to a lack of engagement and motivation.
2.Most students enrolled in this course are in their fourth year, their final year of study. For many of them, this course is taken primarily to fulfil graduation requirements. As a result, some may aim only to pass the course rather than fully engage with the learning process.
3.As this course is practice-oriented and builds continuously on previous lessons, students who miss classes may struggle to follow subsequent content. This lack of understanding can lead to frustration, reduced confidence, and ultimately a growing dislike for the subject, which further contributes to their absenteeism.

Teacher 2 observation

1.Financial difficulties, including the inability to pay tuition fees and the need to work part-time to support their studies.
2.Decline in academic performance due to frequent absenteeism and missed learning opportunities.
3.Weak learning discipline and sense of responsibility, leading to poor study habits and low engagement in academic activities.

Student 1 observation

1.My mental and physical health
2.The unorganized teaching plans, the unskilled and narrow-minded lecturers and the subjects that hold no future value in terms of employment or job.

Student 2 observation

1.Physical: Illness, injuries, fatigue, discomforts, etc.
2.Emotional: Stress, anxiety, depression, emotional distress from bad situations, self-esteem, conflicts, lack or loss of interest.
3.Timing: Poor time management, clashing schedules (class vs. personal stuffs).

Student 3 observation

I think one common reason students miss class is just daily habits. Like some of my friends told me that they stay up late playing games or watching movies. Then the next morning they can't wake up or they wake up too late. When they keep doing that, it starts affecting their health, and after a while they get sick more often. So, they end up missing class a lot.

Student 4 observation

Maybe somewhere in my mind, I feel I can get away with it or the attendance is not that important. But I agree that the attendance does make a difference to the overall learning.

6. Significance of the Study

This study has several important contributions. First, it provides a context-specific understanding of absenteeism among undergraduate students at Fatoni University. Second, it contributes to the development of student-cantered strategies for improving attendance, informed by both theory and lived experience. Third, the study supports institutional policy development, offering insights into how universities can address attendance issues through engagement-focused approaches. Finally, the research contributes to scholarship on action research in higher education, demonstrating how collaborative inquiry can address practical educational challenges.

7. Discussion

Student absenteeism is a complex issue influenced by motivational, instructional, and personal factors. Addressing absenteeism requires more than administrative monitoring; it requires a deeper understanding of students' experiences and challenges. This study proposes a participatory approach to explore absenteeism among undergraduate students at Fatoni University. By integrating theoretical perspectives with student voices and collaborative reflection, the research seeks to develop practical strategies for improving attendance and engagement. Ultimately, the findings support the fact that the attendance plays an important role in shaping students' performances.

8. Acknowledgements

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The Development of Students' Communication and Collaborative Thinking Skills in Organizational Behavior and Human Resource Management Course through Debate-Based Learning

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Abstract: This study aimed to develop a debate-based learning management plan for the course Organizational Behavior and Human Resource Management and to examine its effects on students' communication and collaborative thinking skills, and learning satisfaction. The sample consisted of 48 second-year students in Modern Trade and Service Innovation, divided into 16 groups, enrolled in the second semester of the 2024 academic year. The research instruments included debate-based lesson plans and questionnaires assessing skills and satisfaction. Data were analyzed using mean and standard deviation. The results revealed that most students had moderate to good academic performance, with 80.50% achieving a grade of C or higher. Overall communication skills were rated at a high level (mean = 3.83), with listening skills showing the highest mean, followed by nonverbal communication and speaking skills. Collaborative thinking skills were also rated at a high level (mean = 4.19), with creativity and teamwork at the highest level, while critical thinking had the lowest mean. In addition, overall student satisfaction with debate-based learning was at the highest level (mean = 4.27), with the instructor dimension receiving the highest rating. In conclusion, debate-based learning effectively enhances students' communication and collaborative thinking skills while generating a high level of satisfaction. However, further improvement is needed in speaking and critical thinking skills, as well as in adapting activities to better suit learners' contexts.

Keywords: Debate-based learning; Communication skills; Collaborative thinking skills; Student satisfaction

1. Introduction

Thaksin University is committed to organizing an educational system that emphasizes the application of knowledge for the development and dissemination of benefits to society and the nation. This mission aligns with the university's vision of becoming "a leading social innovation university in Thailand by 2027." Accordingly, students are expected not only to acquire knowledge and understanding across disciplines but also to effectively transfer and apply such knowledge for the benefit of themselves, society, and the country. To achieve these goals, instructional approaches that promote holistic competencies—particularly in communication and systematic collaborative thinking—are essential, as they enhance students' ability to synthesize knowledge and apply it effectively. Such development requires the implementation of Active Learning, which is consistent with the university's educational philosophy that emphasizes learning outcomes leading to social innovation competencies and the cultivation of ethical and knowledgeable entrepreneurial graduates.

However, current classroom environments reveal that students still demonstrate limited ability in summarizing key ideas, presenting their work, and applying creativity in designing tasks and activities. This issue is particularly evident in the course Organizational Behavior and Human Resource Management (3(3-0-6)), which is delivered in a lecture-based format with large class sizes. These conditions pose challenges to achieving the course objectives and expected learning outcomes. Problem analysis indicates several student-related issues, including lack of concentration during lectures, reluctance to read and take notes, preference for working independently rather than collaboratively, limited participation in group work, lack of confidence in self-expression and presentation, and insufficient analytical, discussion, and communication skills. Environmental factors also contribute to these challenges, such as the predominantly theoretical nature of the course content, large class sizes, limited instructor supervision, and classroom layouts that are not conducive to group interaction. Consequently, students struggle to communicate and explain theoretical concepts, analyze and discuss organizational behavior and human resource management scenarios, and actively participate in collaborative activities. These limitations result in students' failure to achieve the expected learning outcomes of the course. Therefore, it is essential to create an engaging learning environment and adopt innovative teaching approaches that integrate knowledge, creativity, and enjoyment throughout the learning process.

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Consequently, students struggle to communicate and explain theoretical concepts, analyze and discuss organizational behavior and human resource management scenarios, and actively participate in collaborative activities. These limitations result in students' failure to achieve the expected learning outcomes of the course. Therefore, it is essential to create an engaging learning environment and adopt innovative teaching approaches that integrate knowledge, creativity, and enjoyment throughout the learning process.

In response to these challenges, this study explores the development of students' communication and collaborative thinking skills through innovative instructional approaches, such as edutainment-based learning programs. Contemporary education emphasizes learner-centered approaches, where students construct knowledge through cognitive and social processes and interaction, with instructors serving as facilitators. This approach is particularly relevant in higher education, where group work is commonly employed. Such practices are consistent with Cooperative Learning Theory (Srisuk, 2009) which focuses on collaborative group processes in which learners work together to explore shared interests. Through cooperative learning, students engage in analysis, synthesis, and knowledge exchange, aiming to produce meaningful content and high-quality outputs by utilizing collective abilities (Ounruan & Aytch, 2021).

One effective instructional technique aligned with this approach is debate-based learning. Debate serves as a teaching strategy that promotes freedom of expression and democratic participation in classroom activities. It encourages students to apply their knowledge and skills to specific topics, conduct research, and prepare information for presentation, thereby enhancing engagement in the learning process. Debate activities also foster systematic thinking, critical reasoning, and communication skills, including questioning, argumentation, evaluation, and the ability to consider diverse perspectives critically. As a result, students gain confidence, broaden their perspectives, and develop essential skills in knowledge, cognition, interpersonal relations, and responsibility. Previous studies have indicated that developing communication skills through debate must be aligned with real-life needs, as debate closely simulates authentic communication situations (Phopum et al., 2019). Similarly, Promkhet (2022) found that debate-based instruction promotes self-directed learning while enhancing both communication and collaborative thinking skills.

These competencies are essential for students to effectively apply academic knowledge in real-world professional contexts, thereby supporting their career advancement and contributing to the reputation of the Faculty of Economics and Business Administration and Thaksin University.

Based on this rationale, the present classroom research aims to investigate the development of students' communication skills in the course Organizational Behavior and Human Resource Management through debate-based learning. The study was conducted during the second semester of the 2024 academic year. The findings are expected not only to support students in achieving the intended learning outcomes of the course but also to enhance their communication skills, which are crucial for learning in other business-related subjects. Furthermore, the study contributes to strengthening institutional credibility and fostering confidence among stakeholders, thereby enhancing the university's image among employers and external organizations and creating greater career opportunities for students in the future.

1.1. Objectives

1.To develop a debate-based learning management plan for the course Organizational Behavior and Human Resource Management.
2.To evaluate students' communication skills and collaborative thinking skills after participating in debate-based learning activities in the course Organizational Behavior and Human Resource Management.
3.To examine students' satisfaction with the implementation of debate-based learning activities in the course Organizational Behavior and Human Resource Management.

1.2. Research Hypotheses

1.Students who participate in debate-based learning will demonstrate communication skills and collaborative thinking skills at a high level.
2.Students will report a high level of satisfaction with the debate-based learning approach in the course Organizational Behavior and Human Resource Management.

1.3. Scope of the Study

1.3.1. Content Scope

This study focuses on the development of students' communication skills and collaborative thinking skills in the course Organizational Behavior and Human Resource Management through debate-based learning. The variables used in this study including; Independent variable, namely; Debate-based learning in the course Organizational Behavior and Human Resource Management, and dependent variables, namely; Communication skills, collaborative thinking skills, and student satisfaction

1.3.2. Data Source Scope

The data were collected from 90 students enrolled in the course Organizational Behavior and Human Resource Management during the second semester of the 2024 academic year.

1.4. Research Framework

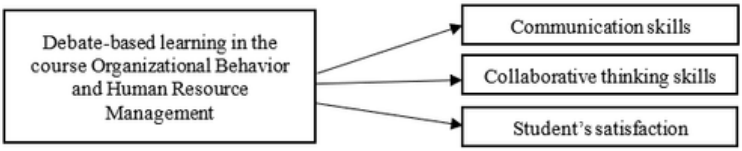

Figure 1: Research framework

2. Literature Review

2.1. Concepts of Debate

Instructional approaches that promote students' communication skills can take various forms. Communicative activities are generally classified into two types: (1) Functional Communication Activities, which focus on developing learners' ability to use language according to its communicative functions, and (2) Social Interaction Activities, which emphasize the use of language for interaction in social contexts. Examples of the latter include conversations, debates, discussions, simulations, and role-playing activities (Phopum et al., 2019).

Debate, therefore, serves both as a learning process and as a simulated communication platform that reflects real-life situations students may encounter. Scholars have defined and explained the concept and process of debate as follows:

According to University of Minnesota (2024), debate helps clarify differing positions on controversial issues. It is typically conducted in groups, often divided into two or more opposing sides, with prior research and preparation. Debate enhances learners' logical reasoning, understanding of issues, as well as their listening and speaking skills.

The Professional and Organizational Development Network of Thailand Higher Education (POD, 2024) defines debate-based learning as a teaching technique that encourages freedom of expression during participation. It motivates learners to conduct research and prepare information for presentation, promotes active participation in a learner-centered environment, and allows students to manage and regulate their own learning processes. Additionally, it fosters the exchange of ideas in public spaces and encourages students to present their viewpoints with logical reasoning, supported by evidence to persuade or inform others.

The debate procedure should be performed as following process (POD, 2024).

2.1.1. Preparation Phase

This stage requires the lecturer or the instructor to prepare debate topics or motions and provide learning materials and relevant resources to support students' research and preparation. It's also relevant to the preparation of the students that require to review key concepts before learning.

2.1.2. Learning Implementation

This second stage are divided into three process, preparation, learning activity, and evaluation. During the preparation stage, instructors design appropriate motions, assign roles, and provide learning resources, while students review content, form groups, and prepare for the activity. In the learning stage, students engage in structured argumentation, supported by evidence, while instructors facilitate and monitor the process. The final stage involves reflection, discussion, and evaluation, focusing on both learning outcomes and skill development.

2.1.3. Instructor Assessment

The course learning outcomes can be evaluated across multiple dimensions, such as participation in data collection and argumentation, analytical and synthesis skills, use of evidence-based reasoning, time management, and adherence to debate rules and etiquette. While, students engage in reflective learning (reflection) on key aspects such as content understanding, skills gained, and application of knowledge. Peer evaluation within groups and audience-based evaluation can also be incorporated

2.2. Cooperative Learning Theory

Cooperative Learning Theory emphasizes learner-centered instruction in which students work in small, heterogeneous groups to collaboratively construct knowledge through interaction, discussion, and shared responsibility. The instructor acts as a facilitator, providing guidance and resources to support learning. This approach promotes key processes such as analysis, synthesis, and knowledge exchange, leading to meaningful learning outcomes and high-quality group work (Srisuk, 2009).

Cooperative learning typically involves structured activities such as group investigation, peer teaching, and problem-solving tasks, which require active participation and interdependence among group members. Core elements include positive interdependence, face-to-face interaction, individual accountability, group processing, and collaborative skills.

Furthermore, cooperative learning supports the development of collaborative thinking skills, which include effective communication, teamwork, critical thinking, creativity, and collaborative problem-solving. These skills enhance students' ability to work effectively in teams, engage with diverse perspectives, and produce well-reasoned and innovative solutions, making them essential for learning in organizational behavior and human resource management contexts.

2.3. Communication Skills

Communication skills refer to the ability to effectively transmit and receive information, ideas, and attitudes through speaking, writing, nonverbal expression, and listening, in ways that are appropriate to different contexts and cultures (Ministry of Education, 2008). These skills are essential in the 21st century, particularly for enhancing interaction, learning, and professional performance in increasingly complex and technology-driven environments (Sukhothai Thammathirat Open University, 2009).

In this study, communication skills are conceptualized as a multidimensional construct comprising four key components: oral communication, written communication, nonverbal communication, and listening skills. These components enable students to clearly articulate ideas, engage in discussions, interpret information, and respond appropriately in collaborative settings (Kongpetdit et al., 2016).

Within the context of debate-based learning, communication skills are developed through structured argumentation, evidence-based presentation, and interactive exchanges among students. Therefore, communication skills serve as a primary dependent variable in this study, reflecting students' ability to effectively express, analyze, and communicate ideas during the learning process.

3. Methods

3.1. Population and Sample

The population consisted of 126 undergraduate students enrolled in the Organizational Behavior and Human Resource Management course (0706113), Sections S101 and S102, during the second semester of the 2024 academic year at Thaksin University. Using purposive sampling, 48 students were selected as debate representatives (three students per group from 16 groups).

3.2. Research Instruments

The study employed four main instruments: A debate-based learning plan designed according to POD Thailand (2024), integrated into the course syllabus. A communication skills assessment (15 items) covering oral, nonverbal, and listening skills. A collaborative thinking skills assessment (15 items) based on Cooperative Learning Theory, including effective communication, teamwork, critical thinking, creativity, and collaborative problem-solving. A student satisfaction questionnaire (17items) evaluating instructor performance, learning activities, and learning outcomes. All instruments used a five-point Likert scale. Content validity was confirmed by three experts using the IOC method, with an overall IOC value of 0.986, indicating high validity.

3.3. Data Collection

Data were collected through the implementation of debate-based learning activities, including theoretical instruction, task assignment, debate practice, and evaluation. Students participated in debates on four human resource management topics. After the activities, data were collected via online questionnaires administered one week later to ensure accurate reflection. All 48 participants completed the survey.

3.4. Data Analysis

Descriptive statistics were employed using SPSS, including frequency, percentage, mean, and standard deviation. These were used to analyze demographic data, communication skills, collaborative thinking skills, and student satisfaction. Content analysis was applied to open-ended responses to identify key themes for instructional improvement.

4. Results and Discussion

4.1. Results

This study aimed to develop a debate-based learning management plan for the course Organizational Behavior and Human Resource Management and to examine its effects on communication skills, collaborative thinking skills, and student satisfaction among second-year students in the Modern Trade and Service Innovation program during the second semester of the 2024 academic year. The sample consisted of 48 student representatives from 16 groups, with a 100% response rate. The results are presented in three main sections: (1) research findings, (2) discussion, and (3) recommendations.

4.1.1. Students' Background Information

Most students demonstrated moderate academic performance, with 80.50% achieving a GPA at grade C or higher. This indicates that the majority of participants had an average academic level, suitable for skill development through active learning approaches.

4.1.2. Communication Skills

Overall, communication skills were rated at a very good level (mean = 3.83). Listening skills showed the highest mean (mean = 4.05), followed by nonverbal communication (mean = 3.73) and oral communication (mean = 3.69). These results suggest that debate-based activities effectively enhanced attentive listening, respect for speakers, and critical interpretation of messages.

4.1.3. Collaborative Thinking Skills

Collaborative thinking skills were rated at a very good level overall (mean = 4.19). Creativity (mean = 4.35) and teamwork (mean = 4.29) were at an excellent level, indicating that debate activities promoted idea generation, acceptance of diverse perspectives, and rational decision-making. Other dimensions included collaborative problem-solving (mean = 4.17), effective communication (mean = 4.17), and critical thinking, which had the lowest mean (mean = 4.03). This may reflect the students' developmental stage, as second-year students are typically at foundational cognitive levels (remembering, understanding, and applying), while critical evaluation represents a higher-order skill.

4.1.4. Student Satisfaction

Overall satisfaction with the debate-based learning approach was at the highest level (mean = 4.27). The instructor dimension received the highest rating (mean = 4.48), highlighting the instructor's effectiveness as a facilitator in designing activities, encouraging participation, and creating a supportive learning environment. This was followed by learning activities (mean = 4.22), while perceived learning benefits had the lowest mean (mean = 4.12), though still at a high level. These findings indicate that students recognized the value of debate-based learning in enhancing communication and collaborative thinking skills.

4.1.5. Open-Ended Feedback

Students highlighted strengths in the instructor's teaching quality and the use of active learning activities. Suggestions for improvement included increasing debate time, incorporating more diverse activities, and improving instructional materials. In particular, the use of English in teaching slides was identified as a potential barrier for students with limited English proficiency.

4.2. Discussion

This study, titled "Developing Students' Communication and Collaborative Thinking Skills through Debate-Based Learning in Organizational Behavior and Human Resource Management", aimed to examine the effectiveness of debate as an instructional approach in enhancing communication skills, collaborative thinking skills, and student satisfaction. The discussion is organized into three key aspects aligned with the research objectives.

4.2.1. Development of Communication Skills through Debate-Based Learning

The findings indicate that debate-based learning effectively enhances students' communication skills at a high level. As a form of active learning, debate promotes essential 21st-century skills, particularly communication and collaboration. Notably, listening skills scored higher than speaking skills, suggesting that students demonstrated strong abilities in information processing and analytical listening within the debate context. This may be attributed to the nature of debate activities, which continuously engage students in critical listening. However, students showed some limitations in maintaining audience engagement during speaking, indicating a need for further structured practice to build confidence and presentation techniques, such as effective voice modulation. Overall, debate serves as an authentic learning approach that closely simulates real-life communication situations.

4.2.2. Development of Collaborative Thinking Skills through Debate-Based Learning

In terms of collaborative thinking, the overall results were at a high level, confirming that debate-based learning effectively promotes this skill. High scores in creativity and acceptance of diverse perspectives reflect a learning environment characterized by psychological safety, where students feel encouraged to express ideas and embrace differing viewpoints. These behaviors are essential components of effective teamwork and also contribute to improved communication skills. Furthermore, collaborative learning through debate enables students to actively engage in knowledge construction, task-sharing, and mutual support, thereby enhancing both academic performance and positive learning attitudes. Thus, debate not only fosters experiential learning but also strengthens collaborative thinking, which is crucial for critical thinking and effective teamwork.

4.2.3. Student Satisfaction with Debate-Based Learning

The high level of satisfaction, particularly regarding the instructor, highlights the important role of the teacher as a facilitator and designer of learning experiences rather than merely a knowledge transmitter. The use of engaging, student-centered activities encourages participation, reflection, and autonomous learning, leading to increased student satisfaction. However, some limitations were identified, particularly concerning time constraints and unequal participation within groups. These challenges reflect structural constraints in implementing debate activities within a limited timeframe, which may affect the depth of discussion and inclusivity. Therefore, further refinement of the instructional process is necessary to enhance the overall effectiveness of the activity.

5. Conclusion and Recommendation

5.1. Conclusion

This study demonstrates that the implementation of a debate-based learning management plan in the Organizational Behavior and Human Resource Management course effectively enhances students' communication skills, collaborative thinking skills, and overall learning satisfaction. The findings reveal that students achieved a high level of communication skills, particularly in listening, indicating that debate activities foster active engagement, attentiveness, and critical interpretation.

In addition, collaborative thinking skills were developed at a very good level, with notable strengths in creativity and teamwork. This suggests that debate-based learning creates a supportive and interactive environment that encourages idea exchange, respect for diverse perspectives, and shared problem-solving. Although critical thinking skills showed relatively lower scores, this aligns with the developmental stage of second-year students, who are still progressing toward higher-order cognitive abilities.

Furthermore, students reported the highest level of satisfaction with the learning approach, especially regarding the instructor's role as a facilitator. This highlights the importance of well-designed, student-centered activities in promoting engagement and meaningful learning experiences.

Overall, the study confirms that debate-based learning is an effective instructional strategy for fostering essential 21st-century skills. However, improvements in time management, activity design, and instructional materials should be considered to further enhance learning outcomes and ensure more inclusive participation.

5.2. Recommendation

5.2.1. Practical Implications

In implementing debate-based learning, instructors should refine the time structure by clearly separating preparation and discussion phases to enhance the depth of idea exchange. Additionally, clearly defined roles within groups should be established to promote shared responsibility and reduce unequal participation.

Supplementary activities should be developed to strengthen professional speaking skills, such as appropriate voice modulation, time management in presentations, and evidence-based argumentation. Continuous practice, combined with systematic assessment and feedback, should be emphasized to support ongoing improvement. Furthermore, nonverbal communication skills—such as posture, gestures, and personal presentation—should be enhanced to build confidence and professional credibility.

Debate-based learning should be integrated with other instructional approaches, such as case studies or educational games, to increase engagement and diversify learning activities. This integration can foster a more supportive and participatory learning environment aligned with active learning and student-centered education, where instructors act as facilitators or learning coaches.

The findings suggest that debate-based learning requires strong critical thinking skills. Therefore, student selection or readiness should consider their analytical and critical thinking abilities. This approach may be more suitable for higher-level students (e.g., third- or fourth-year students) who possess more advanced cognitive and experiential foundations.

5.2.2. Recommendations for Future Research

Future studies should employ a pretest–posttest design to more clearly measure learning development. Given that students still demonstrated limitations in presentation skills, further research should investigate the underlying causes of presentation anxiety and the factors influencing skill development. Longitudinal experimental designs across a semester are also recommended to track continuous improvement, as presentation skills require sustained practice.

Future research should expand the sample to include entire classes for more comprehensive insights. Additionally, applying debate-based learning to higher-level students may better align with the advanced critical thinking skills required and enhance the effectiveness of the instructional approach.

6. Acknowledgements

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GROUP 2
PROSPERITY

Digital Transparency, Consumer Trust, and Sustainable Consumption: A Conceptual Framework for ASEAN Economies

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Abstract: In the digital economy, green marketing has evolved from symbolic environmental communication into a data-driven and transparency-oriented mechanism capable of shaping sustainable consumer behaviour. This conceptual paper examines the role of green digital marketing in influencing sustainable consumption behaviour in ASEAN economies, with particular emphasis on the mediating role of consumer trust and the moderating effect of eco-label counterfeiting in digitally heterogeneous markets. As consumers increasingly rely on social media, mobile platforms, and algorithmic recommendations for purchasing decisions, skepticism toward environmental claims have increased, especially in emerging Southeast Asian contexts characterized by uneven regulatory enforcement and varying levels of digital literacy. Grounded in the theory of planned behaviour and trust-based consumer behaviour models, this study develops an integrative conceptual framework that positions green digital marketing as an interactive system combining persuasive communication with digital transparency mechanisms, such as QR-code traceability, blockchain-based authentication, and real-time supply chain disclosure. The framework explains how these technologies could reduce the negative effects of fake eco-labels, strengthen perceived behavioural control, enhance consumer trust, and ultimately increase sustainable purchase intentions. By synthesizing insights from digital marketing, sustainability governance, and behavioural science, this paper advances green marketing theory by reconceptualizing digital marketing not only as a promotional instrument but as a trust-building and transparency-enabling mechanism. The proposed framework provides strategic implications for firms, digital platforms, and policymakers seeking to promote Responsible Consumption and Production (SDG 12) and sustainable development across ASEAN economies.

Keywords: Digital marketing, Trust, Eco-label counterfeiting

1. Introduction

Sustainable consumption has become an important priority within global development agendas, particularly under the United Nations Sustainable Development Goals. Sustainable Development Goal 12 focuses on responsible consumption and production and emphasizes the need to encourage consumers to adopt environmentally responsible purchasing behaviors. In response to growing environmental concerns such as climate change, resource depletion, and waste generation, businesses increasingly employ green marketing strategies to communicate the environmental benefits of products and services and encourage sustainable consumption patterns (Kadam, 2024). The rapid development of digital technologies has significantly transformed the way firms communicate with consumers. Digital platforms such as social media, e commerce marketplaces, and mobile applications enable organizations to disseminate environmental information more efficiently and interactively than traditional marketing channels. As a result, green marketing practices have evolved into what is increasingly referred to as green digital marketing. This approach integrates sustainability communication with digital tools that allow firms to deliver personalized environmental messages, engage consumers through interactive content, and provide detailed information about sustainable products (Kumar et al., 2025).

Digital marketing channels also enable consumers to access sustainability related information quickly, compare product attributes, and evaluate environmental claims prior to making purchasing decisions. Despite these developments, consumer skepticism toward environmental claims have grown significantly in recent years. Many companies have been criticized for engaging in greenwashing, a practice in which firms exaggerate or falsely communicate the environmental benefits of their products. Such practices undermine the credibility of green marketing and reduce consumer confidence in sustainability claims. One of the most visible manifestations of this problem is the increasing presence of counterfeit eco labels and misleading environmental certifications in the marketplace. These counterfeit labels create confusion for consumers and weaken the credibility of legitimate sustainability certification schemes (Xia, 2026).

The issue of credibility is particularly relevant in the context of ASEAN economies. Southeast Asia has experienced rapid growth in digital connectivity, online commerce, and social media use. This expansion of the digital ecosystem has created new opportunities for firms to promote environmentally friendly products and communicate sustainability initiatives. However, the region is characterized by diverse regulatory frameworks, varying levels of institutional enforcement, and uneven levels of digital literacy among consumers. These differences can increase the risk of misinformation and make it more difficult for consumers to evaluate the authenticity of environmental claims (Maduwinarti et al., 2025). Within this context, consumer trust plays a critical role in shaping responses to green marketing communication.

Consumers often lack the technical knowledge required to verify the environmental attributes of products independently. Consequently, they rely on signals such as eco labels, certifications, and brand reputation when making purchasing decisions. When environmental claims are perceived as credible and trustworthy, consumers are more likely to develop positive attitudes toward sustainable products and demonstrate stronger purchase intentions (Hong et al., 2024).

Recent technological developments have introduced new opportunities to enhance transparency in sustainability communication. Technologies such as QR code based traceability systems, blockchain authentication, and digital supply chain disclosure allow firms to provide verifiable information regarding the origin, production processes, and environmental performance of products. These technologies can reduce information asymmetry between producers and consumers while strengthening trust in sustainability claims (Luo et al., 2026). As a result, green digital marketing is increasingly evolving from a purely promotional approach into a transparency oriented system that combines persuasive communication with verifiable sustainability information. Although the literature on green marketing and sustainable consumption has grown substantially, relatively limited research has examined the interaction between digital marketing technologies, consumer trust, and eco label credibility in emerging markets such as ASEAN. In particular, the role of eco label counterfeiting in shaping consumer responses to green digital marketing remains insufficiently explored. Understanding this relationship is important because the presence of counterfeit labels may weaken the effectiveness of sustainability communication and reduce consumer trust in environmentally responsible products.

To address this gap, the present conceptual study proposes an integrative framework that examines the relationship between green digital marketing and sustainable consumer behaviour in ASEAN economies. The framework highlights the mediating role of consumer trust and the moderating influence of eco label counterfeiting. By integrating perspectives from digital marketing, sustainability governance, and behavioral science, the study conceptualizes green digital marketing as a mechanism that not only promotes sustainable products but also facilitates transparency and trust in sustainability communication. The study contributes to the literature in several ways. First, it extends existing green marketing research by incorporating digital transparency technologies into the analysis of sustainable consumption behaviour. Second, it emphasizes the importance of consumer trust as a key mechanism linking digital sustainability communication to consumer decision making. Third, it provides contextual insights into ASEAN markets, where rapid digital transformation intersects with ongoing challenges related to sustainability governance and regulatory enforcement. Overall, the conceptual framework proposed in this study offers valuable insights for businesses, policymakers, and digital platforms seeking to enhance the credibility of sustainability communication and promote responsible consumption practices in the rapidly evolving digital economy.

2. Literature Review

The literature on sustainable consumption and environmental marketing has expanded significantly in recent years, particularly as digital technologies transform how firms communicate sustainability information to consumers. This section reviews the key scholarly discussions surrounding green digital marketing, sustainable consumer behavior, consumer trust in environmental communication, and the growing challenge of eco label counterfeiting. By synthesizing these strands of literature, the section establishes the theoretical foundation for the proposed conceptual framework.

2.1. Green Digital Marketing

Green marketing has traditionally been defined as the process of promoting products and services based on their environmental attributes, including reduced environmental impact, sustainable production methods, and eco-friendly packaging. Over the past decade, however, the rapid development of digital technologies has fundamentally transformed the way environmental information is communicated. As firms increasingly rely on online platforms, social media channels, and e commerce systems to reach consumers, the concept of green marketing has evolved into what scholars describe as green digital marketing. In addition, green digital marketing refers to the integration of environmental marketing strategies with digital communication technologies that allow firms to promote sustainability initiatives through interactive and data driven platforms. Digital tools such as social media advertising, influencer marketing, mobile applications, and online marketplaces provide new opportunities for firms to communicate environmental information more transparently and efficiently. Kumar et al. (2025) argue that digital technologies enable firms to combine sustainability messaging with real time data and personalized marketing strategies, thereby enhancing consumer engagement with environmentally responsible products.

Recent research highlights the increasing role of digital marketing channels in shaping sustainable consumption decisions. Social media platforms in particular have become powerful tools for disseminating sustainability related information, influencing consumer attitudes, and promoting green purchasing behavior. Studies indicate that digital marketing content emphasizing environmental responsibility, corporate sustainability initiatives, and eco-friendly product attributes can positively influence consumer perceptions and purchase intentions (Tiwari et al., 2025). In addition, digital marketing allows firms to communicate detailed product information, including sustainability certifications and supply chain transparency, which can enhance consumer confidence in environmental claims. In the context of emerging economies, digital marketing plays an especially important role because online platforms often serve as the primary source of product information for consumers.

In Southeast Asia, the rapid growth of digital commerce and mobile internet use has created an environment where consumers increasingly rely on digital channels when evaluating sustainability claims (Maduwinarti et al., 2025). Consequently, green digital marketing has become a critical mechanism for promoting environmentally responsible consumption in the region.

2.2. Sustainable Consumer Behaviour

Sustainable consumer behavior refers to consumption patterns that consider the environmental and social impacts of purchasing decisions. These behaviors include the preference for environmentally friendly products, reduced consumption of resource intensive goods, and the adoption of sustainable lifestyles. Scholars generally agree that sustainable consumption is influenced by a combination of psychological, social, and informational factors. Environmental awareness and ecological concern are frequently identified as key drivers of sustainable consumer behavior. Individuals who possess strong environmental values are more likely to consider the environmental consequences of their consumption decisions and actively seek eco-friendly alternatives. However, awareness alone is often insufficient to translate into actual purchasing behavior. Research has shown that consumers frequently experience an attitude behavior gap, in which positive environmental attitudes do not necessarily result in sustainable purchasing decisions (Ali et al., 2023).

Information availability and credibility therefore play a critical role in bridging this gap. Consumers often rely on environmental signals such as eco labels, certifications, and sustainability claims when evaluating products. These signals simplify complex environmental information and allow consumers to make more informed purchasing decisions. Empirical studies have demonstrated that eco labels can significantly influence consumer purchase intentions when they are perceived as credible indicators of environmental performance (Nguyen Viet, 2022). However, recent research in Asian markets further indicates that digital marketing and online sustainability communication can influence sustainable consumption by shaping consumer perceptions and environmental attitudes. For example, Vironika and Maulida (2025) found that green marketing communication combined with consumer environmental knowledge significantly increases green purchase behavior. These findings suggest that sustainability communication strategies must not only raise awareness but also provide credible and accessible environmental information.

2.3. Consumer Trust in Green Marketing

Consumer trust represents one of the most critical determinants of sustainable consumption behaviour. Because environmental attributes such as carbon emissions, ecological impact, and resource efficiency are often difficult for consumers to verify independently, purchasing decisions frequently depend on the credibility of information provided by firms. In this context, trust functions as a mechanism that reduces uncertainty and facilitates decision making. In addition, scholars widely recognize that trust plays a mediating role between green marketing communication and consumer purchase intentions. When consumers perceive environmental claims as credible and reliable, they are more likely to develop positive attitudes toward environmentally friendly products and demonstrate stronger intentions to purchase them. Conversely, skepticism toward environmental claims can weaken the effectiveness of green marketing initiatives.

Eco labels and environmental certifications are commonly used as trust signals in green marketing. These labels provide standardized information regarding the environmental performance of products and help consumers identify sustainable alternatives in the marketplace. Research indicates that credible eco labeling systems can significantly enhance consumer trust and strengthen the relationship between environmental marketing and purchasing behaviour (Mume & Sun, 2026). Moreover, in digital environments, trust becomes even more critical because consumers are exposed to large volumes of information from diverse sources. Online product reviews, social media discussions, and digital advertisements can influence consumer perceptions of sustainability claims. Consequently, firms must adopt transparent communication strategies that provide verifiable sustainability information. Digital technologies such as blockchain based traceability systems and QR code authentication are increasingly being explored as tools for strengthening consumer trust by enabling consumers to verify the authenticity of environmental claims.

2.4. Eco Label Counterfeiting and Greenwashing

Despite the growing use of eco labels in sustainability communication, the credibility of environmental claims remains a major challenge. Greenwashing refers to the practice in which firms misrepresent or exaggerate the environmental benefits of their products in order to appeal to environmentally conscious consumers. This practice undermines the effectiveness of green marketing and contributes to increasing consumer skepticism toward sustainability claims. In addition, one of the most problematic forms of greenwashing is the proliferation of counterfeit eco labels. These labels imitate legitimate environmental certifications but lack official verification or regulatory oversight. As a result, consumers may find it difficult to distinguish authentic sustainability labels from fraudulent ones. When consumers encounter misleading eco labels, their trust in environmental marketing may decline significantly.

Research in emerging markets indicates that the risk of eco label counterfeiting is particularly high in contexts where regulatory frameworks are still developing. In Southeast Asia, rapid digitalization and the expansion of online marketplaces have increased the visibility of eco labeled products, but they have also created opportunities for misleading sustainability claims to circulate online (Uikey et al., 2025). Without effective verification mechanisms, counterfeit labels may weaken consumer trust and reduce the effectiveness of sustainability communication. Furthermore, recent studies emphasize the importance of technological solutions in addressing this challenge. Digital authentication systems, blockchain traceability platforms, and QR code verification tools allow consumers to access detailed information about product origins and certification status. These technologies can reduce information asymmetry and help restore trust in eco labeling systems by enabling consumers to verify environmental claims independently.

2.5. Summary of Key Studies

Author(s)	Year	Context	Methodology	Key Variables	Key Findings
Ali et al.	2023	Developing economies	Quantitative survey	Green consumption behavior, purchase intention	Environmental awareness and perceived benefits significantly influence green purchase intentions among millennials.
Chen & Chang	2021	Taiwan	Structural equation modelling	Green perceived value, green trust, perceived risk	Green trust mediates the relationship between perceived environmental value and green purchase intention.
Delmas & Burbano	2021	Global corporate sector	Conceptual analysis	Greenwashing, corporate environmental claims	Firms engage in greenwashing due to institutional pressure and market incentives, which can undermine consumer trust.
Goh et al.	2023	Online retail markets	Quantitative study	Social media marketing, sustainability attitudes	Social media marketing significantly influences sustainable consumption behavior through consumer engagement.
Hong et al.	2024	China	Empirical survey	Sustainable consumption practices	Environmental awareness and social influence shape sustainable purchasing

					behavior among young consumers.
Kumar et al.	2025	Global digital markets	Conceptual and empirical analysis	Digital marketing transformation, green marketing	Digital technologies enhance sustainability communication and improve the effectiveness of green marketing strategies.
Luo et al.	2024	Global markets	Empirical study	Digital eco-labels, sustainability communication	Digital eco-labels increase transparency and strengthen consumer trust in sustainable products.
Maduwinarti et al.	2025	Southeast Asia	Bibliometric analysis	Green marketing, social media	Social media platforms play a critical role in promoting sustainable consumption behavior in ASEAN markets.
Mume & Sun	2024	Online commerce environments	Structural equation modelling	Green digital marketing, digital literacy	Green digital marketing positively influences sustainable consumption behavior through consumer trust.
Nguyen-Viet	2022	Vietnam	Survey-based research	Eco-labels, green advertising	Eco-label credibility significantly increases green purchase intention.
Rahman et al.	2022	Hospitality industry	Structural equation modelling	Greenwashing, consumer perception	Greenwashing reduces consumer trust and negatively affects sustainable purchase behavior.
Sharma	2023	Global consumer markets	Conceptual analysis	Eco-label credibility, consumer perception	Fake eco-labels weaken consumer confidence in environmental certifications.
Tiwari et al.	2025	Digital advertising environment	Quantitative survey	Social media advertising, sustainability perception	Social media advertising increases consumer awareness and sustainable purchase intention.
Uikey et al.	2025	Asian markets	Literature review	Green marketing strategies	Green marketing strategies significantly influence sustainable consumer behavior in emerging economies.
Wu et al.	2021	Global food systems	Literature review	Sustainability labels, consumer trust	Consumer trust in sustainability labels is essential for promoting sustainable consumption.
Zhang et al.	2022	China	Quantitative research	Digital technologies, sustainability transparency	Digital technologies improve information transparency and increase consumer trust in sustainability claims.
Chen et al.	2021	Emerging economies	Empirical research	Green consumer behavior	Environmental awareness and product knowledge

					influence sustainable purchasing behavior.
Yadav & Pathak	2022	India	Survey research	Environmental concern, green purchase behavior	Environmental concern and social influence significantly affect green purchasing decisions among young consumers.
Joshi & Rahman	2022	Global consumers	Literature review	Green purchase behavior	Consumer attitudes, environmental awareness, and perceived value influence green purchasing behavior.
Peattie & Peattie	2021	Global sustainability marketing	Conceptual analysis	Social marketing, sustainability transitions	Marketing strategies can influence consumer behavior toward sustainable lifestyles.
Papadas et al.	2022	European firms	Empirical analysis	Green marketing orientation	Firms with strong green marketing orientation demonstrate higher sustainability performance.
Dangelico & Vocalelli	2021	Global markets	Literature review	Green marketing strategies	Green marketing tools play a crucial role in promoting environmentally responsible consumption.
Li et al.	2023	Digital marketplace	Quantitative research	Digital transparency, consumer trust	Digital transparency mechanisms increase consumer trust in sustainability claims.
Han et al.	2022	Hospitality sector	Empirical research	Environmental responsibility, consumer behavior	Environmental responsibility initiatives positively influence consumer attitudes and behavior.

2.6. Research Gap and Comparative Analysis of Previous Studies

The existing literature provides substantial insights into green marketing, sustainable consumer behavior, and eco-label credibility. However, the comparative review of previous studies reveals several important research limitations. Prior research has primarily focused on understanding the determinants of green purchasing behavior through variables such as environmental awareness, perceived value, and eco-label credibility. For instance, Ali et al. (2023) and Yadav and Pathak (2022) emphasize the role of environmental concern and awareness in influencing green purchasing intentions, while Chen and Chang (2021) highlight the mediating role of green trust between perceived environmental value and consumer purchase intentions. Several studies have also examined the influence of eco-labels and sustainability certifications on consumer trust and purchasing decisions. Testa et al. (2021) and Nguyen-Viet (2022) demonstrate that credible eco-labels significantly increase consumer confidence and green purchase intentions. Similarly, Wu et al. (2021) emphasize that consumer trust in sustainability labels is essential for encouraging sustainable consumption.

However, emerging research has identified increasing concerns related to greenwashing and misleading environmental claims. Delmas and Burbano (2021) and Rahman et al. (2022) argue that greenwashing practices can significantly undermine consumer trust and weaken the effectiveness of sustainability marketing strategies.

More recent studies have started to explore the role of digital technologies in sustainability communication. For example, Zhang et al. (2022) and Li et al. (2023) suggest that digital transparency technologies improve consumer confidence by providing verifiable sustainability information. Likewise, Luo et al. (2024) highlight the potential of digital eco-labels to enhance transparency and strengthen consumer trust in environmentally responsible products. Research focusing on digital marketing channels also indicates that social media marketing and digital advertising can positively influence sustainable consumption behavior (Goh et al., 2023; Tiwari et al., 2025). Despite these contributions, several important gaps remain in the literature. First, while many studies examine green marketing or digital marketing separately, relatively few studies have integrated the concept of green digital marketing as a comprehensive framework that combines sustainability communication with digital transparency technologies. Second, although consumer trust has been widely recognized as an important determinant of green purchasing behavior, limited research has examined its mediating role within digital marketing environments. Third, while greenwashing has been discussed extensively, the specific issue of eco-label counterfeiting as a moderating factor influencing consumer trust has received limited empirical and conceptual attention.

Another limitation in the existing literature relates to the geographical focus of prior research. Many studies have been conducted in developed markets such as Europe, Taiwan, or global contexts (Testa et al., 2021; Chen & Chang, 2021), while fewer studies focus specifically on ASEAN economies, where digital transformation and sustainability governance challenges coexist. As highlighted by Maduwinarti et al. (2025), Southeast Asia represents a rapidly expanding digital marketplace where consumers increasingly rely on online platforms for purchasing decisions. However, institutional differences, regulatory inconsistencies, and varying levels of digital literacy may affect how consumers interpret sustainability information in these markets. Furthermore, existing studies tend to examine either consumer behavior factors or marketing communication strategies independently. Few studies adopt an integrated perspective that simultaneously considers digital marketing strategies, trust mechanisms, and institutional challenges such as eco-label counterfeiting. Consequently, there remains a need for a comprehensive conceptual framework that explains how digital sustainability communication influences consumer behavior while accounting for trust-building mechanisms and credibility challenges.

To address these gaps, the present study proposes a conceptual framework that examines the relationship between green digital marketing and sustainable consumer behavior in ASEAN economies. The framework highlights the mediating role of consumer trust and the moderating influence of eco-label counterfeiting. By integrating insights from digital marketing, sustainability governance, and behavioral theory, this study contributes to the literature by conceptualizing green digital marketing as a trust-building and transparency-enabling mechanism capable of promoting responsible consumption and supporting Sustainable Development Goal 12.

3. Theoretical Framework

Understanding sustainable consumer behavior requires a strong theoretical foundation that explains how individuals process information, form attitudes, and make purchasing decisions related to environmentally responsible products. This study draws primarily on the Theory of Planned Behavior and trust based consumer behavior perspectives to explain how green digital marketing may influence sustainable consumption in ASEAN markets. These theoretical perspectives provide a useful framework for understanding the mechanisms through which digital sustainability communication can shape consumer attitudes, trust, and behavioral intentions.

3.1. Theory of Planned Behaviour

The theory of planned behavior, originally developed by Ajzen (1991), is one of the most widely applied theoretical frameworks for explaining consumer decision making and behavioral intentions. According to this theory, an individual's behavioral intention is influenced by three key determinants: attitude toward the behavior, subjective norms, and perceived behavioral control. These components collectively influence whether an individual intends to perform a particular behavior. Attitude toward behavior refers to the degree to which a person evaluates a behavior positively or negatively. In the context of sustainable consumption, consumer attitudes toward environmentally friendly products are shaped by perceptions of environmental benefits, product quality, and personal values related to sustainability. Research has consistently shown that positive environmental attitudes are associated with stronger intentions to purchase green products (Ali et al., 2023).

Subjective norms refer to the perceived social pressure to engage in or avoid a particular behavior. In many cases, social influences such as peer opinions, social media discussions, and cultural expectations play an important role in shaping sustainable consumption behavior. In digital environments, social media platforms can amplify subjective norms by exposing consumers to sustainability related discussions, influencer endorsements, and environmental advocacy campaigns (Tiwari et al., 2025). Perceived behavioral control refers to an individual's perception of their ability to perform a particular behavior. When consumers believe that they have sufficient information, resources, and opportunities to purchase environmentally responsible products, they are more likely to engage in sustainable consumption. Digital technologies can enhance perceived behavioral control by providing accessible product information, sustainability certifications, and price comparisons that help consumers make informed purchasing decisions.

The theory of planned behavior has been widely applied in studies examining green purchasing behavior and sustainable consumption. Scholars have used the framework to explain how environmental attitudes, social influence, and information availability influence consumer intentions to purchase eco-friendly products (Zahro et al., 2025). Within the context of green digital marketing, digital communication strategies can influence all three components of the theory by shaping environmental attitudes, strengthening social influence through online communities, and providing transparent product information that enhances perceived behavioral control.

3.2. Trust Based Consumer Behaviour Perspective

While the theory of planned behavior explains how attitudes and social factors shape behavioral intentions, trust based consumer behavior models highlight the importance of credibility and reliability in consumer decision making. In markets where product attributes are difficult to verify directly, trust functions as a key mechanism that reduces uncertainty and facilitates purchasing decisions. Environmental product attributes often fall into the category of credence attributes, meaning that consumers cannot easily evaluate their environmental performance even after purchase. For example, claims regarding carbon neutrality, sustainable sourcing, or environmentally responsible manufacturing processes cannot be easily verified by consumers without access to reliable information. Consequently, consumers rely on external signals such as eco labels, certifications, and corporate reputation when evaluating green products (Nguyen Viet, 2022).

Consumer trust is therefore essential for the success of green marketing initiatives. When environmental claims are perceived as credible, consumers are more likely to accept sustainability information and develop positive attitudes toward environmentally friendly products. Conversely, when consumers perceive environmental claims as misleading or exaggerated, skepticism may emerge, reducing the effectiveness of green marketing communication. In digital environments, the role of trust becomes even more significant because consumers are exposed to a large volume of information from diverse online sources. Digital platforms allow firms to disseminate sustainability information quickly, but they also increase the risk of misinformation and greenwashing. As a result, establishing trust through transparent communication and credible verification mechanisms is critical for influencing sustainable purchasing behavior.

Recent research emphasizes that digital transparency mechanisms such as QR code traceability, blockchain authentication, and supply chain disclosure can enhance consumer trust by allowing individuals to verify sustainability claims independently (Mume & Sun, 2026). These technologies reduce information asymmetry between producers and consumers and strengthen the credibility of environmental marketing communication.

3.3. Integrating Behavioural and Trust Perspectives in Green Digital Marketing

Incorporating the theory of planned behavior with trust based consumer behavior perspectives provides a comprehensive explanation of how green digital marketing may influence sustainable consumption behavior. Digital marketing strategies can shape consumer attitudes toward environmentally friendly products by emphasizing sustainability benefits and corporate environmental responsibility. At the same time, social media communication and online communities can strengthen subjective norms by promoting environmental awareness and sustainable lifestyle practices. Digital transparency mechanisms can further enhance perceived behavioral control by providing consumers with accessible and verifiable sustainability information. For example, QR code systems allow consumers to access detailed information about product origins, production methods, and environmental certifications through mobile devices. This information empowers consumers to evaluate sustainability claims more confidently and make informed purchasing decisions.

Moreover, consumer trust plays a mediating role within this process. When green digital marketing strategies successfully communicate credible and transparent sustainability information, consumer trust increases. Higher levels of trust subsequently strengthen the relationship between sustainability communication and consumer purchase intentions. However, the effectiveness of this relationship may be weakened by the presence of eco label counterfeiting and misleading environmental claims.

When consumers encounter counterfeit eco labels or unreliable sustainability information, their trust in environmental marketing may decline, reducing the influence of green digital marketing on sustainable consumption behavior. By integrating behavioral and trust based theoretical perspectives, the present study proposes that green digital marketing can influence sustainable consumer behavior through the mediating role of consumer trust, while eco label counterfeiting may moderate this relationship. This theoretical integration provides the foundation for the conceptual framework and hypotheses developed in the following section.

4. Conceptual Framework and Hypothesis Development

Building on the theoretical foundations discussed in the previous section, this study develops a conceptual framework that explains how green digital marketing influences sustainable consumer behavior in ASEAN economies. The framework integrates insights from green marketing literature, behavioral theories, and trust based consumer behavior perspectives. Specifically, the model proposes that green digital marketing influences sustainable consumer behavior through the mediating role of consumer trust, while the presence of eco label counterfeiting moderates the relationship between green digital marketing and consumer trust. The proposed framework reflects the increasing role of digital technologies in sustainability communication. In digital environments, consumers are frequently exposed to environmental information through social media platforms, online marketplaces, and mobile applications. While these platforms allow firms to communicate sustainability initiatives more effectively, they also introduce challenges related to information credibility and trust. Consequently, understanding the mechanisms through which digital sustainability communication influences consumer decision making is essential.

4.1. Green Digital Marketing and Consumer Trust

Green digital marketing refers to the use of digital technologies and online communication platforms to promote environmentally responsible products and corporate sustainability initiatives. Through digital channels such as social media marketing, online advertising, and interactive content, firms can communicate environmental attributes, sustainability certifications, and responsible production practices to consumers. One of the most significant advantages of digital marketing is the ability to provide detailed and transparent information about product sustainability. For example, companies can use QR codes, blockchain based traceability systems, and digital supply chain disclosures to enable consumers to verify environmental claims and access information about product origins and production processes. These transparency mechanisms help reduce information asymmetry between producers and consumers, thereby strengthening the credibility of sustainability communication (Kumar et al., 2025).

Previous research indicates that transparent and credible environmental communication can enhance consumer trust in green marketing initiatives. When consumers perceive sustainability claims as authentic and verifiable, they are more likely to develop trust in environmentally responsible brands (Mume & Sun, 2026). Digital platforms also facilitate two-way communication between firms and consumers, allowing organizations to respond to consumer concerns, clarify sustainability claims, and reinforce brand credibility. In contrast, when environmental claims are vague or unsupported by evidence, consumers may develop skepticism toward green marketing communication. Therefore, digital transparency mechanisms and credible sustainability messaging are essential for building trust in environmentally responsible products. Hence, the following hypothesis is proposed:

H1: Green digital marketing positively influences consumer trust in environmentally friendly products.

4.2. Consumer Trust and Sustainable Consumer Behaviour

Consumer trust plays a critical role in shaping purchasing decisions related to environmentally responsible products. Because many environmental attributes cannot be easily verified by consumers, trust becomes a key factor that influences whether consumers accept sustainability claims and act upon them. Trust reduces uncertainty and perceived risk in purchasing decisions. When consumers trust that a product genuinely meets environmental standards, they are more likely to develop favorable attitudes toward the product and demonstrate stronger purchase intentions. Empirical studies have consistently shown that consumer trust significantly influences green purchasing behavior and sustainable consumption decisions (Vironika & Maulida, 2025).

In digital marketplaces, the importance of trust becomes even more pronounced. Online shopping environments often involve limited physical interaction with products, meaning that consumers must rely heavily on digital information and brand credibility when evaluating sustainability claims. Consequently, trust in environmental communication becomes a crucial factor that determines whether consumers are willing to purchase eco-friendly products. When trust is established through credible eco labels, transparent sustainability communication, and reliable product information, consumers are more likely to adopt sustainable consumption behaviors. Therefore, the following hypothesis is proposed:

H2: Consumer trust positively influences sustainable consumer behavior.

4.3. Mediating Role of Consumer Trust

In the context of green digital marketing, consumer trust functions as an important psychological mechanism that links sustainability communication to purchasing behavior. While digital marketing strategies can raise awareness about environmental issues and promote sustainable products, their effectiveness ultimately depends on whether consumers perceive the information as credible. The mediation perspective suggests that green digital marketing does not directly influence sustainable consumer behavior without first influencing consumer perceptions of credibility and trust. When digital sustainability communication provides transparent, verifiable, and consistent environmental information, consumers are more likely to trust the environmental claims associated with the product. This trust subsequently increases the likelihood that consumers will engage in sustainable purchasing behavior.

Previous studies have highlighted the mediating role of trust in the relationship between environmental communication and green purchase intentions. Research indicates that consumers who trust sustainability claims are more likely to convert positive environmental attitudes into actual purchasing behavior (Nguyen Viet, 2022). In digital environments, the ability to verify environmental claims through technologies such as blockchain authentication and QR code traceability further strengthens the mediating role of trust. These mechanisms allow consumers to validate sustainability information independently, thereby increasing confidence in green marketing communication. Based on this reasoning, the following hypothesis is proposed:

H3: Consumer trust mediates the relationship between green digital marketing and sustainable consumer behavior.

4.4. Moderating Role of Eco Label Counterfeiting

Despite the growing use of eco labels and sustainability certifications in green marketing, the credibility of environmental claims remains a major concern. Eco label counterfeiting refers to the unauthorized or misleading use of environmental labels that falsely signal sustainability credentials. This phenomenon represents a significant challenge for both consumers and policymakers because it undermines trust in environmental certifications and creates confusion in the marketplace. When counterfeit eco labels are prevalent, consumers may become skeptical about the authenticity of sustainability claims. Even when legitimate eco labels are used, the presence of counterfeit labels can reduce overall consumer confidence in environmental certification systems. As a result, the effectiveness of green marketing strategies may be weakened.

Research on greenwashing suggests that misleading environmental communication can significantly reduce consumer trust and weaken the relationship between green marketing and consumer purchasing behaviour (Uikey et al., 2025). In digital marketplaces where information spreads rapidly and regulatory oversight may be limited, counterfeit eco labels can become particularly problematic. Eco label counterfeiting therefore acts as a moderating factor that influences how consumers interpret sustainability communication. When counterfeit labels are perceived as common in the market, the positive effect of green digital marketing on consumer trust may be reduced. Based on this literature, the following hypothesis is proposed:

H4: Eco label counterfeiting negatively moderates the relationship between green digital marketing and consumer trust.

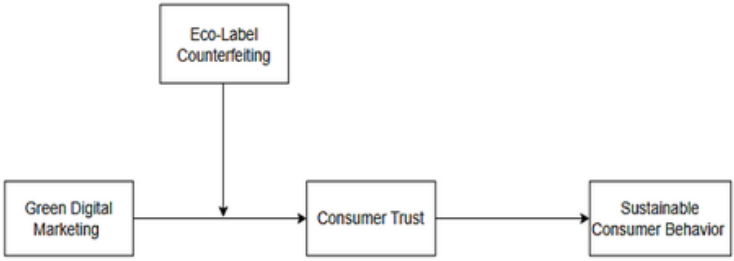

Figure 1: Research framework

4.5. Construct Definitions

Construct	Definition	References
Green Digital Marketing	The use of digital platforms and technologies to communicate environmental product attributes, sustainability initiatives, and corporate environmental responsibility through online channels such as social media, e-commerce platforms, and mobile applications.	Kumar et al., 2025; Maduwinarti et al., 2025
Consumer Trust	The degree to which consumers believe that a firm's environmental claims, eco-labels, and sustainability information are credible, reliable, and truthful.	Nguyen-Viet, 2022; Mume & Sun, 2024
Eco-Label Counterfeiting	The presence or perception of fake, misleading, or unauthorized environmental labels that imitate legitimate eco-certification schemes and reduce consumer confidence in sustainability claims.	Uikey et al., 2025; Sharma, 2023
Sustainable Consumer Behavior	Consumer purchasing behavior that prioritizes environmentally friendly products and considers environmental and social impacts when making consumption decisions.	Ali et al., 2023; Testa et al., 2021

5. Discussion and Implications

The proposed conceptual framework highlights the growing importance of green digital marketing as a strategic mechanism for promoting sustainable consumption in digitally connected markets. By integrating behavioral theory with trust based consumer behavior perspectives, the framework explains how digital sustainability communication can influence consumer decision making through the development of trust while acknowledging the potential challenges created by eco label counterfeiting. This section discusses the theoretical, managerial, and policy implications of the proposed framework, particularly within the context of ASEAN economies.

5.1. Theoretical Implications

The present study contributes to the existing literature on green marketing and sustainable consumption in several important ways. First, the study extends traditional green marketing research by incorporating the role of digital marketing technologies in sustainability communication. Earlier research on green marketing primarily focused on conventional promotional tools such as eco labels, environmental advertising, and corporate sustainability messaging. However, the increasing reliance on digital platforms has transformed the nature of marketing communication, requiring new theoretical perspectives that integrate digital technologies with sustainability communication strategies (Kumar et al., 2025).

Second, the proposed framework highlights the critical role of consumer trust as a mediating mechanism linking green digital marketing and sustainable consumer behavior. While previous studies have recognized the importance of trust in environmentally responsible consumption, relatively limited research has examined how trust functions within digital marketing environments. By emphasizing the mediating role of trust, the framework provides a deeper understanding of how digital sustainability communication can translate into actual purchasing behavior.

Third, the study introduces eco label counterfeiting as a moderating factor within the relationship between green digital marketing and consumer trust. Existing research on greenwashing has primarily examined the effects of misleading environmental claims on consumer attitudes. However, the moderating influence of counterfeit eco labels in digital marketplaces has received limited attention. By incorporating eco label counterfeiting into the conceptual framework, the study expands current understanding of the institutional and informational challenges that affect the effectiveness of sustainability communication.

Finally, the study contributes to the emerging literature on sustainable consumption in developing and emerging markets, particularly within ASEAN economies. Much of the existing research on green consumer behavior has focused on developed markets where environmental regulations and certification systems are relatively strong. In contrast, ASEAN markets present unique challenges related to regulatory diversity, digital transformation, and varying levels of consumer environmental awareness (Maduwinarti et al., 2025). The proposed framework therefore provides a contextual perspective that highlights the importance of trust and information credibility in shaping sustainable consumption behavior in rapidly digitalizing economies.

5.2. Managerial Implications

The findings of this conceptual study provide several important implications for businesses and marketing practitioners seeking to promote sustainable products in digital marketplaces. First, firms should recognize that green digital marketing must go beyond traditional promotional messaging. Simply communicating environmental claims through digital advertising may not be sufficient to influence consumer behavior if consumers question the credibility of the information. Instead, firms should integrate transparency mechanisms into their digital marketing strategies. One effective approach involves the use of digital verification technologies such as QR code traceability systems. These systems allow consumers to access detailed information about product origins, production processes, and sustainability certifications through mobile devices. By providing transparent and verifiable information, companies can strengthen consumer trust and enhance the credibility of their environmental claims.

Second, firms should actively engage with consumers through interactive digital platforms. Social media channels, online communities, and digital storytelling tools allow organizations to communicate sustainability initiatives more effectively and build stronger relationships with consumers. Transparent communication regarding corporate sustainability goals, environmental performance, and supply chain practices can help reinforce consumer confidence in green products. Third, companies should ensure that eco labels and sustainability certifications used in marketing communication are legitimate, recognizable, and supported by credible certification bodies. Collaborating with reputable certification organizations can strengthen brand credibility and reduce the risk of consumer skepticism. Firms should also consider integrating digital authentication systems that allow consumers to verify the authenticity of eco labels.

5.3. Policy Implications

In addition to managerial implications, the proposed framework highlights several policy considerations for governments and regulatory institutions in ASEAN economies. One of the most pressing challenges identified in the literature is the increasing prevalence of greenwashing and counterfeit eco labels in digital marketplaces. Without adequate regulatory oversight, misleading environmental claims can undermine consumer trust and reduce the effectiveness of sustainability initiatives. Policymakers should therefore strengthen regulatory frameworks related to environmental certification and eco labeling systems. Establishing standardized sustainability certification schemes and clear guidelines for environmental claims can help ensure that eco labels used in marketing communication are credible and reliable. Regulatory authorities should also implement monitoring mechanisms to detect and prevent fraudulent sustainability claims.

Another important policy consideration involves the promotion of digital transparency technologies in supply chains. Governments can encourage firms to adopt traceability technologies such as blockchain systems and digital certification platforms that provide verifiable information about product sustainability. These technologies can help improve transparency and reduce the risk of counterfeit eco labels. Consumer education also plays a critical role in promoting sustainable consumption. Public awareness campaigns that educate consumers about environmental labels, sustainability certifications, and responsible purchasing practices can enhance consumer understanding of sustainability information. Improved consumer knowledge can strengthen the effectiveness of green digital marketing initiatives and encourage more responsible consumption patterns.

By addressing these regulatory and educational challenges, policymakers can support the development of a more transparent and trustworthy marketplace for sustainable products. Such efforts contribute directly to the achievement of Sustainable Development Goal 12, which emphasizes responsible consumption and production.

6. Conclusion

Sustainable consumption has become an essential component of global sustainability efforts, particularly within the framework of Sustainable Development Goal 12, which emphasizes responsible consumption and production. As environmental concerns intensify and digital technologies continue to reshape consumer markets, businesses increasingly rely on digital platforms to communicate sustainability initiatives and promote environmentally responsible products. In this context, green digital marketing has emerged as an important strategic approach that integrates sustainability communication with digital transparency mechanisms.

This conceptual study examined the role of green digital marketing in influencing sustainable consumer behaviour in ASEAN economies. By integrating insights from green marketing literature, behavioural theory, and trust based consumer behaviour perspectives, the study proposed a conceptual framework that highlights the mediating role of consumer trust and the moderating influence of eco label counterfeiting. The framework suggests that green digital marketing can positively influence sustainable consumer behaviour when it enhances the credibility and transparency of sustainability communication. Consumer trust serves as a key psychological mechanism that translates digital sustainability messaging into environmentally responsible purchasing decisions.

The study also highlights the challenges associated with eco label counterfeiting and misleading environmental claims in digital marketplaces. The presence of counterfeit eco labels may weaken consumer trust in environmental certification systems and reduce the effectiveness of green marketing initiatives. This issue is particularly relevant in ASEAN markets, where rapid digital transformation is accompanied by varying levels of regulatory enforcement and consumer awareness regarding sustainability certifications.

From a theoretical perspective, the study contributes to the literature by integrating the Theory of Planned Behaviour with trust based consumer behaviour models in the context of digital sustainability communication. While previous research has explored green marketing and sustainable consumption separately, the proposed framework emphasizes the importance of trust and transparency in digital marketing environments. By incorporating eco label counterfeiting as a moderating factor, the study also extends existing research on greenwashing and environmental communication. The study further contributes to the sustainable consumer behaviour in emerging markets. ASEAN economies represent a dynamic context characterized by rapid digital adoption, expanding e commerce platforms, and increasing consumer interest in sustainable products. However, institutional differences and varying levels of environmental awareness create challenges for the credibility of sustainability communication. The conceptual framework developed in this study provides a foundation for future research examining how digital marketing strategies and transparency technologies influence sustainable consumption in the region.

Despite these contributions, the present study is conceptual in nature and therefore provides several opportunities for future empirical research. Future studies may empirically test the proposed framework using quantitative research methods such as structural equation modelling to examine the relationships between green digital marketing, consumer trust, eco label credibility, and sustainable consumer behaviour. Cross country comparative studies within ASEAN economies may also provide valuable insights into how institutional environments and digital literacy levels influence consumer responses to sustainability communication.

In addition, future research may explore the role of emerging technologies such as blockchain based supply chain transparency, artificial intelligence driven sustainability verification systems, and digital product passports in strengthening the credibility of environmental claims. These technologies may offer new opportunities to address challenges related to greenwashing and counterfeit eco labels.

In conclusion, the transition toward sustainable consumption requires not only effective marketing strategies but also credible and transparent communication systems that build consumer trust. Green digital marketing has the potential to play a transformative role in promoting sustainable consumer behaviour when supported by reliable certification systems, transparent supply chain information, and strong regulatory frameworks. By enhancing trust and transparency in sustainability communication, businesses, policymakers, and digital platforms can contribute to the advancement of responsible consumption and sustainable development across ASEAN economies.

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Recommendations from Financial Organization Leaders on Poverty Management in Pattani Province

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Abstract: This qualitative study examines the underlying drivers of poverty and strategic management approaches in Pattani Province from the perspective of financial organization leaders. Utilizing a phenomenological approach, the research conducted semi-structured in-depth interviews with 3 key informants comprising executives from two local Islamic cooperatives. The analysis is structured around three analytical pillars: situational and structural constraints, institutional mechanisms and strategies, and policy recommendations for sustainability. The findings reveal that systemic poverty in the region is driven by a complex interplay of limited capital access and ingrained structural inequalities. To address these challenges, Islamic cooperatives employ specialized financial mechanisms grounded in Islamic principles, which serve as vital tools for socio-economic empowerment. The study concludes that sustainable poverty alleviation requires a collaborative framework between financial institutions and the public sector. These results highlight the critical role of localized financial leadership in bridging resource gaps and fostering long-term community resilience through culturally-aligned policy interventions.

Keywords: Leadership, Poverty, Financial organization, Leaders

1. Introduction

For over half a century, the issue of poverty has remained a topic of intense debate, frequently brought up in academic spheres and policymakers. It is due to the multitude of interpretations and the shifting indicators of poverty over time depending on particular scholars and rating agencies. Morduch (1994) argued that poverty is generally defined as both chronic and temporary, whereas Watts (1968) defined poverty as an individual situation, rather than a set of features or behavioral tendencies. However, the World Bank stated that poverty is “a severe deprivation in well-being” and that poor people are those who possess insufficient income or consumption to exceed the minimum threshold of adequacy (Azevedo, 2009). In international development, despite numerous attempts undertaken by governments across diverse nations, most breakthroughs fail to reach the most vulnerable populations, leaving poverty an enduring challenge. This is a prevalent construction in developing countries such as Thailand.

According to Tantivangphaisal (2024), Thailand performed the best in Southeast Asia when it came to managing the Multidimensional Poverty Index (MPI) in 2024, scoring 0.0002. Vietnam (0.008), Indonesia (0.014), the Philippines (0.016), Cambodia (0.070), Laos (0.108), and Myanmar (0.176) are the countries that come after Thailand. Also, Thailand has significantly decreased the population living in multidimensional poverty from 909,000 in 2012 to 416,000 in 2019, and further to 352,000 in 2022, illustrating the nation's dedication to alleviating poverty. However, the MPI for 2024 has also underscored the existence of disparities. The multidimensional poverty rate exceeds the monetary poverty rate by about 0.5%. Because of this, some people may be over the poverty line, but they still lack access to necessities like housing, healthcare, education, and food (Tantivangphaisal, 2024).

Despite its impressive progress, many people still live in conditions of deprivation due to chronic poverty, especially those living in rural areas. Take the Pattani province, a region situated at the southernmost tip near the Malaysian border consisting of 96 administrative subdistricts, 2 village municipalities, 15 subdistrict municipalities, 115 subdistricts, and 12 districts (UNDP, 2024). The population is 82.1 percent Muslim, 17.8 percent Buddhist, and 0.1 percent Christian forming multiethnic communities influenced by Thai, Chinese, and Malay cultures. Yet behind that, Pattani struggles under entrenched poverty and inequality. Pattani is the only southern province that has suffered the most severe and prolonged poverty for more than 15 consecutive years (NESDC, 2024). In addition, Boonyamanond & Chaiwat (2020) identified the following factors causing poverty in Pattani: the deep inequality in development and low living standards of the local population whose current per capita income is lower than the national average. Second, protracted social and political conflicts have caused thousands of deaths and lagging economic and educational sectors, as most of the victims have been displaced and dropped out of school. Finally, rural communities encounter barriers to accessible education, further exacerbated by violent conflicts in remote areas of Pattani. This led them to rely on third parties such as religious foundation entities, non-profit government, and local community organizations to meet their financial and educational needs, or to seek out Islamic Microfinance Institutions (IMIs) for unsecured, interest-free financing (Nuh, 2019; Samartdee, 2019).

Addressing this issue is not easily accomplished and requires sustained collaborative endeavors among the government, private organizations, and local society. Therefore, it is imperative for authors to explore further insights that could bring about a collective solution to reduce poverty in Pattani from the perspective of local financial organization leaders. To the best of our knowledge, there are not many in-depth studies that reveal findings on poverty alleviation management in Pattani. We therefore need to investigate matters relating to poverty alleviation management in this region. Overall, this study aims to explore relevant recommendations from leaders of financial organizations focused on Islamic microfinance institutions such as Islamic cooperatives that operate in Pattani concerning poverty management and approaches to solving it.

2. Literature Review

According to Holt (1991), organizational structure and managerial leadership were critical components of poverty alleviation institutions. The most appropriate organizational structure was determined by the intricacies of decision-making in the environment in which the organization functions. Holt (1991) emphasized the inappropriate actions of poverty alleviation organizations. Those who deal directly with underprivileged communities, such as establishing groups and offering training, were in a different situation than those who construct irrigation canals or roads in remote locations. As a result, many anti-poverty institutions adhere to Max Weber's basic bureaucratic paradigm. The point here is that the role of organizational leaders should be tailored to the nature of organizations that interact directly with the community in order to have an impact on poverty alleviation.

In the local context, a previous study on microfinance organization leadership by Detthamrong et al. (2023) found that leadership is closely related and positively impacts key success factors for microfinance institutions. Instilling aspects of key success factors, consisting of morale, participation, and group management is likely to leverage the role of institutional poverty alleviation in Chaiyaphum province Thailand.

Soundararajan et al. (2025) stated the engagement of leaders and members towards financial organizations is recognized as a critical factor for success, as attributes ranging from passion, social responsibility, and cultural integration are essential for fostering trust and avoiding mission drift. Cultural attachment, social responsibility, and passion are leadership characteristics identified as factors that strengthen poverty alleviation efforts. Financial organizational leaders had crucial role in acting as a primary bridge between financial organizations and the poor. Conversely, Soundararajan et al. (2025) also noticed organizational leadership served as a double-edged sword, possessing the capacity to either promote poverty alleviation or aggravate poverty. Furthermore, poverty reduction occurs by means of “offering” practices such as investing capital, paying fair wages, providing market access, and transferring knowledge. While poverty is exacerbated when “depriving” practices occur, including raising debt by charging high interest rates, paying unconscionable wages, suppressing worker rights, and perpetuating social marginalization.

The literature review in this study is closely related to organizational leadership in poverty alleviation, including the actions and decisions of leaders in responding to problems. An organization's recommendations for addressing poverty in a particular area are certainly related to leadership, so the authors need to incorporate reviews from earlier studies that address this topic.

3. Materials and Methods

This study used a qualitative method that utilized in-depth interviews as primary data. It was grounded in an investigation of the meaning of organizational leadership in relation to poverty issues, involving an exploratory examination of assumptions and theoretical perspectives (Creswell, 2013). The authors also applied a transcendental empirical phenomenological approach that was appropriate for this study because it followed Moustakas's (1994) work in identifying the phenomenon to be studied, setting aside personal experiences (epoche), and collecting data from participants who had experienced it. The authors then examined the data by reducing it to key remarks or quotes and grouping them into themes. Following that, we created a textual description of the individual experience (what the participants saw), a structural description of the experience (how they saw it in terms of conditions, situations, or context), and a combination of textual and structural descriptions to convey the overall essence of the experience.

Ethical considerations were strictly implemented throughout the research process. This study adhered to the principles of respect for human dignity, privacy, and the rights of participants. To protect confidentiality and prevent personal and institutional identification, the organizations were referred to as “Islamic Cooperative#1” and “Islamic Cooperative#2 as well as participants personal details were anonymized with initials.

3.1. Data Collection and Participants

The primary data collection was conducted using semi-structured and in-depth interviews, which were developed based on a relevant literature review on the role of organizational leaders in addressing poverty issues. The interview framework was based on Creswell (2013), which offers stages of interview treatment, namely identifying phenomena, applying the epoche principle, and determining textual and structural aspects. The interview questions focused on the recommendations of organizational leaders in understanding poverty issues, an overview of the economic and financial behavior of local communities, barriers and mitigation factors, collaboration and integration opportunities, innovations and successful models, and proposed future policies. Data were obtained through face-to-face interviews in which the organization operates. The interviews were recorded by audio devices as evidence to authenticate the compiled data. Interview questions were disseminated in advance to minimize potential misunderstandings and ensure accuracy in the transfer of meaning.

Three participants were deliberately selected based on their direct experience and leadership within the organization. Participants included core committee members responsible for steering the organization and cooperative managers. This sampling strategy is consistent with qualitative research principles that prioritize selected informants who are able to provide rich narratives and interpretations (Palinkas et al., 2015).

3.2. Data Analysis and Trustworthiness

All of the interviews were transcribed verbatim and subjected to thematic analysis. The authors went over the transcripts several times to look for patterns and significant topics that reflected the poverty issue being addressed by financial organizations. The data were interpreted using transcendental phenomenological concepts, focusing on understanding the meanings of participants lived experiences within the financial organisational framework. To establish trustworthiness, this study referred to Lincoln & Guba (1985) model of validation, which comprises the elements of credibility, transferability, dependability, and confirmability. Data triangulation was performed by comparing the perspectives of organizational leaders with documentation of organizational achievements. Participant review was also done to allow participants to check the authors interpretations to validate alignment with their experiences.

4. Findings and Analysis

The research findings indicate that Islamic cooperatives contribute to poverty alleviation and promote financial inclusion among the poor by enabling access to capital. Organizational leaders also respond to the problems faced by the poor by providing financial services that are not available from banks. Data analysis identified three main pillars, as follows:

4.1. Situational and Structural Constraints

The conditions of society in Pattani are unique compared to the majority of other provinces as most of the population is ethnic and religiously Malay-Muslim. A manager (FYS) of Islamic Cooperatives#1 stated:

“….most Pattani's residents lived in rural areas and depended on the harvests from their vegetable and orchard (farming and plantations were their source of livelihood), which were then supplied directly to shops…”

“Decades ago, Islamic financial institutions were absent and only interest-based banking existed. Since the emergence of Islamic cooperatives, Muslims have been able to become cooperative members…”

“…. fifty years ago, Muslims did not have their own shops and had to rent commercial space. Following the establishment of Islamic cooperatives, they were able to become cooperative members and accumulate savings from their business activities, as well as obtain loans to expand their businesses into various trades such as food, meat, chicken, and among others…”

One of the factors contributing to poverty among Pattani Muslims is hindered access to credit, as the available banking institutions operate on interest-based systems that are considered incompatible with Muslim norms. Poverty persisted for more than three decades before the establishment of an Islamic cooperative aimed at providing financial services to both Muslim and non-Muslim members of the community. However, Muslims still encounter hindrances in accessing formal financial services, as explained by the manager (FYS) of Islamic Cooperative#1:

"In the past, when only usurious banks were available and Islamic financial institutions were absent, poor Muslims faced difficulties accessing credit because they did not possess land certificates that could be used as collateral..."

"...sometimes poor Muslims have business ideas and the motivation to pursue them but lack capital. Since the establishment of Islamic cooperatives, they have been allowed to appoint a guarantor (his/ her friends) to support their loan applications..."

The main barrier confronting poor Muslims when applying for bank loans is the requirement for collateral. Islamic cooperatives therefore have introduced an alternative mechanism based on personal guarantees, allowing members to act as guarantors for one another when applying for credit. The cooperative's secretary, who also serves as its manager (AR) of Islamic Cooperative#1, described how Muslim members behaved after joining the cooperative, as follows:

"...when cooperative members earn income from their businesses, they deposit a portion of their earnings with the cooperative, usually under a wadiah contract. However, some place their savings under a mudharabah contract if the funds are not required for immediate use..."

"...some segments of the Muslim community in Pattani continue to rely on additional informal loans from loan sharks operating outside Islamic financial institutions. This practice is often found among economically well-off members of the Muslim community..."

Some Muslims are drawn to loans provided by loan sharks or other informal lenders outside Islamic cooperative services, despite efforts by cooperative staff to educate them about the harmful consequences of such practices. Interestingly, those who do so are generally aware of the risks that may arise in the future, and they tend to come from relatively stable economic backgrounds.

4.2. Institutional Mechanism and Strategies

The cooperative maintains its adherence to Islamic principles by zakat and another social assistance funds to the eight eligible categories (asnaf). It was explained by the cooperative's secretary, who also serves as its manager (AR) at Islamic Cooperative#1, who stated:

"...zakat is distributed to eligible members based on a beneficiary list prepared by the foundation as part of its adherence to Islamic principles..."

"...social assistance is also provided, but its scale remains smaller compared with zakat distribution..."

"....The cooperative also provides Qardh Hasan (benevolent loans) exclusively for members, with a small administrative fee of 54 baht..."

Islamic Cooperative#2 also offered a comparable response, whereby zakat is an integral part of the cooperative's operations in accordance with Islamic principles, as stated by a financial manager (KK):

"...we have dispersed zakat specifically to non-members who are eligible to receive it..."

Some wealthy Muslims in Pattani prefer to distribute their zakat directly instead of channelling it through a zakat organization due to the substantial amount of zakat they pay each year. Some members voluntarily subject their savings in the cooperative to zakat. Likewise, profits generated from their business ventures give rise to zakat obligations, which some members prefer to distribute independently. Members success in expanding their businesses is closely associated with the financial services provided by the cooperative, as explained by AR:

"...the most popular Islamic cooperatives product offered to members is mudharabah under a one-year contractual arrangement with profit-sharing disbursement approximately four times..."

"...the cooperative's mudharabah profit-sharing scheme offers returns that are competitive with conventional bank interest rates..."

The cooperative also offers a Hajj savings scheme to members with a saving period ranging from one to ten years. Regarding the issue of cooperative risk management with social responsibility to the poor, AR said:

"...we still require collateral, but the requirements are adjusted to members' financial capacity, ranging from land certificates and savings in the cooperative to precious metals (gold) or personal guarantees from fellow members..."

"In accordance with the cooperative's Islamic principles, when members pass away with outstanding debts, these obligations are settled by their heirs...."

The cooperative emphasizes to its members that outstanding debts remain payable even after the debtor's death and must be settled by their heirs. If the heirs are unable to repay the debt, it may be covered through zakat funds. Conversely, if a debtor is still alive but fails to repay, legal action may be pursued, including bringing the matter before the court if attempts at amicable settlement reach a deadlock.

4.3. Policy Recommendations and Sustainability

Integration between government and financial institutions appears necessary for sustainable poverty alleviation. The cooperative manager and cooperative secretary (AR) expressed this view as follows:

"...it is hoped that cooperative institutions can collaborate with royal development projects, as these initiatives have been implemented directly to benefit local communities..."

Surprisingly, government authorities at both the regional and central levels often create difficult policies for cooperatives by prohibiting or refusing to allow them to undertake certain activities considered beneficial to their development. Furthermore, technological innovation in the financial sector has become inevitable. AR expressed this view as follows:

"...discussions on fintech and cooperatives have emerged, but we are not yet considered urgent matters. We will likely be addressed more formally in the next five to ten years..."

"...the cooperative has introduced a mobile application for its members, accessible via smartphone..."

The cooperative's mobile app users already account for 20 percent of the total membership. Cooperative management hopes that this figure will increase to 30–40 percent in the coming year. The context of building sustainable livelihoods through gradually reducing reliance on credit was outlined by an Islamic cooperative manager (FYS), who stated:

"...the cooperative has developed a sustainable business model for its members modeled after the approach of Grameen Bank..."

The sustainable business model developed by the cooperative has been in operation for ten years and consists of three groups, each comprising ten members. The final issue concerns the opportunity to submit a roadmap for cooperative development policy to the government, which was raised as part of the interview questions and answered by the manager (AR) as follows:

"...we will propose cooperation with the government to create employment opportunities for the wider community, not limited to cooperative members..."

"...we have proposed to the government the establishment of interest-free savings and loan products aimed at conventional government financial institutions...."

"...we will propose that the government support the provision of interest-free financing for other Islamic cooperatives..."

Cooperatives have previously held meetings with government authorities to discuss employment opportunities for communities in southern Thailand. Given the high unemployment rate in the region, collaboration between Islamic cooperatives and the government is essential.

5. Discussion and Conclusions

The findings indicate that poverty remains a persistent problem in Pattani, which is partly attributable to the scarcity of credit unions that serve the poor and provide accessible financial services. The economically deprived Muslim population has a particularly difficult time obtaining funding from financial firms that uphold Islamic norms. Awareness of Islamic-based financial services began to spread in early 1987, owing to Syaikhul Islam who afterwards had a crucial role in promoting the establishment of Islamic cooperatives in Pattani (Noipom, 2013). Since then, the establishment of Islamic cooperatives catalyzed the emergence of other Islamic financial institutions at the national level, eventually leading to the establishment of Thailand's first Islamic bank in 2003 (Nuh, 2019). Although the emergence and growth of cooperatives based on Islamic principles have contributed to poverty alleviation in the southern region, a number of structural constraints still shadow and threaten the long-term sustainability of their operations. Among the most apparent challenges are regulatory barriers imposed by the government, which restrict the capacity of Islamic cooperatives to extend greater benefits to communities.

The government should encourage micro, small, and medium-sized enterprises (MSMEs), including Islamic cooperative organizations that support their funds by granting greater agility in policy implementation. Considering that these institutions are not large entities such as limited companies with substantial capital, they should be safeguarded and provided broader space to develop and strengthen their capacity for growth. Furthermore, systemic poverty in Pattani is also closely related to the affordability of capital accessible to the community. Islamic cooperative leaders stated access to business credit is increasingly unattainable when the poor are required to provide land certificates as collateral, whereas they only have technical entrepreneurial skills. This standpoint corresponds to empirical research by Thein et al. (2024) and Oshora et al. (2021) which demonstrated that collateral requirements constitute a crucial impediment to financial inclusion and reinforce ingrained structural inequalities. The subsequent example of constraint is the government's prohibition on certain activities undertaken by Islamic cooperatives primarily due to the absence of specific legal and regulatory frameworks governing their operations. This observation echoes the findings of Hama et al. (2024) who reported that Islamic cooperatives face challenges related to regulatory and legislative arrangements that remain neither self-contained nor institutionally distinct. At present, the legal framework governing Islamic cooperatives is still embedded within the Cooperative Act of 1999 and Law No. 3 of 2019. Islamic cooperatives on the other hand, already provided mudharabah financing, which was popular among members due to its competitive profit-sharing scheme. This finding was supported by an empirical study by Izzaty & Sadewa (2024), which highlighted the positive impact of mudharabah products on customers' intention to transact with Islamic financial institutions.

In general, poverty alleviation requires cross-organizational collaboration between the government and private entities such as Islamic cooperatives operating in Pattani. From the perspective of Islamic cooperative leaders, several recommendations can be proposed as follows:

1.Social and community investment projects will be initiated by the government and the royal family should involve Islamic cooperatives, as these institutions possess a deeper understanding of poverty dynamics in the Pattani region. Involving cooperative personnel who are experienced and knowledgeable about the economic characteristics of local communities can also reduce the risk of unmonitored fund circulation.
2.Local and central governments should encourage the implementation of flexible yet responsible policies toward Islamic cooperatives by introducing laws and regulations that are supportive of their operations and activities.
3.The government should introduce Islamic financial services within conventional state-owned banks as a means of expanding access to financial services for the Muslim community.
4.The government should provide interest-free soft loans to Islamic cooperatives in Pattani and surrounding areas as part of its commitment to supporting Islamic microfinance institutions.

This recommendation is intended to offer a wider scope for stakeholders concerned with poverty alleviation in Pattani such that the measures and policies that will be adopted are congruent with the noble purpose of the Sufficiency Economy Philosophy (SEP) in a widespread and equitable manner.

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Factors Influencing Consumers' Purchase Intention toward Upcycling Products: The Roles of Perceived Value and Environmental Self-Identity

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Abstract: This quantitative research investigates the influence of perceived value and environmentally self-identity on consumers' purchase intention toward upcycling products, which are products created by transforming waste materials into higher-value items. The sample consisted of 385 consumers who were interested in upcycling products, selected using purposive sampling. Data were collected through online questionnaires distributed via social media platforms and recycling-related communities. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to analyze the general characteristics of respondents, while multiple regression analysis was employed to test the research hypotheses. The results indicated that most respondents were female, aged between 30 and 39 years, held a bachelor's degree, and worked as government officers or private employees. The overall level of perceived value toward upcycling products was rated at the highest level. Among the five dimensions of perceived value, product value showed the highest mean score, followed by conditional and cognitive value, emotional value, price value, and social value. The hypothesis testing results revealed that product value, conditional and cognitive value, social value, and price value significantly influenced consumers' purchase intention toward upcycling products at the 0.05 significance level, while emotional value showed no significant effect. Additionally, environmentally self-identity significantly influenced purchase intention.The findings suggest that consumers with strong environmental self-identity and high perceived value of product quality and usefulness are more likely to purchase upcycling products. These insights can support entrepreneurs and marketers in developing strategies to promote environmentally friendly products and expand sustainable consumption in the green market.

Keywords: Perceived value, Environmental self-identity, Purchase intention, Upcycling products

1. Introduction

In recent years, waste generation and material overconsumption have become critical global environmental challenges. The continuous increase in waste volume has significantly impacted ecosystems, human well-being, and the sustainable use of natural resources. In particular, non-biodegradable waste such as plastics, textiles, and synthetic materials poses severe environmental threats if not managed effectively, leading to both short-term and long-term ecological consequences. These challenges have prompted businesses and society to place greater emphasis on sustainable production and consumption practices.Within this context, the concept of upcycling has emerged as a key mechanism within the framework of the circular economy. Upcycling refers to the process of transforming waste materials into products of higher value, thereby not only reducing waste but also generating economic benefits and promoting efficient resource utilization. Upcycling products, such as clothing made from fabric scraps, bags created from recycled materials, and jewelry produced from plastic waste, have gained increasing popularity worldwide, including in Thailand. Many entrepreneurs and designers have adopted this concept to develop creative businesses that respond to both environmental concerns and the evolving preferences of modern consumers.

Despite the growing awareness of environmental issues among consumers, purchasing decisions related to upcycling products are influenced by multiple factors. One of the most critical factors is perceived value, which reflects consumers' overall assessment of a product's worth based on dimensions such as quality, price, emotional benefits, and social image (Zeithaml, 1988). In addition, environmental self-identity plays a significant role. Consumers who perceive themselves as environmentally responsible individuals are more likely to support products that align with their values and self-concept (Whitmarsh & O'Neill, 2010). These perspectives suggest that understanding sustainable consumption behavior requires an integrated consideration of both perceived value and environmental self-identity as key internal drivers influencing purchase intention toward upcycling products.

Based on these considerations, this study aims to examine the influence of perceived value and environmental self-identity on consumers' purchase intention toward upcycling products. The findings are expected to provide deeper insights into sustainable consumer behavior and offer practical implications for developing marketing strategies that promote environmentally friendly businesses. Furthermore, this research contributes to guiding Thailand toward a more sustainable circular economy in the future.

1.1. Objectives

1.To examine the effects of perceived value on consumers' purchase intention toward upcycling products.
2.To investigate the influence of environmental self-identity on consumers' purchase intention toward upcycling products.

1.2. Literature Review

This study reviews key concepts and related research on perceived value and environmental self-identity (green self-identity) influencing purchase intention toward upcycling products. The review provides the theoretical foundation for developing the research framework.

1.2.1. Upcycling Products

Upcycling products refer to the creative process of transforming discarded materials or waste such as plastic bottles, paper, cardboard, fabric scraps, or other materials into new products with higher value and functionality through environmentally friendly design and production processes (Suchinroj & Aranyanart, 2024). This concept aims to reduce waste and optimize resource utilization by adding both functional and aesthetic value. Unlike recycling, which involves chemical processing, upcycling emphasizes creative design while preserving the original material quality.

In Thailand, upcycling has gained popularity in fashion and handicrafts, such as the Upcycling Upstyling project by GC, collaborations between MUJI Thailand and the Doi Tung Development Project, and brands like SACKITEM. This approach aligns with the concept of the circular economy.

1.2.2. Perceived Value

Perceived value refers to consumers' overall evaluation of a product's worth based on the trade-off between perceived benefits and costs (Zeithaml, 1988). In the context of environmentally friendly products such as upcycling products, perceived value encompasses multiple dimensions, including product, social, emotional, price, and conditional value.Consumers are more likely to purchase products when they perceive them as valuable in terms of both utility and sustainability.

1.2.3. Environmental Self-Identity

Environmental self-identity refers to an individual's perception of themselves as someone who cares about and is responsible for the environment. It reflects awareness of one's role in environmental protection and a commitment to contributing to sustainable society (Sharma et al., 2020). This concept is part of an individual's broader self-identity and is associated with environmentally responsible roles and behaviors. Individuals with strong environmental self-identity tend to feel connected to nature and demonstrate a sense of responsibility toward environmental conservation. This internal identity serves as a key motivator for engaging in sustainable consumption behaviors. Consistent with the concept of green self-concept, individuals who perceive themselves as environmentally responsible are more likely to choose products that align with their values, such as recycled or upcycling products. Previous studies have shown that environmental self-identity has a positive relationship with green purchase intention, indicating that individuals with strong pro-environmental identities are more likely to engage in environmentally friendly consumption.

1.2.4. Purchase Intention

Purchase intention refers to a consumer's willingness or likelihood to purchase a product or service. It is influenced by factors such as brand trust, perceived value, and customer satisfaction (Keller, 2016). Consumers with higher purchase intention are more likely to be willing to pay for products that meet their needs and provide satisfaction. Purchase intention reflects the relationship between perceived value and positive attitudes toward a brand, including perceptions of quality, price, design, and brand image. This is particularly relevant for products with social and emotional value, such as upcycling products, which combine functional benefits with environmental and symbolic meanings.

1.3. Research Hypotheses

H1: Perceive value has a positive effect on purchase intention toward upcycling products.

H2: Environmental self-identity has a positive effect on purchase intention toward upcycling products

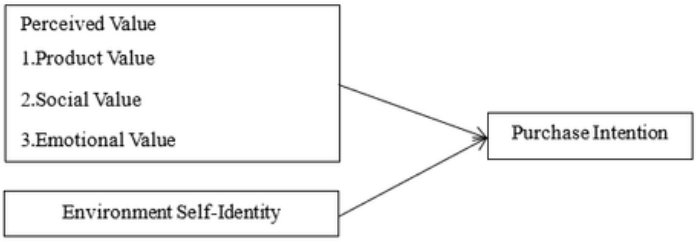

Figure 1: Research conceptual framework

2. Materials and Methods

2.1. Population and Sample

The population of this study comprises consumers in Thailand aged between 20 and 59 years who are interested in purchasing upcycling products. As the exact population size is unknown, the sample was defined as consumers within this age range who express interest in upcycling products in Thailand.

2.2. Sampling Method

This study employed a non-probability sampling technique, specifically purposive sampling. Data were collected from consumers who showed interest in purchasing upcycling products. The researcher distributed an online questionnaire via social media platforms, particularly Facebook groups related to environmental concerns and recycled products. The questionnaire was administered through Google Forms, allowing real-time data collection. Data collection was terminated once the required sample size was achieved.

2.3. Research Instrument, Validity, and Reliability

The primary data collection instrument in this study was a structured questionnaire consisting of five sections. The first section included screening questions with two response options to ensure that respondents met the criteria of having an interest in upcycling products. The second section gathered demographic information, including gender, age, education level, marital status, occupation, income, and purchasing behavior, using closed-ended questions. The third section measured perceived value across five dimensions: product value, social value, emotional value, price value, and conditional and cognitive value. The fourth section assessed environmental self-identity, while the fifth section measured purchase intention toward upcycling products. Sections 3 to 5 were measured using a five-point Likert scale, where 1 indicates “strongly disagree” or “very low” and 5 indicates “strongly agree” or “very high.”

To ensure the quality of the instrument, both validity and reliability were evaluated. Content validity was assessed by three experts using the Index of Item-Objective Congruence (IOC), with values ranging from 0.50 to 1.00, indicating good content validity. Reliability was tested through a pilot study with 30 respondents, and Cronbach’s alpha coefficients ranged from 0.722 to 0.935, exceeding the acceptable threshold of 0.70. These results confirm that the questionnaire is both valid and reliable for data collection.

2.4. Data Collection and Data Analysis

Data collection in this study consisted of both primary and secondary data. Primary data were obtained from 385 respondents who expressed interest in upcycling products through an online questionnaire distributed via Facebook. The researcher closely monitored the data collection process and ensured the completeness and accuracy of the responses prior to analysis. Secondary data were gathered from relevant sources, including academic articles, journals, research studies, and online databases, to support the analysis and discussion of findings.

Data analysis was conducted using both descriptive and inferential statistics. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to describe the general characteristics of respondents and their opinions. Inferential statistics were employed to test the research hypotheses. Specifically, simple regression analysis and multiple regression analysis were used to examine the effects of perceived value and environmental self-identity on purchase intention. The statistical significance level was set at 0.05.

3. Results and Discussion

3.1. Descriptive Results

The findings indicate that the majority of respondents were female (70.1%), aged 30–39 years (54.0%), with a bachelor's degree (67.0%), and employed as government or private sector staff (59.5%). Most respondents earned a monthly income of 20,001–30,000 THB (43.4%) and showed the highest interest in multiple types of upcycling products (61.0%). Social media was the main source of product awareness (37.1%), and the most recognized brand was UpToYou (35.6%)

Table 1: Descriptive analysis of perceived value

Perceived value	Average	Standard deviation	Value conversion
Product value	4.82	0.328	Highest
Social values	4.70	0.330	Highest
Emotional value	4.71	0.347	Highest
Price value	4.70	0.360	Highest
Conditional and cognitive	4.74	0.330	Highest
Total	4.73	0.250	Highest

Regarding perceived value, respondents reported an overall very high level (mean = 4.73, sd = 0.250). Among the dimensions, product value received the highest rating (mean = 4.82), followed by conditional and cognitive value (mean = 4.74). Other dimensions, including emotional, price, and social value, were also rated at a very high level.

Table 2: Descriptive analysis of environmentally self-identity and purchase intention

Environmentally friendly aspects of self-identity	Average	Standard deviation	Value conversion
Environmentally self-identity	4.80	0.302	Highest
Purchase intention	4.80	0.302	Highest

Similarly, environmental self-identity (Mean = 4.80, S.D. = 0.302) and purchase intention (Mean = 4.80, S.D. = 0.302) were both at the highest level, indicating strong pro-environmental attitudes and intentions among respondents

3.2. Inferential Results

Table 3: Regression analysis of perceived value factors and purchase intention

Variable	B	Std error	Regression coeff (β)	t	Sig.
Constant	.897	.231		3.884	.000
Product value	.134	.045	.135	2.954	.003*
Social value	.174	.045	.169	3.547	.000*
Emotional value	-.015	.045	-.015	-.335	.738
Price value	.251	.039	.298	6.368	.000*
Conditional and cognitive	.277	.043	.276	6.513	.000*
$R = 0.667$, $R^2 = 0.445$, Adjusted $R^2 = 0.439$					

The multiple regression analysis revealed that perceived value significantly influences purchase intention ($R^2 = 0.445$). Among the predictors, price value had the strongest effect ($\beta = 0.298$), followed by conditional and cognitive value ($\beta = 0.276$), social value ($\beta = 0.169$), and product value ($\beta = 0.135$), all at a significance level of 0.05. In contrast, emotional value was not statistically significant (sig. = 0.738)

Table 4: Regression Analysis of Environment Self-Identity Factors and Purchase Intention

Variable	B	Std error	Regression coeff (β)	t	Sig.
Constant	1.741	.190		9.185	.000
Environment self-identity	.636	.039	.637	16.161	.000*
$R = .637$, $R^2 = .405$, Adjusted $R^2 = .404$					

Furthermore, simple regression analysis showed that environmental self-identity has a strong positive effect on purchase intention ($\beta = 0.637$, sig. = 0.000), explaining 40.5% of the variance ($R^2 = 0.405$). This indicates that consumers with a strong environmental identity are more likely to intend to purchase upcycling products

3.3. Discussion

This study deepens the understanding of how perceived value and environmental self-identity shape consumers' intention to purchase upcycling products. The results suggest that consumers evaluate such products primarily through functional and contextual considerations rather than emotional attachment.

The significant effect of product value (sig. = 0.003) highlights that quality, durability, and usability remain fundamental drivers of consumer decision-making, even in the context of sustainability-oriented products. This reinforces the idea that environmental positioning alone is insufficient, as consumers still expect tangible product performance. This finding is consistent with prior research indicating that perceived product quality is a key determinant of green purchase intention (Sharma et al., 2020). In addition, social value emerges as an important factor, suggesting that purchasing upcycling products is partly driven by the desire to project a positive social image. Consumers appear to use these products as symbolic expressions of responsibility and modern lifestyle, supporting the argument that social approval influences sustainable consumption behavior (Sirimongkhon, 2022).

The strong influence of price value further indicates that consumers carefully assess the trade-off between cost and benefit. Although they are willing to support environmentally friendly products, this willingness depends on whether the price is perceived as justified by quality and sustainability attributes. This finding aligns with previous studies emphasizing the importance of value-for-money in green purchasing decisions (Ananakkrakun, 2022; Kautish & Sharma, 2019). Similarly, conditional and cognitive value plays a significant role, reflecting that consumers' decisions are shaped by situational factors and environmental awareness. This suggests that contextual relevance can enhance purchase intention (Narumon et al., 2019).

In contrast, emotional value does not significantly influence purchase intention, indicating that consumers rely more on rational evaluation than emotional responses. This implies that sustainable consumption in this context is driven more by utilitarian considerations than hedonic motivations (Ananakkrakun, 2022).

Finally, the strong effect of environmental self-identity underscores the importance of internal values in shaping behavior. Consumers who perceive themselves as environmentally responsible are more likely to translate their beliefs into purchasing decisions. This finding is consistent with previous research demonstrating that green self-identity directly influences environmentally friendly consumption (Silintowe & Sukresna, 2022).

4. Conclusions

4.1. Conclusions and Implications

This study examined the influence of perceived value and environmental self-identity on consumers' purchase intention toward upcycling products. The results confirm that purchase intention is primarily driven by value-based evaluations and consumers' environmental self-concept. Among the perceived value dimensions, product, social, price, and conditional value significantly contributed to purchase intention, while emotional value showed no significant effect.

The findings suggest that consumers approach upcycling products with a rational mindset, emphasizing quality, economic value, and contextual relevance rather than emotional appeal. In addition, environmental self-identity plays a crucial role in reinforcing sustainable consumption behavior, indicating that consumers are more likely to act in accordance with their pro-environmental beliefs.

Overall, this study highlights the importance of aligning functional value and personal identity in promoting upcycling products. These insights contribute to a better understanding of sustainable consumer behavior and provide a foundation for developing more effective strategies to support the transition toward a circular economy

4.2. Practical Implications

The findings provide several important implications for businesses. First, entrepreneurs should emphasize product quality, durability, and production standards to enhance consumer confidence. Second, pricing strategies should clearly communicate value, including material quality and product longevity, to justify the price. Third, storytelling strategies should be employed to highlight the origin of materials, the upcycling process, and environmental benefits, thereby increasing perceived value. Fourth, social value can be enhanced through community-building activities and influencer engagement to strengthen consumers' sense of pride and social recognition. Finally, businesses should foster a "tangible green identity" by integrating digital platforms and real-life experiences that enable consumers to express their environmental commitment.

4.3. Limitations and Future Research

This study focused on purchase intention rather than actual purchasing behavior. Future research should examine actual behavior, such as purchase frequency and repeat purchasing, to provide more comprehensive insights. Additionally, future studies should consider other influencing factors, such as environmental attitude and social norms, which may further explain sustainable consumption behavior. Expanding the research model to include these variables would enhance the understanding of consumer decision-making in the context of upcycling products.

5. Acknowledgements

The authors would like to thank the editors for their assistance in formatting the manuscript to meet the proceedings guidelines.

6. References

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GROUP 3
PLANET

A Comparative Study of the Thermal Properties of a Developed Natural Extract-Based Pain-Relief Gel and Standard Commercial Pain-Relief Gel Products

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Abstract: This research investigated and compared the thermal properties of four locally-developed hot/cold gel formulations derived from natural raw materials: aloe vera/cucumber, tapioca starch, salted stir-fry starch, and sugar-salt stir-fry starch. These formulations were evaluated against a standard commercial gel to provide a cost-effective, eco-friendly, chemical-free alternative for pain management in elderly and athletic populations. The methodology determined specific heat capacity (c) using the principle of thermal equilibrium, with Aluminum 6061 (c = 0.214 cal/g•℃) as the medium. Heat retention capability was also analyzed. Results indicated the standard gel possessed an average specific heat capacity of 1.08 ± 0.11 cal/g•℃ with retention time of 3 hours 45 minutes. The developed gels—aloe vera/cucumber, tapioca starch, salted starch, and sugar-salt starch—exhibited specific heat capacities of 0.92 ± 0.056, 1.14 ± 0.17, 1.02 ± 0.075, and 0.88 ± 0.026 cal/g•℃, respectively. Their heat retention durations were 3:18, 3:34, 2:46, and 2:31 hours. The analysis demonstrated that the tapioca starch gel was the most effective formulation. Its specific heat capacity was 5.6% higher than the standard gel, indicating superior thermal absorption. Its retention duration of 3 hours 34 minutes closely aligned with the commercial gel, differing by only 11 minutes.

Keywords: Learning Organization, Readiness for Change, Public Sector, Civil Servant, Strategic Leadership

1. Introduction

At present, Thailand is entering a fully aged society, resulting in a continuous increase in the elderly population. Consequently, health problems associated with physical degeneration—such as muscle pain, joint pain, and tissue inflammation—have become increasingly important public health issues. In addition, the growing trend of exercise and sports participation among the general population has led to more frequent muscle and joint injuries. Temperature therapy, such as hot and cold compresses, has therefore become a widely accepted method of treatment and care, as it can effectively help reduce pain, decrease inflammation, increase blood circulation, and promote muscle relaxation (Bleakley et al., 2004).

Furthermore, heat therapy helps reduce muscle stiffness and improves tissue flexibility, while cold compresses help reduce swelling and slow down the inflammatory process in tissues (Kumar et al., 2010).

There are various types of polymers, which often involve relatively high production costs and may have environmental impacts when disposed of after use. At the same time, natural materials that are easily available locally—such as aloe vera, cucumber, cassava starch, salt, and sugar—possess properties suitable for application as components in hot–cold gel packs. These materials are safe for users, inexpensive, and environmentally friendly. Moreover, many of these materials contain high water content or structures capable of retaining heat effectively, giving them the potential to maintain temperature for a certain period of time (Çengel & Boles, 2015). Nevertheless, the use of natural materials in the development of hot–cold gel packs require systematic study of their thermal properties, particularly specific heat capacity, which indicates the ability of a substance to absorb and store thermal energy. Substances with high specific heat capacity can store more heat and maintain temperature for longer periods, thereby improving the effectiveness of heat or cold therapy (Lehmann, 1990).

From related articles and research studies, it has been found that gel compress pads made from polymer materials have been developed for medical therapy. Experiments have been conducted to compare the temperature-retention capability of newly developed gel pads with that of standard gel packs. The results showed that the developed gel pads were able to maintain temperature and provide therapeutic performance comparable to standard products. Additionally, they could be reused multiple times and had lower production costs, making them effective for use in healthcare and therapeutic applications (Panngam et al., 2016). Therefore, based on these reasons and research findings, the research team proposes to study and develop hot–cold gel packs made from locally available natural materials, while also investigating their thermal properties—particularly specific heat capacity and temperature-retention capability. The aim is to compare their efficiency with commercially available gel packs and evaluate the potential of natural materials in developing products that are effective, low-cost, and safe for users.

2. Materials and Methods

2.1. Materials and Apparatus

The experimental framework utilized the following materials and equipment as summarized in Table 1.

Table 1: List of materials and apparatus

Item description	Quantity	
KidBright boards	4	boards
USB	4	cable
DS18B20 temperature sensors	3	sensor
Infrared thermometer	1	unit
Insulated cups	3	cup
Aluminum 6061	3	rod
Filling starch	200	g
Tapioca starch	200	g
Aloe vera gel	200	g
Water	100	ml
Cucumber	50	g
Salt	3	tbsp
Sugar	2	tbsp
Digital weighing scale	1	unit
Blender	1	unit
Cooking pot	1	unit

2.2. Preparation of Gel Formulations

Formula 1: Tapioca Starch Gel

1.Mix 100 milliliters of water with 200 grams of tapioca starch.
2.Stir the mixture until the starch is completely dissolved.
3.Heat over medium heat while continuously stirring until the mixture thickens into a gel.
4.Remove from heat and allow to cool.
5.Divide the gel into 3 insulated cups and set aside.

Formula 2: Aloe Vera and Cucumber Gel

1.Cut 50 grams of cucumber into pieces and blend until smooth.
2.Strain the blended cucumber through a cheesecloth to obtain approximately 50 milliliters of cucumber juice.
3.Mix the cucumber juice with 100 milliliters of water, 200 grams of filling starch, and 200 grams of aloe vera gel.
4.Stir until the mixture is uniform.
5.Heat over medium heat while continuously stirring until it thickens into a gel.
6.Remove from heat and allow to cool.
7.Divide the gel into 3 insulated cups and set aside.

Formula 3: Salt and Sugar Gel with Filling Starch

1.Mix 100 milliliters of water with 200 grams of filling starch.
2.Add 3 tablespoons of salt and 2 tablespoons of sugar.
3.Stir until fully dissolved.
4.Heat over medium heat while continuously stirring until the mixture thickens into a gel.
5.Remove from heat and allow to cool.
6.Divide the gel into 3 insulated cups and set aside.

Formula 4: Salt Gel with Filling Starch

1.Mix 100 milliliters of water with 200 grams of filling starch.
2.Add 3 tablespoons of salt.
3.Stir until fully dissolved.
4.Heat over medium heat while continuously stirring until the mixture thickens into a gel.
5.Remove from heat and allow to cool.
6.Divide the gel into 3 insulated cups and set aside.

2.3. Experimental Procedures

This study was divided into two main phases: the determination of specific heat capacity and the analysis of temperature retention.

2.3.1. Procedure for the Determination of Specific Heat Capacity

1.The masses of the Aluminum 6061 rods and the prepared gel samples placed in the insulated cups were measured and recorded using a digital balance.
2.The initial temperature of the gel samples was measured and recorded prior to the experiment.
3.The aluminum rods were heated in boiling water (approximately 100 °C) until they reached a stable high temperature.
4.The aluminum rods were then removed from the boiling water, and their temperature was measured using an infrared thermometer until it reached approximately 80 °C.
5.The heated aluminum rods were placed into the insulated cups containing the gel samples.
6.A DS18B20 temperature sensor was inserted into each cup to monitor the temperature of the gel samples.
7.The sensors were connected to the KidBright board, and the pre-programmed system was initiated to record the temperature data every minute.
8.The recorded temperature data were then used to calculate the Specific Heat Capacity of each gel formulation, and the obtained values were averaged to determine the representative specific heat capacity of the gel samples.

Formula 3: Salt and Sugar Gel with Filling Starch

1.Mix 100 milliliters of water with 200 grams of filling starch.
2.Add 3 tablespoons of salt and 2 tablespoons of sugar.
3.Stir until fully dissolved.
4.Heat over medium heat while continuously stirring until the mixture thickens into a gel.
5.Remove from heat and allow to cool.
6.Divide the gel into 3 insulated cups and set aside.

Formula 4: Salt Gel with Filling Starch

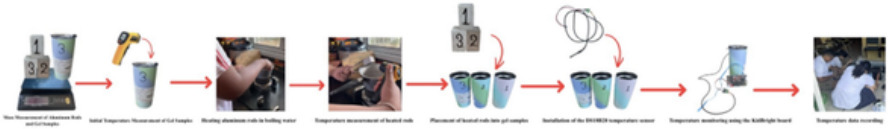

Figure 1: Experimental procedure for determination of specific heat capacity

2.3.2. Procedure for Evaluating Temperature Retention

1. The mass of each prepared gel sample was measured and recorded using a digital balance.
2. The initial temperature of the gel samples was measured and recorded using an infrared thermometer.
3. The gel samples were then heated by immersion in boiling water until a stable temperature was reached.
4. The gel samples were maintained in their experimental containers throughout the experiment.
5. A DS18B20 temperature sensor was inserted into each gel sample to monitor the temperature.
6. The sensors were connected to the KidBright microcontroller board for data collection.
7. Temperature measurements were recorded at 5-minute intervals throughout the experiment.
8. All temperature data were recorded and stored for subsequent analysis of the temperature retention properties of the gel samples.

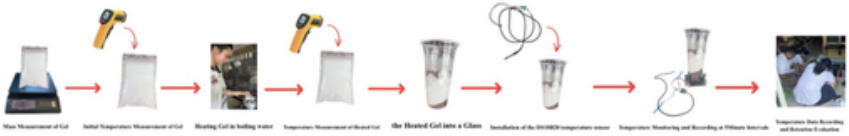

Figure 2: Experimental procedure for evaluating temperature retention

2.3.3. Determination of Specific Heat Capacity Based on Thermal Equilibrium

The determination of specific heat capacity in this study was based on the principle of thermal equilibrium, which is a fundamental concept in physics used to explain heat transfer between objects with different temperatures. When two objects at different temperatures come into contact, heat flows from the object with the higher temperature to the object with the lower temperature. This heat transfer process continues until both objects reach the same temperature, known as the equilibrium temperature. At this state, there is no net heat transfer between the objects.

In this experiment, the principle of thermal equilibrium was applied to determine the specific heat capacity of the gel samples. When the heated aluminum rod was placed in contact with the gel, heat was transferred from the aluminum rod to the gel until both reached the same final temperature. According to the law of conservation of energy, the amount of heat lost by the object with the higher temperature is equal to the amount of heat gained by the object with the lower temperature.

1. The amount of thermal energy can be calculated using the heat capacity equation $Q = mc\Delta T$ where Q represents the thermal energy (J), m is the mass of the substance (g), c is the specific heat capacity (cal/g·°C), and ΔT is the change in temperature (°C).
2. According to the principle of thermal equilibrium, the heat lost by the hotter object is equal to the heat gained by the cooler object, which can be expressed as $Q_{lost} = Q_{gained}$.
3. By substituting the heat capacity equation into the equilibrium condition, the relationship between the aluminum rod and the gel sample can be expressed as $m_1c_1(T_1 - T_F) = m_2c_2(T_F - T_2)$ where m_1 and c_1 represent the mass and specific heat capacity of the aluminum rod, m_2 and c_2 represent the mass and specific heat capacity of the gel, T_1 is the initial temperature of the aluminum rod, T_2 is the initial temperature of the gel, and T_F is the final equilibrium temperature of the system.

3. Results and Discussion

3.1. Analysis of Specific Heat Capacity

The experimental results of the specific heat capacity of the developed gel formulations were systematically analyzed and compared with those of a standard commercial gel in order to evaluate the thermal absorption and heat retention capabilities of each formulation. In this experiment, an Aluminum 6061 rod was employed as the heat transfer medium for the gel samples due to its well-established specific heat capacity value of 0.214 cal/g•°C. This known value was used as a reference for the calculation and analysis of the experimental data. The resulting measurements were subsequently utilized to assess and compare the thermal properties of the developed gel formulations with those of the standard commercial gel.

The graph presents a comparison of the specific heat capacity between the standard commercial gel and the four developed gel formulations, namely aloe vera-cucumber gel, tapioca starch gel, salted starch gel, and sugar-salt starch gel. The experimental results indicate that the specific heat capacities of the different gel formulations show slight variations. Based on the average values, the tapioca starch gel exhibited the highest specific heat capacity at 1.14 ± 0.17 cal/g•°C, followed by the standard commercial gel at 1.08 ± 0.11 cal/g•°C. The salted starch gel showed a value of 1.02 ± 0.075 cal/g•°C, while the aloe vera-cucumber gel exhibited 0.92 ± 0.11 cal/g•°C, and the sugar-salt starch gel had the lowest value at 0.88 ± 0.026 cal/g•°C, respectively.

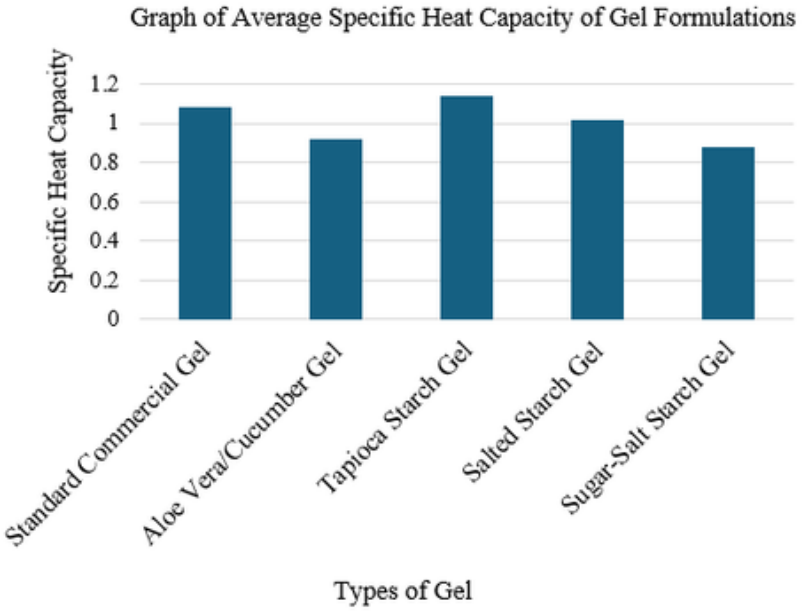

Figure 3: Comparison of the average specific heat capacity of the standard gel and the developed gel formulations

3.2. Temperature Retention

This section presents a comparison of the heat retention duration between the standard gel and the four developed gel formulations. The results indicate that the standard gel exhibited the longest heat retention time, maintaining heat for 3 hours and 45 minutes. This was followed by the tapioca starch gel, which retained heat for 3 hours and 34 minutes, and the aloe vera–cucumber gel, which maintained heat for 3 hours and 18 minutes. In contrast, the salted starch gel and the sugar–salt starch gel retained heat for 2 hours and 46 minutes and 2 hours and 31 minutes, respectively. Overall, the developed gel formulations demonstrated heat retention durations that were relatively comparable to that of the standard gel. Furthermore, these formulations utilize natural materials that are readily available in local communities, which can significantly reduce production costs. Therefore, the developed gels show strong potential for application as an alternative hot compress gel for alleviating muscle and joint pain, as shown in Figure 4.

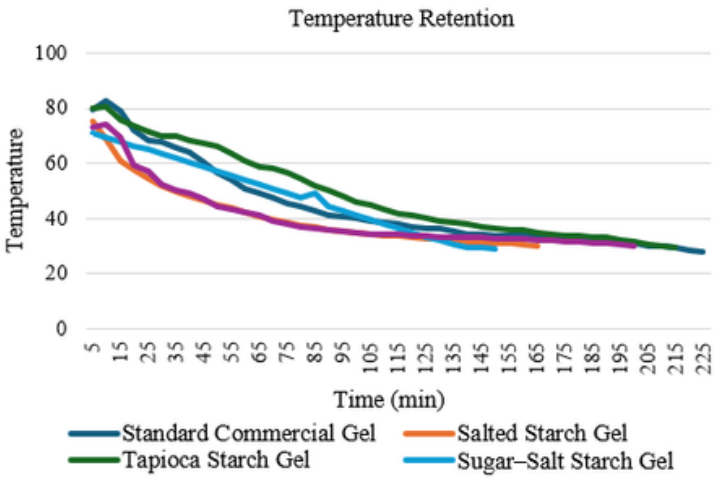

Figure 4: Temperature retention of the standard gel and the developed gel formulations

4. Discussion

Based on the experimental findings regarding the innovation of a fabricated gel pad for nursing therapeutic applications, it was found that gel pads developed from readily available materials can achieve performance comparable to that of commercial standard gel packs. The gel was produced using synthetic polymer fibers obtained from disposable baby diapers, mixed with purified water at an optimal ratio of 60 milliliters of water per 1 gram of polymer fiber. This proportion yielded the clearest and most homogeneous gel texture, likely because purified water contains minimal impurities, thereby enhancing the water absorption capacity of the polymer. Furthermore, the results indicated that a gel pad containing 4 grams of gel was the most suitable for hot compress applications. It was able to maintain tissue temperature within the therapeutic range of approximately 38–40°C for about 20 minutes, which corresponds to the standard duration recommended for heat therapy in clinical practice (Bleakley et al., 2004). No skin irritation was observed among the volunteers who participated in the experiment, suggesting that the material is safe for dermal contact. Additionally, the production cost of the gel pad was relatively low, approximately 1.20 Thai Baht per piece, and the pad could be reused up to nine times, resulting in an average cost of approximately 0.13 Baht per use, which significantly reduces financial constraints in healthcare settings.

In conclusion, the innovative gel pads developed from polymer fibers derived from disposable diapers and from natural materials demonstrate considerable potential as cost-effective alternatives to commercial gel packs. These fabricated gels are capable of maintaining therapeutic temperatures for durations ranging from approximately 20 minutes to over 3 hours, depending on the material composition. This finding aligns with established therapeutic principles regarding the use of heat and cold in the treatment of soft-tissue injuries (Bleakley et al., 2004; Kumar et al., 2010). Moreover, the materials used are inexpensive, easily accessible, and safe for skin contact. Therefore, the developed gel pads present a practical and economical option for application in nursing care and healthcare services. The findings are also consistent with previous research on the application of polymer gel compresses in nursing practice (Panngam et al, 2016).

5. Conclusions

The experimental results demonstrated that each gel formulation exhibited different values of specific heat capacity and heat retention duration. Among the developed formulations, the tapioca starch gel showed the best overall performance, with a specific heat capacity of 1.14 ± 0.17 cal/g·°C, which is approximately 5.6% higher than that of the standard commercial gel. This indicates a greater ability to absorb and store thermal energy. In addition, the tapioca starch gel was able to retain heat for 3 hours and 34 minutes, which is comparable to the standard commercial gel that maintained heat for 3 hours and 45 minutes.

Furthermore, the tapioca starch gel is produced from natural materials that are readily available in local communities, has a low production cost, and is safe for users. Therefore, this formulation demonstrates strong potential for further development as a cost-effective and environmentally friendly alternative to commercially available gel products for hot compress therapy.could be reused up to nine times, resulting in an average cost of approximately 0.13 Baht per use, which significantly reduces financial constraints in healthcare settings.

6. Acknowledgements

This research was successfully completed with the guidance and support of many individuals. The researcher would like to express sincere gratitude to Piya Palakhoj for his valuable advice, suggestions, and continuous guidance throughout the research process. The researcher would also like to thank everyone who contributed assistance and support during this study. Finally, the researcher expresses heartfelt appreciation to their parents and family for their constant encouragement and support. Any errors or shortcomings in this research remain the responsibility of the researcher, and it is hoped that this study will be beneficial for future research and knowledge development.

The authors would like to thank the editors for their assistance in formatting the manuscript to meet the proceedings guidelines.

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A Comparative Study of Velocity Measurements Between GPS Sensors, Mobile GPS and Physical Speed to Evaluate Accuracy and Operational Limitations

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Abstract: This study compared the velocity and positional accuracy of three GPS sensors Ublox NEO-6M, Ublox NEO-7M, and L86-M33 tested on a motorcycle at speeds of 10, 20, 30, 40, 50, 60, 70, and 80 km/h. While the L86-M33 provided mean speeds closest to physical values (8.43, 18.60, 28.36, 38.54, 47.42, 58.70, 68.33 and 78.35km/h), the Ublox NEO-7M demonstrated the highest geographic precision. In comparison to the reference point (8.67542° N, 99.94793° E), the Ublox NEO-7M achieved the most accurate coordinates (8.675739° N, 99.947954° E), followed by the L86-M33 (8.675335° N, 99.94792167° E), while the Ublox NEO-6M showed the lowest precision (8.65021° N, 99.88142° E). The data also revealed slight coordinate fluctuations as velocity increased. In conclusion, while the L86M33 excelled in velocity measurement, the Ublox NEO-7M proved superior in positional accuracy. These findings serve as a critical guideline for hardware selection and future developments in satellite-based positioning systems.

Keywords: GPS sensor performance, Velocity measurement accuracy, Positional precision, Comparative analysis, L86M33

1. Introduction

Global Positioning System (GPS) technology has currently become a cornerstone of daily life and broad technological development, encompassing applications such as navigation, vehicle tracking, surveying, and integration into various transportation systems and electronic devices. GPS sensors serve as critical instruments that receive satellite signals to calculate geographic coordinates and determine movement velocity. Nevertheless, various GPS sensor models exhibit differing levels of efficiency and accuracy in measuring speed and identifying precise latitude and longitude coordinates.

Presently, several GPS sensors with varying specifications have been developed, including the U-blox NEO6M, U-blox NEO-7M, and L86-M33 models frequently utilized in electronics and embedded systems. Selecting the most suitable sensor necessitates a thorough evaluation of its performance and reliability in real-world scenarios, particularly regarding velocity measurement and geographic positioning.

Consequently, this study aims to compare the performance of these three GPS models: U-blox NEO-6M, U-blox NEO-7M, and L86-M33. The experimental framework evaluates velocity measurements during actual motorcycle transit at various speeds and compares latitude and longitude data against a mobile GPS reference to assess the precision and limitations of each model. The findings are expected to provide essential guidelines for sensor selection and serve as a foundation for future advancements in satellite-based positioning accuracy.

2. Materials and Methods

2.1. Materials and Apparatus

The experimental framework utilized the following materials and equipment as summarized in Table 1.

Table 1: List of materials and apparatus

Item description	Quantity	
ESP32 NodeMCU ESP-32S	1	unit
Jumper wires	12	pieces
Sensor gps ublox neo 6m	1	unit
Sensor gps ublox neo 7m	1	unit
Sensor gps Quectel L86-M33	1	unit
Micro USB Data cable	3	piece

Presently, several GPS sensors with varying specifications have been developed, including the U-blox NEO6M, U-blox NEO-7M, and L86-M33 models frequently utilized in electronics and embedded systems. Selecting the most suitable sensor necessitates a thorough evaluation of its performance and reliability in real-world scenarios, particularly regarding velocity measurement and geographic positioning.

2.2. Experimental Procedures

1.Equipment preparation. Prepare three GPS sensor models: U-blox NEO-6M, U-blox NEO-7M, and L86M33, along with an ESP32 microcontroller and a smartphone with GPS capabilities to serve as the reference for positioning data.
2.System development. Connect the three GPS sensors to the ESP32 board and develop a firmware using the Arduino IDE to receive speed data and geographic coordinates (Latitude and Longitude) from the sensors.
3.Hardware installation. Install the GPS sensors and the ESP32 microcontroller on a motorcycle for data collection during movement. 4. Speed Measurement Testing: Conduct the experiment by riding the motorcycle at controlled speeds of 10, 20, 30, 40, 50, 60, 70, and 80 km/h. The motorcycle's speedometer is used as the physical speed reference, and the corresponding data from the GPS sensors are recorded for comparative analysis.
4.Coordinate accuracy testing. Establish one fixed reference point using the smartphone's GPS. Drive the motorcycle through this point at speeds of 20, 40, 60, and 80 km/h while recording the latitude and longitude coordinates obtained from each GPS sensor.
5.Data analysis. Analyze the collected data by comparing the speed measured by the GPS sensors against the physical speed. Additionally, calculate the positional deviation between the sensor coordinates and the reference point to evaluate the accuracy and efficiency of each GPS sensor model.

3. Results and Discussion

3.1. Mathematical Components

3.1.1. Global Positioning System (GPS)

The Global Positioning System (GPS) is a satellite-based navigation system used to determine positions on the Earth's surface. It consists of three main components: the space segment (satellites), the control segment (ground control stations), and the user segment (GPS receivers such as modules or smartphones). A GPS receiver obtains time and position data from satellites to calculate geographic coordinates, including latitude, longitude, and altitude, as well as velocity and direction. The distance between a satellite and the receiver can be calculated using $d = c \times t$ where d is distance, c is the speed of light, and t is the signal travel time.

3.1.2. Trilateration Principle

GPS determines the receiver's position using trilateration, which calculates location based on distances from multiple satellites. If signals from at least three satellites are received, a two-dimensional position can be determined. With four or more satellites, a three-dimensional position including altitude can be calculated.

3.1.3. Speed Measurement Using GPS

GPS can measure the speed of a moving object by calculating the change in position over time. The velocity is determined using v = s/t where v is velocity, s is distance traveled, and t is time.

3.1.4. Geographic Coordinates (Latitude and Longitude)

The geographic coordinate system identifies locations on Earth using latitude and longitude. Latitude represents positions north or south of the Equator, while longitude represents positions east or west of the Prime Meridian. Coordinates are commonly expressed in decimal form, such as 8.67542° N and 99.94793° E, which is widely used in GPS and digital mapping systems.

3.1.5. GPS Signal Errors

GPS positioning may contain errors due to atmospheric delays, satellite clock inaccuracies, orbital data errors, and signal reflections from surrounding objects. The positional error can be calculated using Error = $|X_{measured} - X_{true}|$ where $X_{measured}$ is the measured position and X_{true} is the reference position.

3.2. Comparison of Physical Speed from Motorcycle Movement vs. Speed Measured by GPS Sensors

Based on the experiment measuring motorcycle speeds at physical intervals of 10, 20, 30, 40, 50, 60, 70, and 80 km/h, the study aimed to investigate the relationship between physical speed and the speed data recorded by three different GPS sensor models: Ublox NEO-6M, Ublox NEO-7M, and L86-M33. The experimental results are illustrated in Figure 1. From Figure 1, it is observed that each sensor model can measure speed closely to the actual physical speed, though with varying degrees of error. The L86-M33 sensor provides the highest accuracy, with readings closest to the actual speed across all speed ranges. This is followed by the Ublox NEO-7M and the Ublox NEO-6M, respectively.

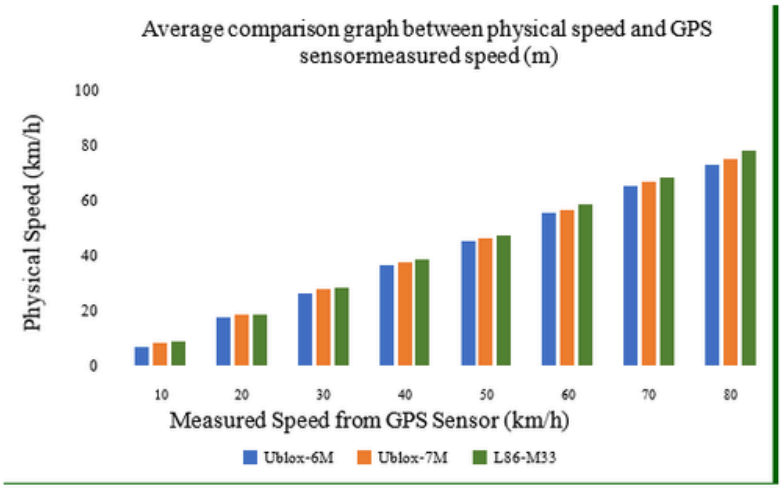

Figure 1: Relationship between physical speed and speed measured by GPS sensors

3.3. Comparison between Reference GPS Coordinates from a Mobile Device and GPS Sensor Measurements

In this section of the experiment, a comparison of geographical coordinates—Latitude and Longitude—was conducted between a mobile phone's GPS system and three GPS sensor models: Ublox NEO-6M, Ublox NEO-7M, and L86-M33. A single reference point was established by dropping a pin at a specific location using the mobile phone's GPS. Subsequently, all three GPS sensors were installed on a motorcycle, which was then driven through the pinned location while recording data. This process was repeated three times to calculate the average results. The experimental findings are presented in Table 2 and Figure 2.

Table 2: Comparison of average latitude and longitude coordinates

Physical speed (km/h)	Mobile phone GPS location	Measured GPS Coordinates		
		U-blox NEO-6M	U-bloxNEO-7M	L86-M33
20	8.668198, 99.88997	8.668343555, 99.89008	8.668087333, 99.88998017	8.668232222, 99.890085
40	8.668198, 99.88997	8.668373944, 99.89004722	8.668296 , 99.89005867	8.668041667, 99.89002722
60	8.668198, 99.88997	8.667686833, 99.88997183	8.667951667, 99.88999789	8.667979445, 99.88999778
80	8.668198, 99.88997	8.668053722, 99.89000467	8.668126111, 99.89000661	8.667793332, 99.88996889

From Table 2, comparing the latitude and longitude coordinates between the mobile phone GPS and the three GPS sensor models at speeds of 20, 40, 60, and 80 km/h, it was found that the coordinates were closely aligned but exhibited minor deviations. The Ublox NEO-7M sensor provided the most accurate coordinates relative to the reference point, followed by the L86-M33 and the Ublox NEO-6M, respectively.

3.4. Positional Error of GPS Sensor Measurements

Based on the experiment in Section 3.3, the average coordinates measured by the GPS sensors were used to determine the positional error relative to the reference coordinates from the mobile phone's GPS system at speeds of 20, 40, 60, and 80 km/h. The averaged coordinates were input into the mobile GPS system to calculate the distance between the sensor-measured positions and the reference point. These distance values were then compared and analyzed to evaluate the accuracy of each sensor model, as illustrated in Figure 2.

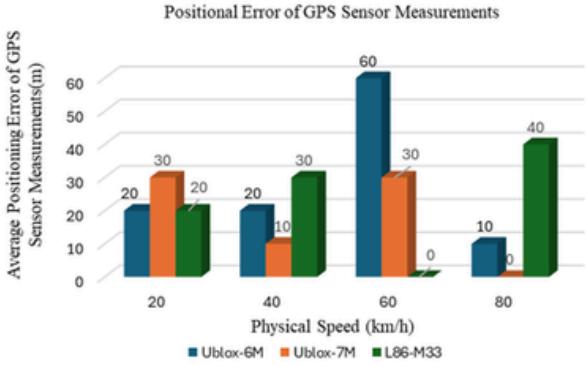

Figure 2: Positional error of GPS sensor measurements

The experimental results indicate that the U-blox NEO-7M has the smallest distance from the reference point, demonstrating the highest positioning accuracy. This is followed by the L86-M33 and the U-blox NEO-6M, which exhibited the largest distance from the reference point, respectively.

An example of inputting the average coordinates obtained from the GPS sensors at a speed of 80 km/h into the mapping system to calculate the distance from the reference point is shown in Figure 3. This figure illustrates a comparison of the positions recorded by the U-blox NEO-6M, U-blox NEO-7M, and L86-M33 sensors against the reference position from the mobile phone's GPS.

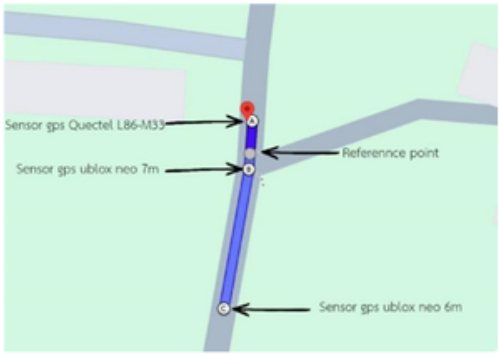

Figure 3. Comparison of coordinate positions from the three GPS sensor models against the reference position.

3.5. Discussion

From the analysis and comparison of the experimental results obtained from the three GPS sensors U-blox NEO-6M, U-blox NEO-7M, and L86-M33 it was found that the overall results are consistent with the theoretical principles of the Global Positioning System (GPS/GNSS). The theory explains that the position of a receiver is calculated by receiving signals from multiple satellites and applying the trilateration principle to determine geographic coordinates, namely latitude and longitude. However, the accuracy of the calculated position can be affected by several factors, such as environmental conditions, the number of satellites available for signal reception, and signal errors caused by atmospheric interference (Kaplan & Hegarty, 2022).

When comparing the latitude and longitude coordinates measured by the three sensors with the reference coordinates obtained from a smartphone, the results show that all sensors were able to provide coordinates close to the reference values, although slight deviations were observed. The experimental results indicate that the U-blox NEO-7M sensor produced the average coordinates closest to the reference values, followed by the L86-M33 and U-blox NEO6M, respectively. These differences may be attributed to variations in receiver capability, satellite signal sensitivity, and signal processing technologies among the sensors (Radicioni et al., 2023; Wang et al., 2023).

In addition, this study compared the physical speed of movement with the speed values measured by the GPS sensors. The experiment was conducted at speeds of 10, 20, 30, 40, 50, 60, 70, and 80 kilometers per hour. The results showed that as the physical speed increased, the speed values measured by the GPS sensors also increased correspondingly. This indicates that the sensors were able to track changes in movement speed in accordance with actual motion. However, slight discrepancies were observed in some cases, particularly during the initial movement or when speed changes occurred. These discrepancies may result from the limitations of the update rate of the sensors and the time required for satellite signal processing (Andreas et al., 2025).

When comparing the speed values obtained from the three sensors with the actual physical speed, it was found that the L86-M33 sensor measured speeds closest to the physical speed, followed by the U-blox NEO-7M sensor, while the U-blox NEO-6M showed slightly larger deviations. These results indicate that each sensor has different performance levels in speed measurement. Such differences may arise from variations in satellite signal processing capability, signal reception sensitivity, and update rate among the sensors. Furthermore, it was observed that at higher speeds, the speed values reported by the sensors tended to be closer to the actual physical speed. This may occur because the positional changes between time intervals become more distinct, allowing the GPS system to calculate speed more accurately.

The results of this experiment also demonstrate that low-cost GPS sensors can still effectively measure both position and speed of movement. This finding is consistent with previous studies evaluating the performance of lowcost GNSS receivers, which reported that such devices can be applied in vehicle positioning and navigation systems, although some level of error may occur compared to higher-precision equipment (Radicioni et al., 2023; Wang et al., 2023).

Moreover, previous research has shown that although the U-blox NEO-6M sensor is an inexpensive and widely used module in microcontroller and electronics projects, it can still provide position data with sufficient accuracy for general applications. Nevertheless, this sensor may have limitations in terms of update rate and signal stability, particularly in certain environmental conditions (Siechko et al., 2025).

In conclusion, the results of this study demonstrate that all three GPS sensors U-blox NEO-6M, U-blox NEO7M, and L86-M33 are capable of measuring both positional coordinates and movement speed. The U-blox NEO-7M sensor showed the highest positional accuracy relative to the reference coordinates, while the L86-M33 sensor provided speed measurements closest to the actual physical speed, followed by U-blox NEO-7M and U-blox NEO-6M, respectively. However, the accuracy of the obtained data still depends on environmental conditions, the number of available satellites, and the characteristics of each sensor. These findings highlight the potential of low-cost GPS sensors for applications in position tracking, navigation systems, and future research in satellite-based positioning technologies.

4. Conclusions

Based on the comparative performance study of three GPS sensor models U-blox NEO-6M, U-blox NEO-7M, and L86-M33 conducted by installing the sensors on a motorcycle and testing at speeds of 10, 20, 30, 40, 50, 60, 70, and 80 km/h, the results comparing measured speed and coordinates against the actual speed and mobile phone GPS reference are summarized as follows:

1.Speed measurement accuracy. All sensors were capable of measuring speed close to the actual value, though with varying degrees of error. The L86-M33 provided the most accurate speed readings, followed by the U-blox NEO-7M and the U-blox NEO-6M, respectively.

2.Positional accuracy (latitude and longitude). From the coordinate comparison with the mobile phone GPS, it was found that the U-blox NEO-7M provided the coordinates closest to the reference position, followed by the L86-M33 and the U-blox NEO-6M, respectively.

3.Positional error. Positional errors varied across different speed intervals, which may be attributed to satellite signal reception, environmental factors, and the movement speed during the experiment.

In summary, the L86-M33 demonstrated the best performance in speed measurement, while the U-blox NEO-7M exhibited the highest positioning accuracy in this study.

5. Acknowledgements

This research was successfully completed with the kind guidance, support, and valuable suggestions provided throughout the study. The researcher would like to express sincere gratitude to Piya Phalakhoj, the research advisor, for his generous assistance, constructive comments, and careful guidance in correcting and improving this work with great attention and dedication. His knowledge, instruction, and encouragement have been invaluable to the completion of this research. The researcher would like to express the deepest appreciation for his support and mentorship.

In addition, the researcher would like to extend sincere thanks to all teachers and staff members who provided helpful advice, support, and necessary assistance throughout the research process. Appreciation is also extended to friends who offered encouragement, cooperation, and the exchange of ideas, which greatly contributed to the successful completion of this study.

Finally, the researcher would like to express heartfelt gratitude to their parents and family for their constant encouragement, support, and inspiration throughout the entire research process. Any errors or shortcomings in this research remain the responsibility of the researcher. It is hoped that this study will be beneficial for further study and future development in related field.

The authors would like to thank the editors for their assistance in formatting the manuscript to meet the proceedings guidelines.

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Study on the Heating Efficiency of Polyimide Electric Heating Films and Thermal Storage Performance Evaluation of Thermal Conductive Gels

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Abstract: This research aims to investigate the heating efficiency of polyimide electric heating films together with the thermal performance evaluation of thermal conductive gels. The study is divided into two main sections first analyzing the relationship between electrical potential ranging from 1 to 12 V and the surface temperature of the film second evaluating heat transfer efficiency by comparing the input electrical power with the thermal energy absorbed by the gel. Experimental results indicate a clear linear relationship between surface temperature and electrical potential. Within a 300 second heating period the maximum temperature increased from 31.00 °C at 1 V to 102.25 °C at 12 V. Furthermore, the thermal performance evaluation conducted over a 50 minute duration revealed average efficiencies of 86.07%, 95.48%, and 69.65% at electrical potentials of 6 V, 9 V, and 12 V respectively. The results demonstrate that polyimide heating films exhibit high stability and accurate responsiveness to electrical potential control. For medical heat compression applications an electrical potential of 9 V is identified as the optimal level because it maintains temperatures within the therapeutic range of 40-45 °C during the eighth to eleventh minutes of operation while achieving the highest thermal efficiency of 95.48%.

Keywords: Polyimide heating film, Thermal conductive gel, Heat transfer efficiency, Medical heat compression device

1. Introduction

Medical heat compression devices play a vital role in the therapeutic treatment of muscle and tissue conditions. Thermal therapy effectively enhances blood circulation, reduces muscle tension, and alleviates pain. Generally, the optimal temperature for therapeutic heat compression ranges between 40°C and 45°C, and it should strictly not exceed 50°C to prevent thermal injury to the tissues (Ma et al., 2022). However, conventional heat compression equipment often lacks precise temperature control systems, which may pose significant safety risks to users.

Polyimide heating films are distinguished by their thinness, flexibility, and ability to distribute heat uniformly. Consequently, they have been extensively integrated into the development of flexible heating components within modern electronics and engineering applications (Panda et al., 2022; Zhang et al., 2024). When utilized in conjunction with thermal conductive gels—noted for their superior heat retention and transfer capabilities—the overall efficiency of heat delivery from the source to the target surface is significantly enhanced (Chen at al., 2022). Previous research has explored the development of flexible heating elements for wearable and medical devices to improve temperature stability and heating performance (Zhang et al., 2024).

Therefore, this research aims to investigate the relationship between electrical potential and the surface temperature of polyimide films, while evaluating the heat transfer efficiency through thermal conductive gels. The study seeks to determine the optimal electrical potential for safe application in medical heat compression devices, based on the fundamental principles of heat transfer and electrical energy (Park et al., 2022).

2. Materials and Methods

2.1. Materials and Apparatus

The experimental framework utilized the following materials and equipment as summarized in Table 1.

Table 1: List of materials and apparatus

Item description	Quantity	
DC power supply	1	unit
Polyimide electric heating film	1	piece
KidBright board	1	unit
Arduino board	1	unit
GY-906 MLX90614 infrared temperature sensor	1	unit
DS18B20 Temperature sensor	1	unit
Jumper wires	7	pieces
USB type-A to type-B cable	1	piece
Micro USB data cable	1	piece
Digital weighing scale	1	unit
Thermal insulated container	1	unit
Hot/cold gel (100 g)	1	piece
Adhesive tape	1	roll
Clamp	1	unit
Ruler	1	unit

2.2. Experimental Procedures

The research was structured into two primary stages to characterize the material's thermal properties and evaluate its efficiency when integrated with a gel medium.

2.2.1. Analysis of the Relationship between Electrical Potential and Maximum Temperature

1. The polyimide heating film was connected to a DC Power Supply. An Arduino board was interfaced with a DS18B20 sensor to monitor the surface temperature of the film.
2. The Arduino board was programmed to retrieve and display temperature data from the GY-906 MLX90614 infrared sensor.
3. The electrical potential supplied to the heating film was incrementally adjusted within a range of 1 V to 12 V.
4. For each level of electrical potential, the system was maintained until the film temperature stabilized, after which the maximum temperature was recorded to analyze the relationship and trends in temperature variation.

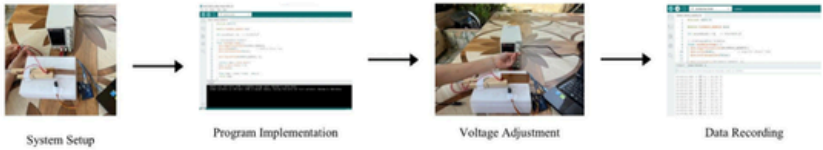

Figure 1: Experimental workflow for phase 1

2.2.2. Evaluation of Electrical-to-Thermal Energy Conversion Efficiency in Gel

1. The KidBright board was connected to the DS18B20 sensor and programmed for real-time temperature data acquisition and display.
2. A 100 g sample of hot/cold gel was measured using a digital scale and placed into a thermal insulated container.
3. The polyimide heating film was installed in direct contact with the gel inside the container, with the DS18B20 sensor positioned to measure the temperature within the gel mass.
4. The system was connected to the DC Power Supply, with the electrical potential set at three test levels: 6 V, 9 V, and 12 V.
5. Gel temperature was logged every 1 minute for a total duration of 50 minutes. Each electrical potential level was tested in triplicate to calculate mean values and ensure data accuracy.
6. The recorded mean temperature data were used to construct time-temperature relationship graphs.
7. The thermal energy absorbed by the gel (Q) was calculated and compared with the input electrical power (P_1) to determine the heat transfer efficiency (η).

Figure 2: Experimental workflow for phase 2

2.2.3. Determination of Heat Transfer Efficiency

1. The measured electrical potential difference and electric current were used to calculate the electrical power input supplied to the system as expressed in $P_1 = IV$ where P_1 represents the input electrical power in Watts (W), I is the electrical current in Amperes (A), and V is the electrical potential in Volts (V).
2. The thermal energy stored in the gel was calculated using the heat capacity equation $Q = mc\Delta T$ where Q denotes the thermal energy in Joules (J), m is the mass of the gel in grams (g), c is the specific heat capacity of the gel (cal/g°C), and ΔT is the observed temperature change in degrees Celsius (°C).
3. After obtaining the thermal energy absorbed by the gel, the thermal power output of the gel was calculated by considering the heating duration of 50 minutes: $P_2 = Q/t$ where P_2 represents the thermal power output and t signifies the heating duration in seconds (s).
4. Finally, the efficiency of the electrical energy converted into thermal energy in the gel was calculated and expressed as a percentage $\eta = (P_2/P_1) \times 100$ where η is the efficiency percentage.

3. Results and Discussion

3.1. Analysis of the Relationship between Electrical Potential and Maximum Temperature

The thermal performance of the polyimide heating film was evaluated by adjusting the electrical potential from 1 V to 12 V to observe the trend in maximum temperature variation. It was found that as the electrical potential increased, the peak surface temperature of the film exhibited a continuous upward trend. At an electrical potential of 12 V, the film reached an average maximum temperature of 102.25°C. These results confirm that electrical potential is a primary variable that directly influences the temperature, allowing for effective heat regulation as shown in Figure 3.

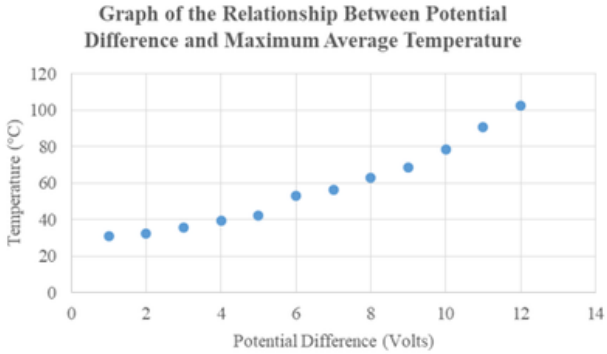

Figure 3: Relationship between electrical potential and maximum temperature of the polyimide heating film

3.2. Comparative Thermal Performance in Conductive Gel

This section evaluates the performance of the polyimide film when integrated with a thermal conductive gel. The temperature changes were compared at electrical potentials of 6 V, 9 V, and 12 V over a 50-minute duration. The results indicated that at 12 V, the temperature increased most rapidly but exceeded safe levels for medical applications. Conversely, the 9 V potential provided a steady and stable temperature increase, which is more suitable for medical use, as shown in Figure 4.

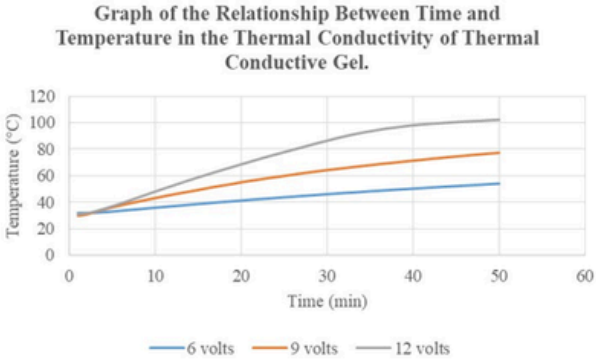

Figure 4: Comparison of gel temperatures at 6, 9, and 12 V electrical potentials

3.3. Heat Transfer Efficiency

Numerical data from the experiments were utilized to calculate the mean heat transfer efficiency (η) for a quantitative performance comparison. The summary of mean performance and the comparative graph are presented in Table 2 and Figure 5, respectively.

Table 2: Summary of mean thermal performance and heat transfer efficiency

Electrical Potential (V)	Final Average Temperature (°C)	Average Efficiency (η)
6	51.46	86.07%
9	77.14	95.48%
12	98.32	69.65%

According to Table 2 and Figure 5, the electrical potential of 9 V yielded the highest efficiency at 95.48%, representing the optimal energy level for heat absorption by the gel. At 12 V, the efficiency decreased to 69.65% due to excessive heat dissipation into the environment outstripping the absorption capacity of the gel medium.

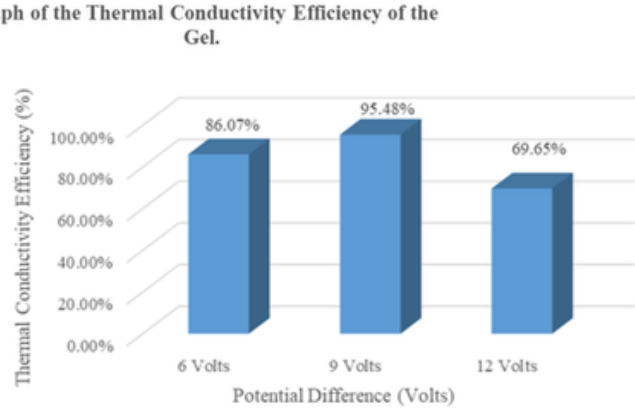

Figure 5: Heat transfer efficiency of the gel at different electrical potentials

3.4. Discussion

From the comparative analysis between the obtained experimental results and the data reported in related research articles, it was found that the experimental findings are consistent with theoretical principles, although differences exist in terms of the materials used and the level of quantitative data, particularly in studies concerning thermally conductive hydrogels for biomedical applications (Chen et al., 2022).

Firstly, regarding the fundamental principle of heat generation from electrical current, the experimental results are consistent with the principle of Joule Heating, which states that an increase in potential difference leads to an increase in electrical current passing through a conductor, resulting in greater heat generation and consequently a rise in the temperature of the material. The obtained experimental results demonstrate that the maximum average temperature tends to increase as the applied potential difference increases. This observation is consistent with the aforementioned theory and also aligns with studies on thin-film heating devices used in wearable and medical applications (Panda et al., 2022; Park et al., 2022).

Furthermore, the use of thermal conductive gel in the experiment is conceptually consistent with research on hydrogels developed to enhance thermal conductivity. Previous studies have reported that incorporating carbon nanotubes into hydrogel structures can create a thermal conductive network, thereby improving heat transfer efficiency [1]. This concept is similar to the experimental approach in which thermal conductive gel was used together with a heating film to enhance heat transfer to the surface.

However, when considering the thermal performance of the materials, significant differences were observed between the experimental results and those reported in the referenced studies. Some previous studies utilized fabric-based or flexible materials coated with conductive substances, which produced temperatures within the medically appropriate range of approximately 40–45 °C (Panda et al., 2022; Park et al., 2022). In contrast, the present experiment employed a polyimide heating film capable of generating substantially higher temperatures, while also exhibiting excellent thermal stability and rapid heating response (Zhang et al., 2024). This finding indicates that the base material plays a significant role in determining heating performance.

In addition, the experimental results clearly identified an optimal potential difference suitable for medical applications. It was found that an applied voltage of 9 V could maintain the temperature within the range of approximately 40–45 °C, which is considered a safe and effective temperature range for biological tissues according to medical guidelines (Ma et al., 2022).

In conclusion, the results of this study are consistent with previous research in terms of the fundamental principles of electrical heat generation and the concept of using thermally conductive materials to enhance heat transfer. However, the combination of a polyimide heating film with thermal conductive gel provides improved heating performance and more effective temperature control. Moreover, the system can maintain temperatures within a medically safe range, demonstrating its potential for application in therapeutic heating devices and other biomedical heat-treatment technologies in the future.

4. Conclusions

4.1. Analysis of Research Findings

This study evaluated the thermal efficiency and stability of a polyimide heating film integrated with a thermal conductive gel for medical heat compression applications. The conclusions derived from the experimental results are as follows:
1.Thermal stability and control. The tests conducted within the 1-12 V range confirmed a linear correlation between electrical potential and the film's maximum temperature. At 12 V, the film reached a peak temperature of approximately 102.25°C. This indicates that electrical potential serves as a precise control variable for regulating heat levels in the device.

2.Heat transfer performance. The use of conductive gel significantly improved heat distribution uniformity. The 9 V potential achieved the highest average heat transfer efficiency at 95.48%, whereas the 6 V and 12 V potentials yielded efficiencies of 86.07% and 69.65%, respectively.

3.Optimal operational potential. From a medical safety perspective (Safety Threshold), the 9 V potential is determined to be the most suitable for practical use. It maintains a stable temperature within the therapeutic range of 40-45°C during the 8-11 minute usage window. This ensures patient safety by preventing thermal injury while maintaining maximum energy efficiency.

4.2. Recommendations for Future Research

Based on the limitations observed during this study, the following recommendations are proposed for future development:

1.Feedback control system. Future designs should incorporate an automated feedback control system to maintain a constant temperature throughout the duration of use and to prevent excessive long-term heat accumulation.
2.Advanced encapsulation materials. Subsequent studies should investigate various medical-grade encapsulation materials, such as silicone or specialized fabrics. This would allow for a more accurate assessment of environmental heat loss in conditions that closely simulate application on the human body.

5. Acknowledgements

This research was successfully completed with the kind guidance, support, and valuable suggestions provided throughout the study. The researcher would like to express sincere gratitude to Piya Phalakhoj, the research advisor, for his generous assistance, constructive comments, and careful guidance in correcting and improving this work with great attention and dedication. His knowledge, instruction, and encouragement have been invaluable to the completion of this research. The researcher would like to express the deepest appreciation for his support and mentorship.

In addition, the researcher would like to extend sincere thanks to all teachers and staff members who provided helpful advice, support, and necessary assistance throughout the research process. Appreciation is also extended to friends who offered encouragement, cooperation, and the exchange of ideas, which greatly contributed to the successful completion of this study.

Finally, the researcher would like to express heartfelt gratitude to their parents and family for their constant encouragement, support, and inspiration throughout the entire research process. Any errors or shortcomings in this research remain the responsibility of the researcher. It is hoped that this study will be beneficial for further study and future development in related field.

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