กลุ่มที่ 1

บทความระดับนานาชาติ

(International Papers)

Room 1:

Management, Liberal Arts

Effect of person- Job fit Degree on government officers' burnout:

The Moderating Effect of Professional Mission

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ABSTRACT

Reducing the burnout of grassroots civil servants can improve the work performance and policy implementation of government agencies, and improve the physical and mental health and public image of grassroots civil servants. In order to determine the relationship between the independent variable person Job matching, the influencing factors occupational mission and extrinsic motivation and job burnout, and to establish an effective human resource management model, this study collected 387 valid questionnaires, and analyzed data such as correlation analysis and moderating effect analysis. The results showed:

1) There is a significant negative correlation between person Job fit and job burnout, indicating that the higher the degree of person Job fit, the lower the degree of job burnout. There is a significant positive correlation between person Job fit and professional mission, indicating that the improvement of person Job fit degree is helpful to enhance the individual's sense of professional mission.

2) The sense of professional mission plays a moderating role in the relationship between person Job fit and job burnout, and the sense of professional mission of grassroots government officers enhances the negative impact of person Job fit on job burnout.

3) Extrinsic incentives play a moderating role in the relationship between person Job fit and job burnout, and the extrinsic incentives of grassroots government officers weaken the negative impact of job matching on job burnout.

Based on the findings and the actual situation in China, this study proposes a human resource management model to improve the degree of person Job matching, strengthen the sense of professional mission and make full use of external incentives. And put forward effective suggestions for reducing the burnout of grassroots civil servants.

KEYWORDS: Grassroots Government Officer; Person Job Fit; Burnout

1. Introduction

According to a 2018 People's Daily survey report, more than half of grassroots government officers said they were increasingly less enthusiastic about their work, with burnout ranging from severity to severity. Burnout refers to a lack of enthusiasm, a negative attitude, impatience, and irritability in the work environment. Burnout is accompanied by low self‑esteem, numbness, and external behaviors such as coping, malaise, apathy, and reluctance to innovate, and even more severe with self-denial, self-doubt, resignation, depression, suicide, etc. In organization and management, motivation as the driving force of employees' work has always been the focus of research. Psychologist Deci pioneered the distinction between external and internal motivation attributes. The former is mainly derived from the income return provided by the employer for the employee. The economic interest is closely related to its work behavior and results. The latter refers to the specific content, characteristics, or meaning of the work to meet the needs of the employee's preferences, self-worth realization, work fulfillment, etc., which is the employee's positive response to the work itself(Deci & Psychology, 1971). Person Job Fit is a Person Job Fit proposed by Edwards, that is, the degree of matching between the characteristics of the work or tasks performed by employees and their needs and abilities based on their characteristics, and the matching degree between employees' personal abilities, interests, personalities, preferences, and other characteristics and job positions(Edwards, 1991). Some researchers have pointed out that the burnout of government officers is at a medium-to-high level(Gangqiang, Zhihong, & Yangshu, 2017). Burnout not only hurts the health of government officers but also has adverse consequences for the stable development of society(Runxin, columns, & Mengyuan, 2023).

2. Research Objective

(1) To determine the impact of person Job fit on burnout among grassroots government officials.

(2) To develop a management model for the burnout of grassroots government officials based on person-job fit.

（3）Propose countermeasures to reduce burnout among government agency employees and provide valuable services to the public domain.

3. Literature Review

3.1 Theory, Concept and Related Research

Based on the theory of burnout, the theoretical model of burnout can be established around three dimensions: emotional exhaustion, depersonalization, and low personal fulfillment. The theory of job matching is based on the relevant theories of personality psychology and difference psychology, and it is a theory that people's characteristics are consistent with the nature of occupation. The primary and fundamental argument is that individual differences are universal, any individual has unique characteristics, and any professional position will have different demands on the skills, knowledge, ability, temperament, and psychological quality that staff should possess because of their various working conditions, working environment, and work nature. When people make career decisions, they should choose the matching career position according to their personality characteristics, that is, the matching of people and positions.

The concept of burnout in this study is Maslach because Maslach's three-dimensional burnout theoretical model is currently the most recognized, widely used, and frequently used in the field of burnout research; that is, burnout is a comprehensive psychological manifestation produced by individual practitioners in long-term work, which is manifested in three aspects, namely, emotional exhaustion, depersonalization and low self-fulfillment related to personal stress. This study defines person post matching as the relationship between personnel and positions. The matching of people and posts has double matching characteristics, and the job requirements need to match the person's knowledge reserve and technical ability. The remuneration needs to be matched with the motivation for the job. This is consistent with Edwards' definition of person-to-post matching.

Previous studies have shown that the main factors that cause burnout are resilience, low self-esteem, self-efficacy, perceived leadership support, workload, organizational mismanagement, and social factors. (Ashton-James & McNeilage, 2022; Efremova, 2020; Gascón et al., 2021; Roslan et al., 2021)，From the human resource management perspective, this paper explores the factors that reduce job burnout.

Research on matching people and jobs appears in organizational performance improvement management.(Gong et al., 2024; Hasan, Jawaad, & Butt, 2021; Tang, Shao, Chen, & Ma, 2021).This paper combines person Job Fit with burnout to explore the relationship between the two.

Career mission is a hot topic in the future research field of organizational management, and the research shows that career mission has a significant prosocial tendency in organizational management(Bloom, Colbert, & Nielsen, 2021; Cardona & Rey, 2022; Janssen, Torrens, Wesseling, Wanzenböck, & policy, 2021), and this paper takes career mission as a moderating variable to explore whether it has a relationship between person Job matching and job burnout.
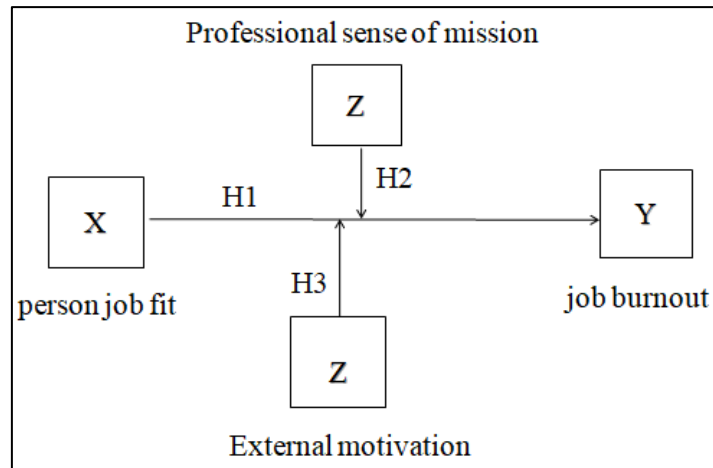
3.2 Research Framework

Figure 1 Research Framework

3.3 Research Hypotheses

H1: person Job fit for grassroots government officers is negatively correlated with burnout.

H2: professional mission has a moderating effect on the relationship between job matching and job burnout.

H3: Extrinsic motivation moderates the relationship between job matching and burnout.

4. Research Methodology

4.1 Research Design

In this study, Person Job fit was taken as the independent variable, burnout was taken as the dependent variable, and sense of mission and extrinsic motivation were taken as the moderating variables. Through the questionnaire survey method and the efficient software analysis method, the formation mechanism of job burnout was discussed, and effective suggestions were put forward for the next step to reduce job burnout and improve work performance.

4.2 Population and Sample

According to the Guangdong Provincial Appointment Government Network, there will be nearly 360,000 civil servants in Guangdong Province in 2023 and almost 200,000 grassroots civil servants in cities, counties, and districts. The scope of grassroots government officers in this study is the state public officials in Guangdong Province, China, whose administrative establishment belongs to the party and government departments at the county (city) level and below and works in the party and government departments at the county (city) level and below. Four hundred thirty-eight questionnaires were collected in this survey, and 387 valid questionnaires were left after screening.

4.3 Data Collection

The data collection uses the electronic upward distribution of questionnaires, with the main methods being forwarding to the circle of friends and distributing them through friends in government departments below

the county level. A total of 438 questionnaires were collected, and 387 valid questionnaires were obtained, with an effective rate of 88.36%, except for invalid missing answers, short-term random answers, and unified answers.

4.4 Data Analysis

1) Reliability analysis

variable	Item	Canbach
Person Job fit	4	0.890
Burnout	15	0.984
A sense of professional mission	12	0.980
Extrinsic motivation	4	0.892

2)Validity analysis

KMO value	Bart spherical values	*df*	*p* value
0.962	16940.701	595	0

3) Descriptive statistics and correlation analysis

	average value	standard deviation	Person-Job fit	Burnout	professional mission	Extrinsic motivation
Person Job fit	3.149	1.109	1			
Burnout	2.845	1.123	-0.433**	1		
professional mission	3.432	1.147	0.361**	-0.534**	1	
Extrinsic motivation	3.014	1.043	0.422**	-0.508**	0.414**	1

* $p<0.05$ ** $p<0.01$

5. Research Findings

This study has determined the effect of person Job fit, professional mission, and Extrinsic incentives on the Job burnout dependent variable. The result shows that X1 person Job fit, Z1 professional mission, and Z2 extrinsic incentives affect YJob burnout, and an empirical model has been formulated. From the result, it is shown that X1 provides the most effect on Y compared to the remaining X. Z1 and Z2 have a moderating impact on job matching and burnout. This study can be implemented.

	Research hypothesis	Test results
H1	Person Job fit for grassroots government officers is negatively correlated with burnout.	The assumption is true
H2	professional mission has a moderating effect on the relationship between job matching and job burnout.	The assumption is true
H3	Extrinsic motivation moderates the relationship between job matching and burnout	The assumption is true

6. Discussion

Through correlation analysis, it was found that there was a significant negative correlation between Person Job fit and job burnout and a significant positive correlation between Person Job fit and career mission and extrinsic motivation. There was a significant negative correlation between burnout and career mission. There is a positive correlation between career mission and extrinsic motivation.

Through two six regression models, it is found that there is an inverse relationship between Person Job fit and job burnout of grassroots government officers, and hypothetical H1 is true, indicating that the higher the degree of Person Job fit of grassroots government officers, the less noticeable the burnout phenomenon is, which is consistent with the previous research results. It is verified that the sense of professional mission and extrinsic motivation play a significant moderating role in the correlation between the two, and the negative correlation between them is enhanced. Hypothesis H2 is valid; that is, when the sense of professional mission of grassroots government officers is high, the negative correlation between Person Job fit and job burnout is stronger. When the sense of professional mission of grassroots government officers is low, the negative correlation between job matching and job burnout is weak. Extrinsic motivation plays the same moderating role as the sense of professional mission, but extrinsic motivation weakens the negative correlation between the two. That is, when the extrinsic incentive is high, the negative correlation between Person Job fit and burnout is weak. When extrinsic motivation is low, the negative correlation between job matching and job burnout is more robust, so it is assumed that H3 is valid.

7. Suggestion

(1) College students who have just stepped out of campus need more independent thinking about their career development planning to help graduating college students establish a good career outlook and improve their understanding of the degree of job matching.

Many college graduates choose to work as civil servants not because they like the work content of the profession itself but because they like the relatively stable working environment in the system or because they are only guided by their families to become members of this group. They need a comprehensive and correct understanding of the work of grassroots civil servants. Therefore, when choosing a job, you should properly assess and understand your personality, abilities, interests, and values. On this basis, you should find a job that

meets your needs to avoid falling into the trap of high burnout from the beginning. At the same time, we should also conscientiously understand that the work of grassroots civil servants is relatively simple in basics. Still, it is also a sacred duty entrusted by the party and the people, and grassroots civil servants need to have such political literacy and a clear understanding of the particularity of their posts so that they can more firmly overcome the troubles and difficulties they will face in their future work that are different from those of other ordinary posts.

（2）As a grassroots civil servant already on the job, he needs to learn to recognize and manage the pressure generated at work and alleviate or even overcome burnout through self-psychological adjustment.

Grassroots civil servants should realize that it is normal for the results of the work to be different from expectations. It is expected to encounter various obstacles in the job's progress because of the complexity of the grassroots governance environment. It should continue to improve their ability to perform their duties, pay attention to their mental health, take the initiative to learn relevant knowledge, and actively prevent the occurrence of burnout.

（3）Recruitment management bodies should improve the relevant systems for recruiting and retaining basic‑level civil servants, increasing the degree of matching between the recruited basic‑level civil servants and the jobs they enter.

（4）Departments at all levels should establish and improve grassroots government officers' training and rotation mechanisms.

All departments should thoroughly combine their realities, formulate scientific and complete training plans according to the characteristics of grassroots civil servants in their departments, gradually standardize the training methods of grassroots civil servants, complete and improve all aspects such as pre‑service, new tasks, and promotion, improve the professionalism and effectiveness of training, and indeed promote the normalization of training in grassroots departments so that education and training can become an essential guarantee for improving the matching degree of grassroots civil servants and their sense of professional mission.

(5) Strengthen vocational mission education based on improving the matching of people and posts

The sense of professional mission can enhance the negative correlation between job matching and job burnout. In the case of a low degree of job matching, grassroots government officers may invest more physical or psychological resources to meet the higher requirements brought about by a higher sense of professional mission, resulting in negative emotions such as malaise, nervousness, anxiety, and anxiety, thereby aggravating the degree of job burnout. The grassroots government officers with a high matching of people and posts like and are good at this job, which effectively realizes the requirements of the sense of professional mission for the work, not only does not produce more pressure than the individual bears but also may alleviate the burnout because of the satisfaction and sense of achievement obtained from completing the work.

(6) Make full use of extrinsic incentives

The scientific assessment mechanism and the open and transparent promotion mechanism can better meet the external incentive needs of grassroots government officers and are among the most effective ways for them to realize their work value and enhance their work motivation.

8. Acknowledgement

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Design Thinking in Agribusiness:

Bridging the Gap Between Theory and Practice

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ABSTRACT

Design Thinking, a human-centered problem-solving technique, is widely used in a variety of industries, including technology and services, by companies such as Google, Apple, and Amazon. Despite its success in various industries, its application in agricultural education, particularly among small- scale farmers, remains limited. This case study looks into the incorporation of Design Thinking into agribusiness education, highlighting its potential to improve teaching and learning in business planning, investment management, personnel development, and innovation management. This study is an invaluable resource for educators and practitioners looking to implement Design Thinking in the agricultural industry, providing practical insights and techniques.

KEYWORDS: Design Thinking, problem-solving, Agribusiness

1. Introduction

Design Thinking, which first appeared in industrial product and architectural design processes in the 1950s and 1960s (Rowe, 1991), is now widely accepted as a strategy for driving organizational innovation. Over the last few decades, it has grown into a formidable tool for addressing complex societal challenges, strategic innovation, and organizational management. Toyota, Starbucks (Beckman & Barry, 2007), and Apple (Rauth et al., 2010) have successfully used Design Thinking principles to foster innovation and meet changing consumer expectations.

Despite theoretical advancements over the last 50 years, Design Thinking remains underutilized in policy development, with little collaboration between Design Thinkers and policymakers (Pattnaik & Banerjee, 2020; Shergold, 2015). The agricultural economic landscape has shifted dramatically, forcing players to adapt to rapid global changes, particularly in consumer behavior. However, many farmers struggle to adapt their offerings to changing consumer needs, limiting their ability to create value.

Design Thinking emerges as a critical tool for farmers looking to gain a better understanding of consumer preferences and develop systematic problem solutions. This article investigates the use of Design Thinking approaches in agriculture and offers a detailed road map for incorporating Design Thinking into various agricultural business domains. It investigates how Design Thinking principles can improve teaching and learning experiences in areas such as business planning and investment, agricultural business management, staff development in agricultural firms, and agricultural innovation management.

In this study, the Design Thinking framework consisting of five stages—Empathize, Define, Ideate, Prototype, and Test—was employed to systematically explore challenges and opportunities in agribusiness. These stages guided the analysis and implementation of innovative strategies in teaching and business practices.

2. Objective

(1) To explore the incorporation of Design Thinking into agribusiness education.

(2) To evaluate the impact of Design Thinking on innovation and problem-solving in the agricultural industry.

3. Design Thinking

Design Thinking emerges as an important tool for farmers looking to gain deeper insights into consumer preferences and develop systematic problem-solving strategies. This article looks into the use of Design Thinking approaches in agriculture and offers a detailed road map for incorporating Design Thinking into various agricultural business domains. It looks into how Design Thinking principles can improve teaching and learning experiences in areas like business planning and investment, agricultural business management, personnel development in agricultural firms, and agricultural innovation management.

Human-centered design has been developed over a long period of time, with support from renowned design firms and design schools around the world. However, David Kelley, Tim Brown, and Roger Martin did not officially coin the term "Design Thinking" until the 1990s (Auernhammer & Roth, 2021). Design Thinking emphasizes incorporating user perspectives into problem statements, which promotes a thorough understanding of challenges and leads to more effective problem-solving strategies (Henriksen, Richardson, & Mehta, 2017).

The Design Thinking methodology encourages collaborative and iterative work among users, policy designers, and government employees. A Design Thinker must be able to see the world from multiple perspectives, including those of current and future partners, clients, users, and service recipients (Brown, 2008). Rather than relying on preconceived answers, Design Thinking promotes the examination of problem statements with user participation from the start.

One widely recognized and adopted approach is the Stanford d. school's Design Thinking process, which comprises five steps (Dorst, 2011):

1) **Empathize:** Deeply understand the target group by immersing oneself in their experiences and engaging in conversations to uncover their needs.

2) **Define:** Clearly identify the key problem that needs addressing, ensuring that the solution aligns with the target group's needs.

3) **Ideate:** Generate a variety of solutions, aiming for both quantity and diversity to address different problem scenarios.

4) **Prototype:** Translate ideas into tangible forms such as sketches or models to explore alternatives and facilitate learning.

5) **Test:** Experiment with prototypes among the target audience to refine and enhance the concepts iteratively.

Design Thinking is critical for developing products and services that meet the actual needs and problems of the target audience. It fosters innovation by encouraging action, creating prototypes, and testing them to identify strengths and areas for improvement.

1) **Empathize:** This stage is centered on gaining a thorough understanding of the target group. Designers must thoroughly understand their target audience's desires, needs, and priorities because they frequently solve problems for others. To avoid making snap judgments, designers should immerse themselves in firsthand experiences, converse with their target audience, and adopt a Beginner's Mindset. Designers question everything, actively listen, and ask three types of questions: What, How, and Why. This method aids in more effectively identifying the target group's problems and needs (Siricharoen, 2021).

2) **Define:** This stage is the foundation for Design Thinking. It allows designers to clearly identify the key problem that needs to be addressed, ensuring that the solution meets the needs of the target group. Problem framing occurs when designers combine their early findings to gain a comprehensive understanding of the target group's actual needs. This thorough understanding is then applied to create problem statements that guide practical implementation. A well-defined problem focuses on critical issues without being overly broad, encouraging team participation and creativity in defining the scope of work within time constraints (Bender-Salazar, 2023).

3) **Ideate:** This stage entails creating a number of solutions that deviate from traditional frameworks in order to address various problem scenarios. The goal of ideation is to increase "quantity" and "diversity" in problem-solving approaches. Asking questions like, "How might we...?" is an important step in this process. These questions should start broad to encourage new problem-solving approaches while remaining narrow enough to generate specific and distinct ideas. Ideation solutions are then developed into prototypes (Kenny, Regan, Hearne, and O'Meara, 2021).

4) **Prototype:** This stage involves transforming ideas into tangible forms that can be seen or touched, such as communicating with sticky notes, drawing pictures, or performing skits. Initially, rough prototypes should be created quickly to allow for learning and exploration of alternative possibilities. When design teams, users, and others interact with prototypes, they improve understanding and lead to more effective problem-solving paths. Prototyping encourages learning because failures occur quickly and inexpensively, adhering to the "Fail Fast, Fail Cheap" principle and adopting a "Fail Forward" attitude. It is an essential

component of the problem-solving development process, helping to reduce time and cost constraints in the early stages (Carlgren, Rauth, & Elmquist, 2016).

5) **Test:** This phase entails testing low-fidelity prototypes with the target audience in real or simulated environments to see if the designer's understanding is consistent with the target group. Testing enables designers to iteratively refine and improve their ideas, guiding ongoing development and refinement. It allows you to reroute the development of prototypes for subsequent iterations. Testing offers designers new perspectives, and feedback, whether positive or negative, is useful for improving future prototype iterations (Carlgren, 2016).

Design thinking is critical for any organization developing products and services because it helps identify the true needs and problems of the target audience. It enables different groups to work together and develop alternative solutions. It emphasizes action, requiring the development and testing of prototypes to identify strengths and areas for improvement before iterating the design. Design thinking emphasizes "doing a lot" rather than "thinking a lot." It is a critical process that fosters innovation in both public and private sector organizations.

4. Methodology

In this study, the Design Thinking process was used to address the challenges in agribusiness education and practice. The methodology followed the five key stages of Design Thinking:

1) **Empathize**: Engaged with farmers and agribusiness stakeholders to gain deep insights into their challenges and needs.

2) **Define**: Identified and framed the key problems related to business planning, investment, and innovation in the agribusiness sector.

3) **Ideate**: Collaboratively brainstormed potential solutions, generating diverse ideas to address the defined problems.

4) **Prototype**: Developed low-fidelity prototypes of business models and strategies to test different solutions.

5) **Test**: Conducted field testing of prototypes with farmers and stakeholders to refine and improve the proposed solutions.

5. The problem suitable for design thinking

Design thinking is not a tool for every situation or problem because it requires more time than linear analysis. Linear analytics is the process of solving problems for which we can identify the obvious causes without further investigation. We can start resolving the problem immediately. For example, if we know that a machine is broken because a specific part is damaged, we can order that part for repair, allowing the machine to resume operation without the need for the design thinking process. As a result, before applying design thinking to the problem, the team must first determine whether the situation is suitable for design thinking (Liedtka and Ogilvie, 2011). Design thinking is appropriate for solving problems that have the following characteristics:

1) Problems involving people

Design thinking is well-suited to dealing with people-related issues that necessitate a thorough understanding of human emotions, behaviors, and needs. Farmers' challenges, understanding consumer preferences, and improving employee satisfaction within companies are some examples. In these cases, design thinking enables empathetic exploration and innovative solutions that are tailored to human experiences. However, for problems that do not directly involve human interactions, such as diagnosing a malfunctioning production machine or calculating an investment's breakeven point, using linear analysis methods for immediate problem solving may be more appropriate (Gheerawo, 2018).

2) Limited understanding of the problem

Design thinking is especially effective for addressing problems where there is a lack of understanding of the underlying issues, particularly when stakeholders such as farmers are uncertain about the current situation or consumer needs. In such cases, stakeholders may struggle to identify the underlying cause of the problem or accurately articulate their requirements. For example, manufacturers frequently produce goods in large quantities without fully understanding consumer preferences. Design thinking aids in gaining deeper insights into the problem, allowing adjustments to product development or manufacturing processes to better align with consumer needs. However, if the problem is clearly understood and there is confidence in finding a definitive solution, a linear problem-solving approach may be more appropriate and efficient (Bender-Salazar, 2023).

3) Insufficient relevant information

Decision-making can become difficult when faced with a lack of comprehensive information about a problem, such as uncertainty about consumer needs or difficulty gathering relevant data from various sources, or when there is an overwhelming amount of difficult-to-interpret data. Furthermore, if the information is constantly changing, design thinking can be made more difficult to apply. In such cases, designing through understanding and testing with real users can provide more clear insights. Decisions can be made more confidently in the case of problems with sufficient and high-quality data. Linear problem-solving approaches are frequently more appropriate when there is an abundance of reliable data (Daymond & Knight, 2023).

6. Benefits of design thinking in agriculture business

Design thinking is extremely important for agricultural businesses in the modern era due to the evolution of agricultural practices over time. Consumer behavior is rapidly changing, including the increased use of agricultural products for purposes other than consumption. This shift reflects the emergence of the " Lazy Economy," in which consumers seek convenience in their products and services. Furthermore, there is an increasing demand for convenience foods tailored to different age groups. These factors all contribute to changes in consumer behavior, necessitating new approaches to agricultural business strategies (Phunphon, Yongphet, & Nakpibal, 2023).

Making decisions based on historical data may no longer meet the needs of agricultural businesses. Design thinking also helps us find solutions to existing agricultural problems by exploring new perspectives. For

example, it enables us to sell existing products to new consumer segments by developing new value propositions. This concept is consistent with Business Model Innovation, which enables farmers to increase their income without having to sell new products or services. Design thinking addresses these challenges by providing a process for deeply understanding consumer needs, allowing us to see the big picture and the true needs of consumers (De Oliveira, Fernandez, Hernández, & del Pino, 2022).

Design thinking also promotes an adaptive culture among farmers, allowing them to experiment with new ideas and test them in real-world scenarios. If the experiments are unsuccessful, they are not considered failures, but rather part of the iterative design process. Farmers who continue to use traditional agricultural business practices without adapting to changing consumer behavior may struggle to keep up with the changing world (Kenny, Regan, Hearne, and O'Meara, 2021).

7. Applications of Design Thinking in Agribusiness

Design Thinking has been successfully applied in various aspects of agribusiness, including:

Developing farmer-friendly technologies: Design Thinking can be used to develop user-friendly agricultural tools, apps, and platforms that help farmers make informed decisions, increase productivity, and access critical information (Kenny, Regan, Hearne, & O'Meara, 2021).

Designing sustainable packaging solutions: Design Thinking can help guide the creation of eco-friendly packaging materials and designs that reduce environmental impact while appealing to environmentally conscious consumers (Zeng & Durif, 2019).

Creating innovative marketing strategies: Design Thinking can assist agribusinesses in creating effective marketing campaigns that connect with their target audiences, promote their products and services, and foster brand loyalty (van Dijk et al., 2021).

Enhancing agricultural extension services: Design Thinking can be used to redesign agricultural extension services so that they are more relevant, accessible, and effective for farmers, addressing their specific needs and challenges (Eastwood, Turner, & Romera, 2022).

8. Conclusion

To summarize, Design Thinking provides a systematic approach to problem solving by deeply understanding user needs and iterating over potential solutions. Its five-step process ensures that the problem space is thoroughly explored, and proposed solutions are tested with real users. However, it is critical to recognize that Design Thinking may not be appropriate for all types of problems, and it must be carefully evaluated before implementation.

Design Thinking can help agricultural businesses, particularly farmers, adapt to the ever-changing consumer landscape. Farmers can remain relevant and competitive in the market by understanding and responding to changing consumer needs. Embracing Design Thinking can help agricultural businesses navigate change and thrive in today's rapidly evolving industry.

In the context of Thai agribusinesses, Design Thinking is an effective tool for navigating the challenges and opportunities of the digital age. By adopting Design Thinking principles, agribusinesses can improve their understanding of stakeholder needs, foster innovation, create user‑centered solutions, and contribute to a more sustainable and resilient agriculture. As Thailand's agribusiness sector evolves, Design Thinking will become increasingly important in driving innovation, maintaining competitiveness, and promoting long-term growth.

The application of Design Thinking's structured process, from empathizing with stakeholders to testing prototypes, resulted in the development of practical and innovative solutions for agribusiness education and business management. This iterative approach fostered deeper understanding and more adaptive strategies to meet the evolving challenges of the industry.

9. Suggestion

Suggestion: Implementation Challenges and Strategies

1) Implementing Design Thinking in agribusiness may pose a number of challenges, particularly given the industry's unique nature. Some possible challenges include:

2) Limited Access to Resources: Small-scale farmers and rural agricultural communities may lack the resources and training needed to effectively implement Design Thinking methodologies.

3) Cultural Barriers: The agricultural community's cultural and traditional practices may make it difficult to adopt innovative problem-solving approaches.

4) Technological Barriers: A lack of technological infrastructure and digital literacy among farmers and stakeholders may impede the implementation of technology‑driven solutions resulting from Design Thinking processes.

5) Resistance to Change: Farmers and stakeholders accustomed to traditional methods of operation may be hesitant to adopt Design Thinking principles.

Suggestion for Future Directions and Emerging Trends

1) Discussing future directions and emerging trends in the application of Design Thinking in agribusiness will help readers understand changing opportunities and challenges. Some themes to explore include:

2) Integration of Artificial Intelligence and Data Analytics: Artificial intelligence and data analytics have the potential to improve Design Thinking processes and enable data‑driven decision-making in agriculture.

3) Blockchain Technology for Supply Chain Transparency: Looking into how blockchain technology can improve transparency, traceability, and trust in agricultural supply chains, in accordance with Design Thinking principles of user‑centered design and collaboration.

4) Climate Resilience and Adaptation Strategies: Addressing the impact of climate change on agricultural practices, as well as how Design Thinking can help develop new solutions to improve climate resilience and adaptive capacity in agribusiness.

5) Cross-Sector Collaboration and Ecosystem Partnerships: Emphasizing the importance of cross-sector collaboration and partnerships in the agricultural ecosystem when applying Design Thinking to address difficult challenges and drive comprehensive solutions.

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Analysis and Dissemination of the Women's Rights Movement via Weibo under China's Socialist State

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ABSTRACT

This study examines the role of Weibo in shaping and spreading feminist discourse in China's socialist state. It draws on Nancy Fraser's theories of the public sphere and counter-publics to analyze how Chinese women use Weibo to resist patriarchal control and government censorship. The research highlights the strategies used by women to challenge restrictive media environments and demonstrates that Weibo serves as a critical space for feminist activism despite state surveillance and censorship.

KEYWORDS: Weibo, State Censorship, Nancy Fraser

1. Introduction

Weibo, a popular microblogging platform in China, has significantly empowered women and transformed traditional media. However, It faced challenges but proliferated to over 100 million users by 2011. Partnering with Alibaba in 2013, it ventured into e-commerce, broadening its content range and user base. By 2018, Weibo had 420 million users, with 75% being women, and had become a critical space for women's self-expression and activism, challenging traditional media portrayals and supporting women's rights movements in China. It shows the impact of new media on women's rights and highlights the ongoing gender awakening and the need for supportive norms in dissemination (Chen, 2014).

2. Research Objective

(1) Examine the interactions between the Chinese government, patriarchal ideology, and Weibo's commercialization.

(2) Understand the methods through which female Weibo users challenge and negotiate patriarchal control in socialist and capitalist states.

3. Literature Review

3.1 Theory, Concept and Related Research

According to Nancy Fraser (1990), Habermas's (1991) concept of the public sphere lacks a female perspective and marginalizes women. Fraser offers revisions and rebuttals to four assumptions of Habermas's concept:

First, Habermas overlooks the disadvantaged position of women in the public sphere and the imbalance between male and female discourse.

Second, Habermas advocates for a singular public sphere, while Fraser promotes a more inclusive public sphere with diverse subaltern counterpublics.

Third, Habermas excludes women's domestic issues from the public sphere, while Fraser argues for rediscovering the boundaries between "public" and "private."

Fourth, Habermas assumes a complete separation between civil society and the state. However, Fraser introduces the concepts of "strong public" and "weak public" to enhance the effectiveness of women's public sphere.

3.2 Research Framework

The study analyzes how female Weibo users in China challenge capitalism and patriarchy through the platform despite state and patriarchal limitations. It aims to shed light on the evolving landscape of women's rights on the Internet in China.
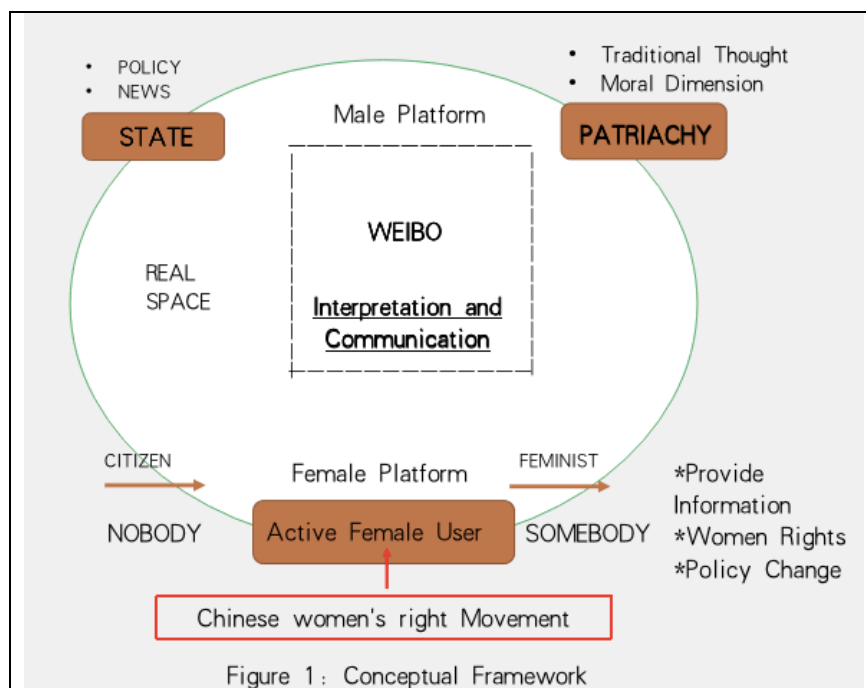

Figure 1: Conceptual Framework

Figure 1 Research Framework

3.3 Research Hypotheses

To investigate the interplay between the Chinese government, patriarchal ideology in China, and the commercialization of Weibo.

To analyze how female Weibo users interpret and communicate their challenges to, and resistances against, patriarchal control within the context of socialism and capitalism.

4. Research Methodology

4.1 Research Site

This study focuses on the interactions between active female users, official accounts, and patriarchy on the Chinese Weibo platform. Specifically, I will investigate how female Weibo users shape and promote women's rights issues and resist patriarchal norms. To gain a deeper understanding of this topic, I will conduct interviews with thirteen different active female Weibo users.

4.2 Unit and Level of Analysis

This study focuses on the activities of engaged female Weibo users at the individual, state, and patriarchal societal levels, specifically their involvement in advocating for women's rights in China on the Weibo platform. The study aims to examine the dynamic interactions between active female Weibo users, the state, and the patriarchy.

4.3 Research Methods

The research methods used to study case studies include literature research, online surveys, in-depth interviews, and non-participant observation focusing on social networks, the interaction between Chinese patriarchy and the state, and the development of feminist movements. These methods aim to provide a comprehensive understanding of how feminist movements develop and operate on Chinese social networks.

4.4 Data Collection

The literature review will focus on the expansion of social media, state control, the structure of Weibo, and the feminist movement. A case study approach will be adopted, involving in-depth interviews with respondents via WeChat to gather personal information and their perspectives on women's rights-related topics on Weibo. Additionally, non-participant observation will include monitoring Weibo content related to women's rights and examining how bloggers and official state accounts interpret these topics to observe how patriarchy and the state collaborate on Weibo.

4.5 Data Analysis

The study aims to analyze the dynamics of active female Weibo users, focusing on their interactions with women's issues and the transition of ordinary women into "activists" on the platform. It will explore the influence of state policies, patriarchy, and social media mechanisms on these discussions and uncover the platform's response to and role in women's socio-political engagements. Through interviews, the study will delve into the motivations and experiences of active female Weibo users and their efficacy in advancing

women's rights and ultimately providing a comprehensive view of the interplay between female users, patriarchy, and the state within the Weibo context.

5. Research Findings

The research delves into the dynamics of the online feminist movement within China, particularly through the lens of female Weibo users. It highlights the role of Weibo as a platform for women to share their narratives and foster solidarity. The study uncovers challenges imposed by censorship and entrenched patriarchal and state ideologies, impacting the visibility and efficacy of feminist advocacy on the platform. Participants revealed innovative tactics to bypass censorship. The research suggests that the movement could benefit from increased offline mobilization and strategic collaborations with other social movements.

Table 1 Basic personal Background Information

No.	Age Group:	Education Level:	Current Occupation:	Marital Status:	Living Place
1.	26-35	Master's degree	Accountant	Single	urban area
2.	26-35	Bachelor's degree	Teacher	Single	rural area
3.	26-35	Bachelor's degree	Self-employed	Married	urban area
4.	26-35	Bachelor's degree	New Media Operator	Single	urban area
5.	26-35	Bachelor's degree	Government Employee	Single	urban area
6.	18-25	Bachelor's degree	Company Employee	Single	urban area
7.	18-25	Master's degree	Student	Single	urban area
8.	26-35	Master's degree	Teacher	Single	urban area
9.	18-25	Bachelor's degree	Employee at a Foreign Trade Company	Single	urban area
10.	18-25	Bachelor's degree	Student	Single	urban area
11.	26-35	Master's degree	Currently Unemployed	Married	urban area
12.	26-35	Bachelor's degree	Government Employee	Single	urban area
13.	18-25	Master's degree	Student	Single	urban area
Total			13		

6. Discussion

Weibo, as a publicly accessible platform, serves as a significant stage for various voices and public opinions. More importantly, it is a tool for marginalized groups, such as women, to engage in public participation and democratic practices from the periphery of mainstream discourse.

Drawing from Fraser's critique of Habermas's public sphere theory, it is evident that the women's public sphere is transforming from an overlooked, marginalized, and even suppressed experiential social realm into a recognized, valued, and increasingly theorized political space. However, this transformation does not imply that it has become a ready-made tool for women's liberation. The relationships between the government, the Weibo platform, and female users remain complex. Therefore, the specific implications of the publicness of the women's public sphere and the critical normative foundations underlying **it still require in-depth exploration**

7. Suggestion

(1) Deconstructing the male-dominated public sphere, constructing symbolic discourse for women.

(2) Actively constructing gender issues, promoting the formation of public opinion

8. Acknowledgement

I want to express my deepest gratitude to my advisor, Dr. Paiboon Hengsuwan, whose guidance, encouragement, and insightful feedback have been invaluable throughout this research. I am also profoundly thankful to Dr. Ariya Svetamra for her continuous support and expertise, which have greatly enriched my work. I appreciate the Women's Study Center faculty under the Faculty of Social Sciences at Chiang Mai University for providing a nurturing academic environment. Finally, I am grateful to my family and friends for their unwavering support and encouragement.

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Prosocial Teams and Work Engagement: Dual Pathways of Pleasure and Pressure-Based Prosocial Motivation Among Rescue Volunteers

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ABSTRACT

Past research has provided valuable insights into the antecedents and outcomes of prosocial motivation, highlighting its role in driving altruistic behaviors and enhancing well-being. However, several critical questions remain unanswered, particularly concerning the specific sources of prosocial motivation within volunteer settings. This study aims to examine a potential sources of volunteers' prosocial motivation prosocial team and their effects on work engagement. Grounded in self-determination theory (SDT), we propose that prosocial teams can positive outcomes for volunteers' engagement through pleasure-based and pressure-based prosocial motivation. Our analysis of survey data from 476 volunteers across 69 Thai charity organizations supports these hypotheses. The finding shows that prosocial teams positively influence work engagement via pleasure-based and pressure-based prosocial motivation.

1. Introduction

Volunteering in emergency services, such as responding to road accidents, natural disasters, and rescue operations, involves navigating high-pressure situations that can profoundly impact volunteers' well-being (Caricati et al., 2023). These roles require quick decision-making under intense conditions, often leading to psychological strain, burnout, and even physical injuries. Volunteers frequently encounter traumatic events, such as severe injuries or fatalities, which can result in emotional fatigue and vicarious trauma, affecting even those with strong coping mechanisms. The demanding nature of the work, combined with long and unpredictable hours, disrupts work-life balance, leading to physical exhaustion and further compromising overall well-being. Despite these challenges, prosocial motivation the intrinsic drive to help others plays a crucial role in sustaining volunteers' engagement and sense of purpose (Batson, 1987; Grant, 2007). This motivation helps them persevere through the emotional and physical toll of their work, maintaining their commitment to serving others in critical situations.

While traditionally seen as enhancing well-being, prosocial motivation can be a double-edged sword. Through the lens of self-determination theory (SDT) (Ryan & Deci, 2000), we distinguish between *pleasure-*

based and *pressure-based* prosocial motivation (Gebauer et al., 2008; Liao et al., 2022). When rooted in intrinsic (pleasure-based motivation), it fosters work engagement and overall well-being, energizing volunteers and making their contributions more fulfilling. Conversely, when driven by external expectations or obligations (pressure-based motivation), it can lead to stress and burnout, ultimately compromising volunteer well-being. This dual nature underscores the need for organizations to cultivate environments that encourage pleasure-based prosocial motivation, helping volunteers remain engaged and healthy.

Despite extensive research on prosocial motivation, gaps remain in understanding the immediate sources of volunteers' motivation (Hui et al., 2020). Most studies focus on job-related factors like perceived impact and organizational support, while less attention is given to the day-to-day influences on motivation. This study addresses this gap by investigating prosocial teams as a key source of motivation in volunteer settings. By shifting focus from traditional job-related factors to team dynamics, this research offers a more nuanced understanding of what drives prosocial behavior among volunteers.

This study contributes to the prosocial motivation literature in two significant ways. First, it expands the understanding of prosocial motivation sources by examining the role of teams, moving beyond traditional job-related factors. Second, it applies self-determination theory to explore the complex dynamics between pleasure-based and pressure-based prosocial motivation and their impact on volunteer engagement. By investigating how prosocial teams can both enhance and undermine motivation, this study provides valuable insights into how organizations can foster supportive environments that encourage sustained volunteer involvement and positive outcomes.

2. Research Objective

(1) To examine the role of prosocial teams as a key source of motivation in emergency service volunteering, shifting focus from traditional job-related factors to team dynamics.

(2) To explore the interplay between pleasure-based and pressure-based prosocial motivation using self-determination theory (SDT), and assess their impact on volunteer engagement and well-being in high-pressure volunteer roles.

3. Literature Review

3.1 Theory, Concept and Related Research

Prosocial Motivation: Its Antecedents and Outcomes

Prosocial motivation, the desire to help others or contribute positively to their well-being, has several key antecedents that shape this behavior, particularly within work environments. One major antecedent is relational job design, where job roles are structured in a way that highlights the positive impact of the individual's work on others. This design fosters a deeper connection to the beneficiaries of one's work, making employees more likely to be motivated by helping others (Grant, 2007). Another antecedent is the presence of collectivistic norms within the workplace, where the organization promotes group harmony and collaboration, encouraging

employees to act in ways that benefit the collective. Additionally, personal characteristics such as empathy and social identity—the sense of belonging to a particular group—further drive prosocial motivation as these traits make individuals more inclined to act for the benefit of others (Grant & Berg, 2011).

The outcomes of prosocial motivation are notably positive, both for individuals and organizations. Employees with high levels of prosocial motivation often exhibit enhanced job performance, showing increased effort, persistence, and engagement in helpful behaviors. Their desire to contribute to the well-being of others drives them to go beyond the basic requirements of their job. Prosocially motivated individuals also tend to display greater innovation and creativity, as their collaborative spirit and desire to support collective goals push them to think outside the box and engage with others more freely (Grant, 2008).

Furthermore, prosocial motivation has a significant impact on personal job satisfaction. Employees who feel their work benefits others often experience a greater sense of fulfillment and job satisfaction, as their roles become intrinsically rewarding. This sense of purpose, tied to their contributions to others' well-being, creates a more meaningful and satisfying work experience (Grant & Berg, 2011). These outcomes highlight the power of prosocial motivation as a driver of positive behaviors and attitudes in the workplace, benefiting both individual employees and their organizations.

The Dual Nature of Prosocial Motivation and Its Effect on Work engagement

Incorporating Self-Determination Theory (SDT) enhances the understanding of the dual nature of prosocial motivation by focusing on the fulfillment of basic psychological needs: autonomy, competence, and relatedness. Pleasure-based prosocial motivation is strongly aligned with SDT, as it satisfies these needs, particularly autonomy and competence, leading to intrinsic motivation and higher engagement. Conversely, pressure-based prosocial motivation aligns with external regulation, where actions are driven by obligation, reducing autonomy and leading to burnout, stress, and disengagement (Ryan & Deci, 2000).

Pleasure-based prosocial motivation supports sustained engagement because it connects to intrinsic rewards, aligning with the need for autonomy and self-determination. Employees motivated by this internal drive experience enhanced job satisfaction and performance, finding meaning in their contributions. SDT argues that fostering environments where individuals have the freedom to act in ways that fulfill their competencies increases long-term motivation and productivity. Conversely, pressure-based prosocial motivation, driven by external demands or social obligations, often undermines these psychological needs. When people feel pressured, autonomy is compromised, leading to stress, exhaustion, and reduced engagement over time (Gebauer et al., 2008).

To improve employee engagement, organizations should design work environments that promote autonomy and competence, nurturing pleasure-based motivation. By reducing the emphasis on external pressures, companies can create a more self-sustaining workforce, one that is creative, persistent, and satisfied with their work. SDT further emphasizes that satisfaction of these basic psychological needs leads to improved well-being, making it a crucial framework for understanding the sustainability of prosocial behavior in the workplace (Deci & Ryan, 2000; Grant & Berg, 2011).

The Influence of Prosocial Teams

In the context of rescue volunteering, prosocial teams greatly enhance both mission effectiveness and volunteer well-being. These teams are characterized by a shared commitment to helping others, which fosters an environment of trust, collaboration, and mutual support. In high-stress, high-risk situations like emergency rescues, the presence of a prosocial team allows individuals to perform better under pressure, knowing they can depend on their teammates. This atmosphere of psychological safety promotes quick decision-making and encourages volunteers to take initiative, crucial for navigating life-or-death scenarios (Hu & Liden, 2015)

Research further demonstrates that working in prosocial teams leads to greater job satisfaction and resilience among rescue volunteers. The intrinsic motivation to save lives, combined with strong team support, helps mitigate the physical and emotional stress that often accompanies rescue work. This not only improves engagement and performance but also reduces the risk of burnout, a common concern in high-intensity roles like rescue volunteering (Deci & Ryan, 2000; Hu & Liden, 2015)

Moreover, prosocial teams foster a sense of purpose and collective efficacy, which boosts creativity and adaptability in unpredictable rescue situations. Teams with strong prosocial bonds are more likely to work cohesively and develop innovative solutions to complex problems. This sense of community and shared mission not only enhances team effectiveness but also contributes to the overall mental and physical well-being of volunteers, creating a cycle of sustained motivation and long-term commitment to the cause (Babič et al., 2019).

3.2 Research Framework

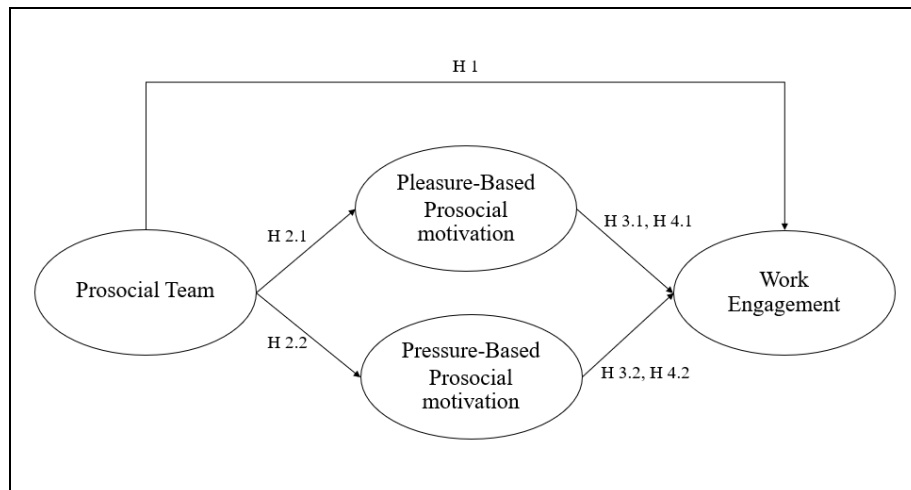**Figure 1** Research Framework

3.3 Research Hypotheses

Based on the above theoretical rationale and empirical evidence, our study formulates the following hypotheses.

Hypothesis 1: Prosocial teams have a positive effect on work engagement.

Hypothesis 2: Prosocial teams have a positive influence on pleasure-based prosocial motivation (2.1) and pressure-based prosocial motivation (2.2).

Hypothesis 3: Pleasure-based prosocial motivation has a positive effect on work engagement. (3.1) and Pressure-based prosocial motivation has a non-significant relationship with work engagement (3.2).

Hypothesis 4: Prosocial teams have a positive indirect influence on work engagement via pleasure-based prosocial motivation (4.1) and Prosocial teams have a non-significant indirect influence on work engagement via pressure-based prosocial motivation (4.2).

4. Research Methodology

4.1 Research Design

This study employed a survey-based research design to test the hypotheses related to prosocial motivation and volunteer engagement. The survey was distributed to volunteer emergency services across Southern Thailand, specifically targeting volunteers involved in high-pressure situations such as road accidents, fires, search and rescue operations, and natural disasters. A multi-stage sampling design was used to purposively select foundations from several provinces, ensuring a representative sample of volunteer services across the region.

4.2 Population and Sample

The population for this study consisted of volunteer emergency services operating within 125 charities across 14 southern provinces of Thailand. The sample included 750 volunteers from 75 foundations, with approximately 10 volunteers from each foundation participating. The sampling process, guided by foundation leadership, aimed to capture a diverse and representative group of emergency service volunteers in Southern Thailand.

4.3 Research Instrument

The survey instrument was administered in Thai, using back translation (Brislin, 1970) from the original English scales to ensure accuracy. To address common method bias (CMB), different scale formats were used (Jordan & Troth, 2020). *Prosocial teams* were assessed with a reliable four-item scale by Grant (2008) ($\alpha = .90$), emphasizing team-oriented prosocial beliefs with wording adjusted to "We/us." *Pleasure-based and pressure-based prosocial motivation* were measured with two subscales by Gebauer et al. (2008), both demonstrating strong reliability ($\alpha = .92$ and $\alpha = .90$, respectively). Responses were rated on a 5-point Likert scale. *Work engagement* was measured using the 17-item Utrecht Work Engagement Scale (UWES) (Schaufeli et al., 2006) with three dimensions: vigor, dedication, and absorption ($\alpha = .90$), rated on a 7-point scale.

4.4 Data Collection

Collecting questionnaire data from volunteer emergency services can be challenging due to their work on night shifts and weekend schedules, which often coincide with their free time from regular work. With the assistance and support of the foundation's Chairman, a total of 750 survey questionnaires from 75 foundations were distributed by hand to volunteer emergency services. About 10 volunteers from each foundation were asked to participate in the study. This procedure was based on a multi-stage sampling design in which foundations were purposively sampled from several provinces across fourteen provinces in the South of Thailand.

4.5 Data Analysis

We conducted structural equation modeling (SEM) in Mplus Version 8.2 (Muthén & Muthén, 1998-2012) using the TYPE = COMPLEX option and robust maximum likelihood (MLR) estimation to account for clustered data. Validity and reliability were assessed via confirmatory factor analysis (CFA), using indices such as Chi-square (χ2/df), CFI, TLI, and RMSEA. A good model fit was indicated by χ2/df < 3, CFI and TLI > 0.90, and RMSEA < 0.08. After confirming the measurement model, we tested structural relationships and calculated indirect effects to examine the mediating roles of pleasure-based and pressure-based prosocial motivation.

5. Research Findings

Over a period of three-months, Of the 750 questionnaires distributed, a total of 476 usable questionnaires were returned from 69 foundations with response rates of 63% and 92%, respectively. The respondents were 69.12% male; 82.56% undergraduate degree. Their average age was 25.80 years old (with a standard deviation [SD] of 7.72 years) Their average organizational tenure and tenure with team leader (dyad tenure) were about 4.17 years (with a SD of about 3.30) and 3.28 years (with a SD of about 3.90), respectively.

Table 1 Bivariate Correlations, Means and Standard Deviations

	Mean	*SD*	1	2	3	4
1. Prosocial team Motivation	4.15	.65	(.90)			
2. Pleasure-based prosocial	4.49	.60	.51**	(.92)		
3. Pressure-based prosocial	3.57	.84	.45**	.25**	(.90)	
4. Work engagement	5.68	.93	.64**	.55**	.41**	(.90)

Note. N = 476; * p < .05; ** p < .01; Numbers in the parentheses are square roots of AVEs, which are greater than the size of the correlations shared between the local construct and other constructs in the model.

To test for convergent validity, factor loadings of each construct were examined. The factor loadings were all above .70, range from .79 to .92, indicating a good amount of variance explained by each construct. Composite reliabilities (CR) of constructs also ranged from .90 to .92, exceeding the recommended value of .60 (Bagozzi & Yi, 1988). In addition, Cronbach's alphas showed satisfactory levels of internal consistency, ranging from .90 to .92 (Nunnally, 1978).

5.1 Common Method Bias

To address the potential issue of common method bias (CMB) due to self-reported data, we conducted Harman's single-factor test. The test indicated that the largest factor accounted for 47.58% of the variance, which is below the 50% threshold, suggesting that CMB is not a significant concern. This finding aligns with our CFA results, indicating that CMB is unlikely to confound our interpretations.

5.2 The Structural Model

As shown in Figure 2 and Table 2, results showed that prosocial team had a direct positive relationship with work engagement (β = .45, p < .001). The results thus provide support to Hypotheses 1. The results further revealed that prosocial team motivation had direct significant positive effects on both pleasure-based and pressure-based prosocial motivation (β = .51, p < .001; β = .46, p < .001, respectively). These results provide full support to Hypotheses 2.1 and 2.2. Furthermore, pleasure-based prosocial motivation was found to have a significant positive relationship with work engagement (β = .35, p < .001).
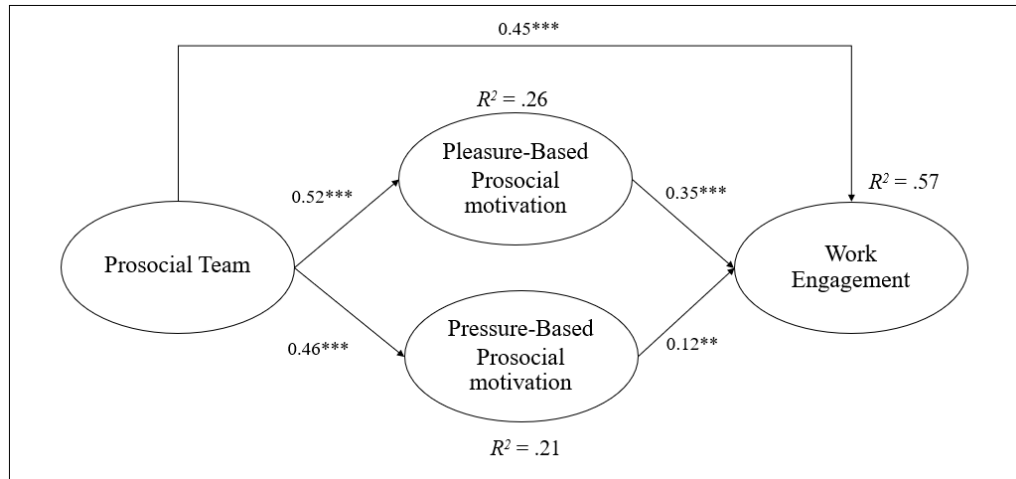
Figure 2 Latent Structural Equation Modeling Results

Conversely, quite unexpectedly, the results showed that pressure-based prosocial motivation had direct positive relationships with work engagement (β = .12, p < .01). These results fail to support Hypothesis 3.2 but supported Hypothesis 3.1. Overall, the hypothesized theoretical model explained 26%, 21%, and 57% of the variance in pleasure-based prosocial motivation, pressure-based prosocial motivation, and work engagement, respectively.

Table 2. Path Coefficients for the Latent Structural Equation Models

Estimated Paths	β	t	p-value
Hypothesis 1			
Teams → Engagement	0.449***	0.065	0.000
Hypothesis 2			
2.1 Teams → Pleasure	0.516***	0.050	0.000
2.2 Teams → Pressure	0.464***	0.054	0.000
Hypothesis 3			
3.1 Pleasure → Engagement	0.351***	0.057	0.000
3.2 Pressure → Engagement	0.124**	0.045	0.006

Estimated Paths	β	t	p-value
R^2 (Pleasure)	.26		
R^2 (Pressure)	.21		
R^2 (Engagement)	.57		

Note. $N = 476$; * $p < .05$; ** $p < .01$; *** $p < .001$.

In terms of indirect effects, as shown in Table 3, the results revealed that prosocial teams significantly influence work engagement through pleasure-based prosocial motivation (0.24, 95% CI [0.15,0.34]). This provides support to Hypothesis 4.1. On the other hand, and rather surprisingly, for the mediation paths involving pressure-based prosocial motivation the indirect effect of prosocial teams on work engagement through pressure-based prosocial motivation is significant (0.08, 95% CI [0.02,0.14]). These results fail to support Hypothesis 4.2. The difference between these two paths approaches significance (0.17, 95% CI [0.04, 0.28]), indicating a potentially meaningful difference in how prosocial teams influence work engagement through pleasure-based and pressure-based motivation.

Table 3 Indirect Effects

Mediated paths	Indirect Effects			95% Confidence intervals (CIs)	
	Coefficient	SE	p value	LLCI	ULCI
Hypothesis 4.1					
Teams → Pleasure → Engagement	0.24**	0.05	0.00	0.147	0.340
Hypothesis 4.2					
Teams → Pressure → Engagement	0.08*	0.03	0.01	0.016	0.138
Difference between 4.1 & 4.2	0.17**	0.06	0.00	0.045	0.287

Note. $N = 476$; * $p < .05$; ** $p < .01$; *** $p < .001$. CI = confidence interval; LLCI = lower limit confidence interval; ULCI = upper limit confidence interval. CIs that exclude zero indicate that the conditional indirect effects are significant; * = significant indirect paths (95% CI).

5.3 Conclusion

This study provides valuable insights into the role of prosocial teams and the dual pathways of pleasure-based and pressure-based prosocial motivation in driving volunteer engagement in emergency services. The findings demonstrate that prosocial teams significantly enhance engagement by fostering both intrinsic and external obligation, suggesting that both types of prosocial motivation can positively contribute to sustained volunteer involvement. While pleasure-based motivation was expected to enhance engagement, the positive

influence of pressure-based motivation challenges conventional views, showing that external pressures can also reinforce commitment in high-stakes environments like rescue operations.

6. Discussion

This study offers valuable insights into how prosocial teams and different types of prosocial motivation contribute to volunteer engagement, particularly in high-stress roles like emergency response. The results show that prosocial teams significantly enhance engagement both directly and indirectly through pleasure-based and pressure-based motivation. Pleasure-based motivation had a strong positive impact on engagement, confirming that intrinsic rewards such as joy and purpose are key to sustaining volunteer commitment. Volunteers driven by personal satisfaction tend to be more energized, dedicated, and resilient, maintaining engagement despite the challenges of their roles.

Unexpectedly, pressure-based prosocial motivation also positively influenced engagement. Contrary to initial expectations, external pressures like societal expectations or feelings of duty did not harm engagement but reinforced a sense of responsibility. In critical roles such as emergency response, these pressures can complement intrinsic motivations, driving volunteers to remain committed. This challenges the traditional view that pressure-based motivation always undermines well-being. This finding aligns with the work by Contreras-Huerta (2023), highlights that pressure-based motivation—stemming from external pressures such as societal expectations—can still foster commitment, especially in settings where individuals feel responsible for the well-being of others.

The dual pathway model highlights how prosocial teams enhance both pleasure-based and pressure-based motivation, emphasizing the importance of team dynamics. Teams that share a commitment to helping others foster a supportive environment, where volunteers feel both intrinsically fulfilled and externally validated. This dynamic helps buffer against job stress and strain, keeping volunteers engaged (Hu & Liden, 2015). The findings underline the need for organizations to foster prosocial team environments and recognize the complex mix of motivations driving volunteer engagement in high-pressure contexts like emergency services.

7. Suggestion

Based on the study's findings, organizations reliant on volunteer emergency services should focus on building prosocial teams and balancing both pleasure-based and pressure-based motivation. A cohesive team environment, built through team-building activities, collaborative training, and fostering a shared mission, strengthens mutual support and helps volunteers stay resilient under pressure. To boost pleasure-based motivation, organizations should offer autonomy, recognize contributions, and provide growth opportunities, while ensuring volunteers receive feedback on their impact to enhance their sense of fulfillment.

At the same time, pressure-based motivation from external expectations can drive engagement, but it is important to balance this with structured support and public recognition. Emotional and psychological support, such as counseling, peer support groups, and debriefings, is also crucial for managing the stress of

emergency work. Tailored training that emphasizes teamwork and resilience, along with work-life balance initiatives, will help maintain volunteer engagement and improve overall effectiveness.

Future research should focus on exploring the balance between intrinsic (pleasure-based) and extrinsic (pressure-based) motivation in volunteer emergency services to better understand their long-term effects on volunteer engagement and retention. Studies could also quantify how team cohesion directly impacts performance metrics like response times and decision-making under pressure. Additionally, assessing the effectiveness of emotional support interventions, such as counseling and debriefing, in reducing burnout is crucial. Finally, investigating how cultural differences and digital tools influence prosocial behavior and team cohesion could provide new insights into enhancing volunteer effectiveness in diverse and remote settings.

8. Acknowledgement

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A Factor Analysis Study on the Influence of Online Behavioural Advertising on Consumers' Purchase Intentions through Advertising Value

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ABSTRACT

This study mainly focuses on the impact of online behavioral advertising in the cosmetics industry on the purchase intentions of the social group of Generation Z in China. The research employs a questionnaire analysis method, utilizing a sample of 387 participants, and conducts data analysis using advanced software. The findings indicate that factors such as information sufficiency, personalization, entertainment value, interactivity, and aesthetic appeal positively influence consumers' perceived value of online behavioral advertising. Additionally, the advertising value of online behavioral ads in the cosmetics industry positively affects consumers' purchase intentions. This paper addresses the research gap concerning the social group of Generation Z in the advertising field, providing valuable insights for the advertising industry, advertisers, and governmental entities.

KEYWORDS: Online behavioural advertising, Consumer purchase intention, Cosmetic products, Advertising value.

1. Introduction

In the context of rapid development of the digital economy, China's income is generally above average, and the potential for cosmetics consumption is rapidly released. The cosmetics industry has become a consumer necessity and an important lever for China's economic transformation and upgrading. According to data from the National Bureau of Statistics of China from 2012 to 2021, the total retail sales of consumer goods in China have maintained a growth trend of around 10%. Only during the COVID-19, it decreased by 0.2% in 2022, and then rapidly increased to 516.9 billion yuan in 2023, up 6.4% year on year. Overall, the Chinese cosmetics market maintains a stable growth trend and is expected to continue expanding in the coming years. Advertising is the window of a product, which can effectively stimulate consumers' "implicit" consumption demand for cosmetics, making high-quality cosmetics well-known and stimulating users' consumption desire.

2. Research Objective

This study aims to fill the gap in research on online behavioural advertising for cosmetics by analysing Generation Z's preferences for online behavioural advertisements for cosmetics in China and how these advertisements influence their purchase intentions through perceived advertising value. The intention is to provide new business ideas for cosmetic companies, create strategic advertisements for ad producers to attract Gen Z consumers, and lay the foundation for subsequent research.

3. Literature Review

3.1 Theory, Concept and Related Research

3.1.1 Advertising Value:

In 1995, Ducoffe developed a method for evaluating the effectiveness of online advertising based on its advertising value. He believes that the three elements that affect the value of online advertising include informativeness, entertainment, and stimulation (Ducoffe, 1995). Some scholars believe that information sufficiency and entertainment are two dimensions commonly considered in the value model of online advertising (J.U. Kim, Kim, & Park, 2010).Aesthetic appeal influences users' opinions and preferences towards various objects, such as web pages and advertisements (Lavie&Tractinsky, 2004).

In summary, this study selected the dimensions of entertainment and information sufficiency in the online advertising model proposed by Ducoffel . Based on this, due to the lack of research on interactivity and mobile advertising page design, considering the characteristics of online behavioral advertising in the Chinese context, interactivity, aesthetic attractiveness, and personalization were included, providing a new perspective on the perception of advertising value.

3.1.2 Consumer Purchase Intention

Purchase intention refers to the likelihood of consumers making a purchasing decision based on their subjective evaluation of a product and personal information, including brand impression, attitudes, and related psychological activities. Some scholars have pointed out that purchase intention is the probability that consumers plan or are willing to buy a particular good or service in the future (Wu, Yeh, & Hsiao, 2011). Generally, the stronger the consumer's desire to buy, the greater their preference for the product or service, and the higher the likelihood of purchase (Cao Zheng, Li Runfa, & Lan Xue, 2021). When consumers evaluate a product and form purchase intentions, they are influenced not only by the characteristics of the product but also by other external factors (Zhao Yixuan & Zhao Fucai, 2021).

In summary, this study adopts the concept proposed by Zhao Yixuan, defining consumer purchase intention as a combination of consumer evaluation of a product or brand and other factors. When consumers evaluate a product and form purchase intentions, they are influenced not only by product characteristics but also by external factors that may inhibit their consumption behavior.

3.1.3 Related Research.

Purchasing Decision Model:The purchasing process takes place before the final sale and the results are displayed after this step. The illustration simplifies this process by presenting a model that helps marketers to focus fully on the decision-making process. The model assumes that customers go through all stages before purchasing a specific product. However, in everyday purchases, customers sometimes skip certain stages or adjust their behavioural scenarios.
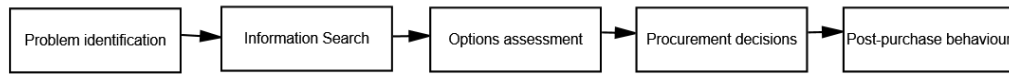
Figure 1. Purchase Decision Model

3.2 Research Framework
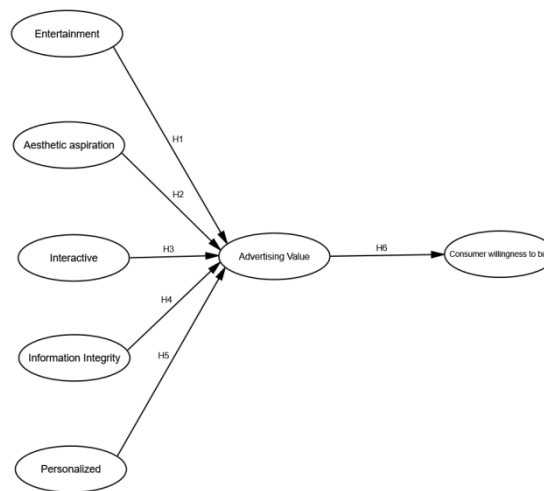
Figure 2 Research Framework

3.3 Research Hypotheses

H1: Entertainment has a positive impact on consumers' perception of the value of online advertising behavior.

H2: Aesthetic attractiveness has a positive impact on consumers' perception of the value of online behavioral advertising.

H3: Interactivity has a positive impact on consumers' perception of the value of online behavioral advertising.

H4: Information sufficiency has a positive impact on consumers' perception of the value of online behavioral advertising.

H5: Personalization has a positive impact on consumers' perception of the value of online advertising behavior.

H6: Perceived positive impact of online advertising value on consumer purchase intention

4. Research Methodology

4.1 Research Design

This study primarily employs literature review, survey methodology, and empirical analysis for its research.

4.2 Population and Sample

A total of 460 questionnaires were distributed, and the valid sample questionnaires obtained from those born after 1995 who had been exposed to online behavioural advertisements and purchased cosmetic products amounted to 387 questionnaires and 73 invalid samples, which were screened by setting up screening questions and screening out those who did not meet the requirements.

4.3 Research Instrument

This paper uses spss26.0 and AMOS software tools for data processing.

4.4 Data Collection

Table 4-1 Exploratory Factor Analysis

KMO Sampling Adequacy Measure		0.927
Bartlett's Test of Sphericity	Chi-Square	5598.763
	Degrees of Freedom	325
	Significance	0.000

Table 4-2 Model Fit Assessment

Indicator Type	Fit Indicator	Fit Standard	Indicator Value.	Whether it is suitable for analysis
Absolute fit indices	CMIN/DF	$<$ 3 OR 5	1.108	adapter
	GFI	$>$ 0.9	0.943	adapter
	AGFI	$>$ 0.9	0.928	adapter
	RMSEA	$<$ 0.05 OR 0.08	0.017	adapter
Relative fit indices	TLI	$>$ 0.9	0.994	adapter
	IFI	$>$ 0.9	0.994	adapter
	RFI	$>$ 0.9	0.937	adapter
	NFI	$>$ 0.9	0.946	adapter
	CFI	$>$ 0.9	0.994	adapter
Parsimonious fit indices	PNFI	$>$ 0.5	0.809	adapter
	PGFI	$>$ 0.5	0.747	adapter
	PCFI	$>$ 0.5	0.851	adapter

4.5 Data Analysis

4.5.1. Exploratory Factor Analysis

As can be seen from Table 4-1, the overall KMO measure for the scale is 0.927, which is greater than 0.8, indicating that the data for the overall scale is very suitable for factor analysis. The Bartlett's test of sphericity has an approximate chi-square value of 5598.763, with 325 degrees of freedom and a significance level of 0.000, which is less than 0.01, passing the significance test at the 1% level. Therefore, it can be concluded that the data for the overall scale is very suitable for factor analysis.

4.5.2. Confirmatory Factor Analysis

As can be seen from Table 4-2, it can be seen that in the absolute fit indices of the model fitting

Table 4-3 Analysis results of the theoretical assumptions of the model

Pathway	Standardized Path Coefficients	Estimate	S.E.	P	Hypotheses
Advertising value ← information sufficiency	0.142	0.151	0.066	0.021	Accepted
Advertising value ← Personalization	0.161	0.165	0.07	0.018	Accepted
Advertising value ← entertainment	0.171	0.171	0.072	0.017	Accepted
Advertising value ← Interactivity	0.184	0.177	0.071	0.012	Accepted
Advertising value ← aesthetic attractiveness	0.173	0.17	0.07	0.016	Accepted
Purchase intention ← advertising value	0.584	0.591	0.061	***	Accepted
P<0.05 is significant					

indicators, the Chi-square/df (CMIN/DF) value is 1.108, which is between 1 and 3, meeting the range of fit standards; the GFI value is 0.943, which meets the standard; the AGFI value is 0.928, which meets the requirements, and the root mean square error of approximation (RMSEA) value is 0.017, less than 0.05, which meets the standard, indicating that the absolute fit indices have good fit; in the relative fit indices, the TLI is 0.994, the IFI is 0.994, the RFI is 0.937, the NFI is 0.946, and the CFI is 0.994, all of which meet the fit index standards, indicating that the relative fit indices also have good fit. Additionally, in the parsimony fit indices, the PNFI is 0.809, the PGFI is 0.747, and the PCFI is 0.851, all of which meet the fit index standards, indicating that the parsimony fit indices also have good fit. According to the above fit parameter results, it can be concluded that

the research data and the model match well, and the proposed manifest and latent variables align with the true situation, demonstrating the accuracy and validity of the model.

4.5.3 Structural Equation Modeling Analysis

As can be seen from Table 4-3, The table presents the path analysis results of the model, including standardized path coefficients, estimates, standard errors, p-values, and hypotheses related to each path. The path from advertising value to information sufficiency has a standardized path coefficient of 0.142 and a p-value of 0.021, supporting the hypothesis of this path. The path from advertising value to personalization has a standardized path coefficient of 0.161 and a p-value of 0.018, supporting the hypothesis of this path. The path from advertising value to entertainment has a standardized path coefficient of 0.171 and a p-value of 0.017, supporting the hypothesis of this path. The path from advertising value to interactivity has a standardized path coefficient of 0.184 and a p-value of 0.012, supporting the hypothesis of this path. The path from advertising value to aesthetic appeal has a standardized path coefficient of 0.173 and a p-value of 0.016, supporting the hypothesis of this path. The path from purchase intention to advertising value has a standardized path coefficient of 0.584 and a p-value of less than 0.001 (indicating a very high level of significance), supporting the hypothesis of this path. Thus, it can be concluded that in this study, information sufficiency, personalization, entertainment, interactivity, and aesthetic appeal have a significant positive effect on advertising value, which in turn has a significant positive effect on purchase intention.

5. Research Findings

This study investigates the impact of information sufficiency, personalization, entertainment, interactivity, and aesthetic appeal on the advertising value of online behavioral advertising, as well as the effect of this advertising value on consumers' purchase intentions, using Chinese Generation Z cosmetics consumers as a case study. According to the data analysis results in Chapter Four, this research hypothesis received partial support, leading to the following conclusions: Hypothesis one demonstrates that entertainment has a positive effect on consumers' perception of the value of online behavioral advertising, aligning with Martins' research on the significant impact of entertainment on advertising value. Hypothesis two shows that visually appealing stimuli can enhance consumers' cognition and understanding of visual objects; consumers respond to products or services based on aesthetic attributes, favoring the use of dynamic themes, brightness, patterns, and shapes (Tuch, Bargas-Avila, Opwis, & Wilhelm, 2009). Hypothesis three establishes that the interaction between enterprises and consumers is crucial for the success of marketing and advertising (Grönroos, 2011). Hypothesis four indicates that the characteristic of online behavioral advertising is its ability to entertain while allowing audiences to naturally perceive various information about the products or services that the enterprise or brand wishes to convey (Tang & Wang, 2018). Hypothesis five asserts that when advertisements tailor marketing content to categorized users based on enterprise needs, they can accurately target potential customers, thereby enhancing consumers' purchase intentions. Consumers always hope that advertising information aligns with their interests, which is the essence of personalized advertising customization. Hypothesis six confirms that

scholars have found that advertising plays a key role in guiding consumers from contemplation to decision-making; the higher the perceived value of the advertisement, the greater the likelihood of a purchase decision (RADZOL, CHENG, HASHIM, & ISMAIL, 2017).

6. Discussion

Based on the online advertising value model, this paper considers the specificity of OBA advertising and examines its impact on consumers' purchase intentions. It explores the perceived value of OBA advertising through five dimensions: entertainment, information sufficiency, personalization, interactivity, and aesthetic appeal. Previous research on traditional rich media advertising has not clarified which variable is the most important among different forms of advertising. The results of this study indicate that interactivity is the most influential factor affecting the perceived value of OBA advertising, followed by aesthetic appeal, entertainment, personalization, and information sufficiency. Building on prior research, this paper constructs a conceptual model illustrating how OBA advertising influences consumers' purchase intentions, thereby further enhancing the related studies on the online advertising value model.

7. Suggestion

This study provides guidance for marketers and advertisers in choosing OBA advertising strategies. First, OBA advertising has become the mainstream form of mobile internet advertising. Therefore, understanding its key influencing factors is crucial for marketers and advertisers. When consumers view and engage with OBA ads, the ads should convey information valuable to them. Relevant personnel should design OBA ads that meet consumer needs and ensure they are part of the communication strategy. Secondly, this paper offers valuable insights into OBA ads that enhance consumers' purchase intentions, helping marketers and advertisers develop OBA ads that capture consumer attention and engage them. Although the current number of OBA ads is vast and their quality varies, targeted design can be based on this study's findings when investing in OBA ad design.

8. Acknowledgement

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Room 2:

Education, Liberal Arts

The Salient Factors Affecting the Digital Technology Acceptance Model

for Education Management Service Providers

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ABSTRACT

Aiming at the issues related to service providers' behavior habits and willingness to use digital technology in education management, this paper proposes various hypotheses. It designs a corresponding questionnaire based on the improved Technology Acceptance Model (TAM) and establishes a structural equation model using statistical programs to verify the correctness of these hypotheses. Finally, based on the verified hypotheses, the paper presents corresponding improvement measures and suggestions.

KEYWORDS: Education management for service provider, Technical acceptance model, UTAUT

1. Introduction

The swift advancement of technology has facilitated the widespread integration of digital technology across various sectors. Education management service providers, as an important driving force of digital teaching, have their acceptance and effective use of digital technology directly affecting learners' learning experiences and outcomes. Although some education management service providers have mastered the application of digital technology, the degree of its application in practical teaching still needs improvement. Therefore, it is crucial to focus on a variety of factors that impact the acceptance of technology among education management service providers. Sholikah Maratus et al. (2020) explored the determinants of college learners' satisfaction with e-learning platforms using the Technology Acceptance Model (TAM). They found that perceived usefulness and ease of use significantly impacted college learners' satisfaction with e‑learning platforms. Drueke Barbara et al. (2021) investigated the effects of implementing, accepting, and utilizing virtual teaching services, also using TAM. Wannapiroon P et al. (2021) examined the acceptance of online teaching among vocational instructors in Thailand, employing TAM. Alfadda and Mahdi (2021) studied the readiness to utilize Zoom for online English

instruction, demonstrating that Zoom software usage influenced learners' attitudes and willingness to use, and analyzed gender and technical experience differences as external variables.

2. Research Objective

The primary aim of this research is to thoroughly analyze and investigate the key factors influencing the acceptance and utilization of digital technologies by educational management service providers. The specific research objectives are as follows:

(1) Identification of Key Elements

In the realm of educational management, it is crucial to pinpoint the primary factors influencing service providers' acceptance and use of digital technologies. These factors include, but are not limited to, perceived usefulness, ease of use, technology self‑efficacy, social influence, institutional support, and personal innovation capability.

(2) Development of a Theoretical Model

Develop an extended Technology Acceptance Model (TAM) tailored for educational management service providers. This new model will incorporate the identified key elements to more comprehensively explain and predict technology acceptance.

(3) Empirical Validation of the Model

Design and administer questionnaires to gather relevant data from educational management service providers. Employ descriptive statistical analysis, regression analysis, structural equation modeling (SEM), and other analytical methods to empirically test the extended Technology Acceptance Model, evaluating the relative impact and significance of each factor on technology acceptance behavior.

(4) Strategic Recommendations

Based on the empirical findings, propose specific and practical strategies to help educational management service providers overcome various obstacles and challenges related to technology acceptance. Provide targeted interventions and optimization strategies for different factors to enhance the effective application of digital technology in educational management.

(5) Policy Formulation Support

Offer a scientific basis, derived from empirical research, for education policymakers to support the development and implementation of policies and measures that facilitate the adoption of digital technology. Ensure that these policies effectively address the actual needs and challenges faced by educational management service providers during the technology acceptance process.

3. Literature Review

3.1 Theory, Concept and Related Research

Theoretical models of behavior, including the Theory of Reasoned Action (TRA), the Theory of Planned Behavior (TPB), the Motivation Model (MM), the Technology Acceptance Model (TAM), the Combined

TAM and TPB (C-TAM-TPB), the Innovation Diffusion Theory (IDT), and the Social Cognitive Theory (SCT), have each contributed significantly to our understanding of information technology acceptance. However, as digital technologies continue to evolve, these theories face limitations. Although each theory incorporates different information technologies as influencing factors when studying users' acceptance of technology, these factors are essentially similar in concept. Recognizing the complex landscape of user behavior research and the challenges faced by scholars, Venkatesh et al. (2003) amalgamated elements from these eight models to propose the Unified Theory of Acceptance and Use of Technology (UTAUT). UTAUT consists of four main components: performance expectancy, effort expectancy, social influence, and facilitating conditions, alongside four moderating variables: gender, age, experience, and voluntariness. Expanding upon the TAM framework, UTAUT organizes the factors influencing users' technology acceptance into these four dimensions, offering a comprehensive insight into users' acceptance behaviors.

Sholikah Maratus et al. (2020) explored the determinants of college learners' satisfaction with e-learning platforms, employing the technology acceptance model. They found that perceived usefulness and ease of use significantly impacted college learners' contentment with e-learning platforms. Drueke Barbara et al. (2021) investigated the effects of implementing, accepting, and utilizing virtual teaching services, utilizing the technology acceptance model. Wannapiroon P et al. (2021) examined the acceptance of online teaching among vocational instructors in Thailand, employing the technology acceptance model. Alfadda and Mahdi (2021) studied the readiness to utilize ZOOM for online English instruction, demonstrating that ZOOM software usage influenced learners' attitudes and willingness to use, and analyzed gender and technical experience differences as external variables. Hsu and Lin (2022) introduced internal motivation and psychological construction concepts to the technology acceptance model, further illustrating its explanatory power in Mobile-Assisted Language Learning (MALL) settings.

3.2 Research Framework

Based on UTAUT, we introduced perceived interactivity as the core variable, with gender, age and experience as regulatory variables, and constructed the initial study model shown in Figure 1, and demonstrated hypothesis in the following text.
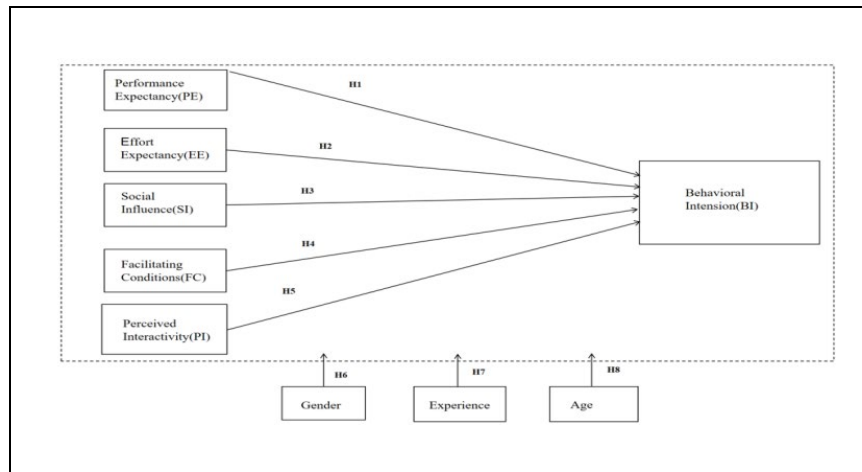
Figure 1 Research Framework

3.3 Research Hypotheses

Scholar Tian Xueying and colleagues (2021) conducted a survey on the acceptance willingness of five universities in Shanghai and Suzhou using the UTAUT theory. The results demonstrated that performance expectations positively impact college learners' acceptance intention of the ERP teaching experiment platform. Scholar Lian Yanling et al. (2023) conducted an investigation and study on Chinese listed manufacturing enterprises and found that innovation performance expectations significantly promoted cross-regional and cross-industry search behavior of enterprises. Based on this, the following assumptions are proposed:

H1: Performance expectancy is positively related to education management for service providers' intention to use digital teaching.

Liao Qian et al.（2023）examined college learners' online learning behaviors using planned behavior theory and the Technology Acceptance Model（TAM）. Their findings indicated that perceived usefulness positively impacts online learning intentions. Based on this, the following hypotheses are proposed:

H2: Effort expectancy is positively related to education management for service providers' intention to engage in digital teaching behaviors.

Niu Chunhua et al. (2023) employed an integrated model of technology acceptance and usage to explore public usage behavior regarding tracking technology. Their findings indicated that social impact significantly and positively influences the public's intention to use contact tracking technology. Based on these findings, the following hypotheses are proposed:

H3: Social influence is positively related to education management for service providers' intention to engage in digital teaching behaviors.

Li Wen et al.（2023）conducted a study on the usage behavior of users of an online psychological counseling platform using the UTAUT model. Their findings revealed that facilitating conditions significantly and positively impact user behavior. Based on these findings, the following hypotheses are proposed:

H4: Facilitating conditions are positively related to education management for service providers' intention to engage in digital teaching behaviors.

Wang Cuicui et al. (2023) explored how the high interactivity of virtual anchors in e-commerce live broadcasts can encourage consumers to focus on products and virtual anchors, reduce their attention to interactive barrage, and enhance their purchase intention. To summarize, the current study posited the subsequent hypotheses:

H5: Perceived interactivity is positively related to education management for service providers' intention to use digital teaching.

Wang Ling (2023) explored the factors affecting the readiness to use AI voice assistants using the Technology Acceptance Model (TAM), identifying that empirical factors moderate this readiness. Yang Yuxuan and Li Qian (2023) investigated the willingness to use digital museums based on the UTAUT and Value Adoption Model (VAM) theories, revealing that gender and age moderate users' perceived value and usage intentions. Based on these findings, the following assumptions are proposed:

H6: Gender shows significant differences in performance expectancy, effort expectancy, social influence, facilitating conditions, perceived interactivity, and behavioral intention.

H7: Age shows significant differences in performance expectancy, effort expectancy, social influence, facilitating conditions, perceived interactivity, and behavioral intention.

H8: Experience shows significant differences in performance expectancy, social influence, effort expectancy, facilitating conditions, perceived interactivity, and behavioral intention.

4. Research Methodology

4.1 Research Design

Empirical analysis was employed in this study. During the questionnaire design phase, extensive literature was reviewed, and established scales from both domestic and international sources were utilized for the variables under investigation. After multiple revisions, the questionnaire was finalized, and data were collected to facilitate subsequent statistical analysis.

4.2 Population and Sample

This study focused on education management service providers from four county-level administrative districts: Liupanshui City, Guizhou Province; Panzhou City; Shuicheng District; and Zhongshan District. A total of 435 education management service providers with digital teaching experience were selected through random sampling for a questionnaire survey. According to the guideline that the sample size for a scale questionnaire should be 5-10 times the number of items, the maximum sample size for this study is calculated as $31 \times 10 = 310$.

4.3 Research Instrument

To investigate the determinants of digital teaching among education management for service provider education management for service providers, the questionnaire utilized the maturity scale of the existing UTAUT model to assess influencing factors. The questionnaire comprises two sections: the initial part collects demographic details of education management for service provider education management for service providers,

encompassing gender, age, teaching tenure, and experience with digital teaching.The subsequent section assesses the influencing factors of digital teaching among education management for service provider education management for service providers. It consists of 25 questions rated on a five-point Likert scale.

The collected data underwent reliability and validity analysis of the questionnaire, factor analysis, and correlation analysis, which were carried out using statistic program software. Furthermore, structural equation modeling software, statistic program, was employed to validate the initial model and research hypotheses.

4.4 Data Collection

This study was conducted from September 2023 to December 2023. The questionnaire was distributed through WeChat and QQ groups associated with education management service providers in Liupanshui City, Panzhou City, Shuicheng District, and Zhongshan District. Distribution was facilitated by the English teaching and research staff in each district to collect data.

4.5 Data Analysis

(1) Reliability analysis

Table 1: Reliability test

Dimension	Number of terms	The Cronbach's α coefficient
Performance Expectancy	4	0.820
Effort Expectancy	4	0.829
Social Influence	4	0.838
Facilitating Conditions	4	0.848
Perceived Interactivity	4	0.853
Behavioral Intension	5	0.865
Overall scale	25	0.924

As indicated in the table above, the reliability α coefficients for performance expectation, effort expectation, social influence, convenience conditions, perceived interaction, and behavioral intention were 0.820, 0.829, 0.838, 0.848, 0.853, and 0.865, respectively, all exceeding the threshold of 0.7. These α coefficients adhere to the predefined criteria for this study, with the overall scale's α coefficient reaching 0.924, surpassing the threshold of 0.8. This signifies robust consistency in the questionnaire scale data outcomes.

(2)Validity analysis

Table 2: KMO and Bartlett tests

Number of KMO sampling suitability quantities.		0.923
The sphericity test of the Bartlett	Last read card square	4807.268
	free degree	300
	conspicuousness	0.000

Based on Table 4-4, the KMO value for the entire scale is 0.923, surpassing the minimum threshold of 0.7, while Bartlett's test of sphericity produces a chi-square value of 4807.268, with a significance level (Sig.) of 0.000, which is below 0.01. These findings suggest that the questionnaire scale is highly appropriate for conducting exploratory factor analysis.

(3) Correlation analysis

The correlation analysis explored the interrelationships among expectations, including performance and effort expectations, social influence, convenience conditions, perceived interactivity, and behavioral intention. Utilizing Pearson's correlation coefficient (two-tailed test, $p < 0.01$), the analysis unveiled significant positive correlations across these dimensions. Specifically, a noteworthy positive correlation emerged between performance expectation and effort expectation ($r = 0.386$, $p < 0.01$), signifying a favorable association between individuals' performance expectations and their willingness to exert effort. Moreover, positive correlations were evident between performance expectations and both social influence ($r = 0.382$, $p < 0.01$) and convenience conditions ($r = 0.435$, $p < 0.01$), suggesting that heightened performance expectations correlate with anticipations of greater social influence and facilitative circumstances. Additionally, a robust positive correlation was observed between perceived interactivity and behavioral intention ($r = 0.494$, $p < 0.01$), indicating that there is a positive relationship between individuals' perception of interactivity and their behavioral intention. Overall, important information about the degree of association between the dimensions is known through the correlation analysis, which provides a strong basis for further research and discussion of the influence of these factors in a specific context.

5. Research Findings

As per the analysis conducted using statistic program, all pathways were deemed statistically significant ($P < 0.05$), validating the overall model across all paths. Specifically, the path coefficient for performance expectation was 0.148, with a significance level of $P=0.020 < 0.05$, indicating a notable positive impact on behavioral intention. Similarly, the path coefficient for effort expectation stood at 0.132, with $P=0.029 < 0.05$, reaffirming a significant positive influence on behavioral intention. Moreover, the path coefficient for social influence was 0.196, with $P=0.002 < 0.01$, underscoring a significant positive effect on behavioral intention. Additionally, the path coefficient for convenience conditions was 0.205, with $P=0.002 < 0.01$, further supporting a significant positive impact on behavioral intention. The path coefficient for perceived interaction was 0.217, with $P=0.001 < 0.01$, highlighting its significant positive influence on behavioral intention.

Table 3: The SEM path coefficient table

Influence path	Standard path coefficient	Estimate	S.E.	C.R.	P
PE→BI	0.148	0.149	0.064	2.334	0.020
EE→BI	0.132	0.133	0.061	2.188	0.029
SI→BI	0.196	0.19	0.061	3.113	0.002
FC→BI	0.205	0.187	0.061	3.06	0.002
PI→BI	0.217	0.208	0.064	3.239	0.001

6. Discussion

This study developed a model to forecast the intentions of education management service providers using the UTAUT model, achieving satisfactory overall results and validating the research hypotheses. By applying the Technology Acceptance Model framework, we investigated the determinants affecting education management service providers' adoption of digital teaching, providing insights into their behavioral tendencies. In summary, evaluating the stances and inclinations of education management service providers regarding digital teaching can be conducted by assessing their performance expectations, effort expectations, social influence, convenience conditions, perceived interactivity, and behavioral intentions. To enhance the acceptance and intention of education management service providers towards digital teaching, it is crucial to understand the role of these influencing factors in practical teaching, taking into account both the individual characteristics of the providers and the features of digital teaching.

7. Suggestion

Drawing from the validated outcomes of model testing and analysis discussed earlier, we have gained scientifically supported insights into the adoption of digital teaching among education management service providers. To facilitate the integration of digital teaching within this group, the following suggestions are offered to address both external contextual factors and individual circumstances:

（1）Formulating relevant policy documents is essential for clarifying the support and requirements for digital teaching from schools and education departments. This ensures that promotion goals and policy guidance for digital teaching are clearly defined.

(2) Assess the digital teaching needs and proficiency levels of education management service providers through questionnaires or group discussions. Based on these assessments, tailor the training content and format to effectively address their actual needs.

(3) Design a simple and intuitive user interface to reduce learning difficulty. Use clear labels and icons to enable education management service providers to quickly locate the required functions.

（4）Utilize digital platforms to offer multimedia teaching resources such as English animations, children's songs, and story videos. This approach aims to stimulate learners' interest and enhance their motivation to learn.

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The Relationship of Chinese Grade 5 Students' Motivation and Self-efficacy for Learning English with English Academic Achievement

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ABSTRACT

The aims of this research were to assess the motivation and self-efficacy levels for learning English among Grade 5 students at a public primary school in Shaanxi province, China, and to evaluate their English academic achievement. Additionally, the study sought to determine whether there was a significant relationship between motivation and self-efficacy for learning English and English academic achievement. The sample consisted of 160 students from four Grade 5 classes at the target school during the 2023-2024 academic year. To measure the students' motivation for learning English, Gardner's 2010 International Attitude/Motivation Test Battery (AMTB) was used, while Pint rich et al.'s 1991 Motivated Strategies for Learning Questionnaire (MSLQ) was employed to assess their self-efficacy for learning English. The students' English Final Examination scores were collected to gauge their English academic achievement. The study's findings indicated that the Grade 5 students at the public primary school in China had moderately high levels of motivation and self-efficacy for learning English. Furthermore, the results revealed a significant, positive, and strong correlation between the students' motivation and self-efficacy for learning English and their English academic achievement. Based on these findings, recommendations are made for students, teachers, school principals, and future researchers.

Keywords: Motivation, Self-efficacy, English Academic Achievement, Grade 5 Students, A Public Primary School in Shaanxi Province China

1. Introduction

The status of English language education in China became particularly significant starting in the late 20th century and gained momentum with major educational reforms initiated in the early 2000s. The first significant reform in English education occurred in 2001, followed by further updates in 2011 and 2022. These reforms aimed to align China's educational system with international standards, emphasizing English's critical role in enhancing global competitiveness (Yang, 2024).

English was designated as the primary foreign language and was given equal importance alongside other subjects in the entrance examination for higher education. As a result, proficiency in English has become an essential requirement, especially for the younger generation. The incorporation of English education in elementary schools has evolved into a global trend, drawing increasing attention in China.

Given the prominence of English learning, there is a growing focus on the factors influencing language acquisition. Two pivotal factors are motivation for learning English and self-efficacy in English learning, as highlighted by Bandura (1997). This study specifically targeted a public primary school in Shaanxi province, China, with a student population primarily composed of local residents.

This study focused on investigating the relationship among motivation and self-efficacy for learning English with students' English academic achievement.

2. Research Objectives

(1) To determine the level of Grade 5 students' motivation for learning English as a foreign language at a public primary school, Shaanxi province, China.

(2) To determine the level of Grade 5 students' self-efficacy in learning English as a foreign language at a public primary school, Shaanxi province, China

(3) To determine the level of Grade 5 students' English academic achievement in learning English as a foreign language at a public primary school, Shaanxi province, China.

(4) To determine if there is a significant relationship of Grade 5 students' motivation and self-efficacy for learning English as a foreign language with English academic achievement at a public primary school, Shaanxi province, China.

3. Literature Review

The following sections discuss Gardner's **Socio-Educational Model of Second/Foreign Language Acquisition** (1985) along with associated variables, introduce the concept and relevant research for this study, and then outline the research framework and hypothesis.

3.1 Theory, Concept and Related Research

Socio-Educational Model of Second/Foreign Language Acquisition (Gardner, 1985)

Gardner's socio-educational model stands as a prominent theory in the field of language acquisition. Rooted in Lambert's social-psychological model, Gardner began developing socio-educational models in the 1960s, examining the role of attitudes and motivations in second language learning. He asserts that various factors, such as integration, situational learning attitudes, motivation, and language anxiety, impact second or foreign language learners. Gardner (2005) suggests that highly motivated students outperform those with lower motivation levels due to their determination to accomplish their learning objectives. Central to this theory is the motivation to learn second or foreign languages.

Self-Efficacy Theory (Bandura, 1994)

Self-efficacy stands as a pivotal concept in Bandura's (1994) theory of social cognition, denoting individuals' confidence or conviction in their capability to attain behavioral objectives within a particular domain. This research will explore the application of self-efficacy theory in learning English as a foreign language (EFL), aiming to ascertain students' self-efficacy in EFL learning and its association with motivation and academic achievement. According to Bandura (1994), self-efficacy beliefs shape students' cognition, emotions, self-motivation, and learning behaviors. Students exhibiting high levels of self-assurance are inclined to tackle more challenging tasks in the classroom. Their motivational levels, emotional states, and behaviors are primarily influenced by their beliefs rather than external circumstances (Bandura, 1995).

3.2 Research Framework
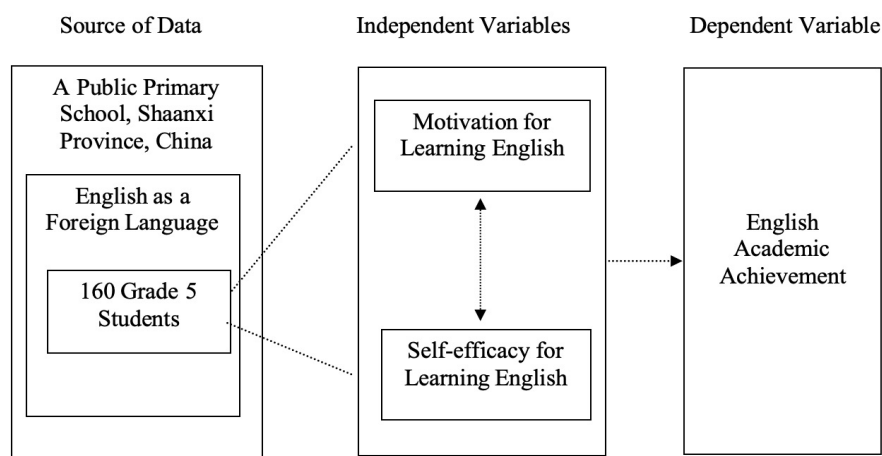
Figure 1 Conceptual Framework of the Study

3.3 Research Hypothesis

There is a significant relationship of Grade 5 students' motivation and self-efficacy for learning English as a foreign language with English academic achievement at a public primary school, Shaanxi province, China, at a significance level of .05.

4. Research Methodology

This research was a quantitative correlational research design.

4.1 Research Design

The purpose of this study was to investigate the relationship between motivation and self-efficacy for learning English with English academic achievement of Grade 5 students at a public primary school, Shaanxi province, China.

4.2 Population and Sample

The study's target population consisted of 320 fifth-grade students enrolled in English as a foreign language classes across eight different classrooms at a public elementary school in China during the 2023-2024

academic year. The sample group, comprising 160 students, was drawn from four classes: Class 1, Class 2, Class 5, and Class 7. These specific classes were selected using a convenience sampling method, as the teacher of these classes, who is a friend of the researcher, agreed to assist with data collection. This facilitated access to the students and ensured the smooth implementation of the study's procedures.

4.3 Research Instrument

For this study, the researcher used two research instruments. The first was the Motivation and Self-Efficacy for Learning English Questionnaire, which was used to collect data. Part I collected students' demographic information, Part II examined their motivation for learning English, and Part III assessed their self-efficacy in learning English.

The questionnaire was adapted from established sources, including three subscales from the international Attitude/Motivation Test Battery (AMTB), which has been widely validated in previous studies. The items were modified to suit the context of fifth-grade students learning English as a foreign language in China, ensuring relevance and alignment with the study's objectives. Experts in language learning and educational psychology likely reviewed the modified version to ensure its appropriateness for measuring motivational intensity, desire to learn English, and attitudes toward learning English. The questionnaire consisted of 30 items measured on a 6-point Likert scale. In this study, reliability measures such as Cronbach's alpha were likely recalculated for the modified questionnaire to confirm consistency with the sample population.

Additionally, the study used the Motivated Strategies for Learning Questionnaire (MSLQ), developed by Pintrich et al. (1993), consisting of 8 items on a 7-point Likert scale to assess students' self-efficacy in learning English. The original questionnaire has been extensively validated and used across different cultural and educational settings. The MSLQ has demonstrated high reliability in various contexts, with Cronbach's alpha values typically above 0.70. The 8-item scale used in this study is expected to have been checked for internal consistency to ensure reliability within the specific sample of Grade 5 students.

The second research instrument was the final examination for the English subject. Specifically, this was the English exam taken by Grade 5 students in the 2023-2024 academic year at a public primary school in China. The content validity of this examination is supported by the fact that it was designed to align with the Grade 5 curriculum and assess students' proficiency in key areas of the English language. It serves as a direct measure of students' academic achievement in English. The reliability of the exam is typically ensured by the standardized test construction processes used by the school, which would include item analysis and consistency checks across different test versions.

4.4 Data Collection

To collect data, the researcher, along with another English teacher, distributed the Motivation and Self-efficacy for Learning English questionnaire to 160 Primary Grade 5 students at the target school. The English teacher and researcher assisted the students in completing the questionnaires. All 160 students returned

their responses, and all were valid, resulting in a 100% response rate. Additionally, the researcher requested the English exam scores from the target classes.

4.5 Data Analysis

Descriptive statistical analysis and correlational analysis were carried out through use of a statistical software package.

5. Research Findings

The research findings obtained from data collection and analysis are presented in alignment with the research objectives.

5.1 Finding of Research Objective 1

Table 1 shows the mean scores, standard deviations, and interpretation of three subscales and total of motivation variable for learning English.

Table 1: The Grade 5 Students' Mean Scores, Standard Deviations, and Interpretation of the Motivation for Learning English

Variable	Grade 6		
	M	SD	Interpretation
Motivational intensity learning English	5.34	.98	Moderately high
Desire to learn English	5.17	1.19	Moderately high
Attitudes toward learning English	5.33	1.04	Moderately high
Overall	5.28	1.07	Moderately high

The first objective was to determine the level of Grade 5 students' motivation for learning English as a foreign language at a public primary school, Shaanxi province, China. Motivation was measured using three subscales: motivational intensity, desire to learn English, and attitudes toward learning English. The research instrument, The Motivation for Learning English Questionnaire, comprised 30 items, with 10 items in each subscale. Each subscale included five positively worded and five negatively worded items. The questionnaire employed a 6-point Likert scale ranging from 1 (Strongly Disagree) to 6 (Strongly Agree).

According to Table 1, Primary Grade 5 students demonstrated a moderately high motivation for learning English, with an overall mean score of 5.28. Table 1 above summarizes the findings for Objective 1. The overall mean score of students' motivation in foreign languages was 5.28 which was interpreted as moderately high on the research interpretation scale of 4.50-5.49.

5.2 Finding of Research Objective 2

Table 2 presents the overall mean scores, standard deviations, and interpretations of the level of self-efficacy for learning English of Grade 5 students at a public primary school in China.

Table 2: The Grade 5 Students' overall Mean Scores, Standard Deviations, and Interpretation of the Self-efficacy for Learning English

Variable	Grade 5		
	M	SD	Interpretation
Self-efficacy for Learning English	6.20	1.29	Moderately high

In this study, to assess the self-efficacy of Grade 5 students learning English as a foreign language, a 7-point Likert scale was employed. Students chose from seven options: 1 = Not at all true of me, 2 = Untrue of me, 3 = Somewhat untrue of me, 4 = Neutral, 5 = Somewhat true of me, 6 = True of me, 7 = Very true of me. As shown in Table 2, the mean score for self-efficacy in learning English among Primary Grade 5 students at a public primary school in Shaanxi province, China was 6.20. This score falls within the range of 5.51 to 6.50, which is interpreted as moderately high.

Finding of Research Objective 3

Table 3 shows the mean scores of English Final Examination scores as English academic achievement.

Table 3: Frequency Distribution, Overall Mean Score and Standard Deviation of Grade 5 Students' English Academic Achievement from the Final Exam

Primary Grade Level	N	Maximum	Minimum	M	SD	Interpretation
Primary Grade 5	160	100	60	92.15	8.28	Excellent

According to Table 3, the mean score of Primary Grade 5 students on the English final test was 92.15, which is above 91% and interpreted as Excellent. The standard deviation of the scores was 8.28, indicating that the students' final test scores varied by approximately 8.28 points from the mean. The range of scores for the English final test among Primary Grade 5 students was from 60.00 to 100.00 points.

Finding of Research Objective 4

The fourth research objective was to determine whether there was a significant relationship among motivation and self-efficacy for learning English with English academic achievement of Grade 5 students at the target school. Table 6 presents the multiple correlations of motivation and self-efficacy for learning English with English academic achievement of Grade 5 students.

Table 4: Bivariate Correlations Among Grade 5 Students' Motivation, Self-efficacy, and English Academic Achievement

	Variables	1	2	3
1.	Motivation for learning English	-		
2.	Self-efficacy for learning English	.994** (<.001)	-	
3.	English Academic Achievement	.937** (<.001)	.945** (<.001)	-

Note. **denotes a statistically significant relationship (statistical significance level set at p = .05, two tailed). p-values appear within parentheses below the correlation coefficients.

Table 4 presents the results of a multiple linear regression analysis to explore the relationships among the variables. The bivariate correlations among the three variables in this study—motivation for learning English, self-efficacy for learning English, and English academic achievement—showed that Primary Grade 5 students' motivation for learning English had a significant, positive, and strong correlation with their English academic achievement (r = .937, p < .001) at a significance level of .05.

6. Discussion

Motivation for Learning English

Motivation is a key factor in successful foreign language acquisition, with more motivated students typically achieving better results, as supported by Gardner (2010) and Hattie (2008). The study found that Primary Grade 5 students in Shaanxi province, China, had moderately high motivation for learning English, along with a positive attitude and behavior towards the subject. This aligns with Hattie's research on "visible learning," which highlights motivation as a major influence on student achievement. The study also confirmed previous findings by Siphora & Lynch (2019) and Chao & Lynch (2023) that highly motivated students generally have positive attitudes towards learning English. The researchers suggested that these positive attitudes might be linked to students' preferences for indirect learning strategies, which help boost motivation and enhance the overall language learning experience. The study also found a significant positive relationship between the students' motivation and their English academic achievement.

Self-efficacy for Learning English

The study found that fifth-grade students at a public school in Shaanxi province, China, generally achieved excellent academic results in English, with the majority scoring above 85%. These students also demonstrated a high level of belief in their ability to learn English, reflecting a strong sense of self-efficacy. The bivariate correlations revealed a significant positive relationship between self-efficacy and English academic achievement (r = 0.65, p < 0.01), indicating that students who had higher confidence in their English

learning abilities tended to achieve higher scores in their English exams. There was a significant positive correlation between the students' self-efficacy for learning English and their academic achievement.

The Relationship Among Students' Motivation, Self-efficacy, and English Academic Achievement

One finding of the current study was that there was a positive and significant relationship between students' motivation for learning English and the English academic achievement of Primary Grade 5 students at a public primary school in Shaanxi province, China. As noted above, this result aligns with previous research by Hattie (2008). Hattie argued that motivation is a critical factor in learning, as it influences students' willingness to engage with the material, persist through challenges, and ultimately achieve higher academic outcomes. Hattie's research consistently shows that students who are motivated tend to perform better academically, as their motivation drives them to invest more effort and sustain their focus on learning tasks. This finding is consistent across various educational contexts, underscoring the importance of fostering motivation to enhance academic success.

Chao and Lynch's (2023) study found a significant, positive, and strong correlation between self-efficacy and Chinese learning achievement among 100 Grade 6 students studying Chinese as a Foreign Language (CFL) at an International School in Bangkok, Thailand. The results highlighted that self-efficacy was a crucial factor in their success in learning Chinese. High levels of self-efficacy were associated with better outcomes, enabling students to progress to the next phase once they met the required standards.

7. Suggestions

(1) Teachers should be mindful of their students' motivation and self-efficacy levels in English learning and work to enhance these through various strategies. This includes fostering independent problem-solving skills, encouraging students to share challenges and support one another, and providing assistance when needed. Teachers should aim to boost students' enthusiasm for learning English by promoting active participation and enjoyment in the classroom. Adapting instructional methods based on student feedback and experimenting with different teaching approaches can make lessons more engaging. By setting specific, tailored goals for each class, teachers can help improve students' motivation and self-efficacy in learning English.

(2) It is recommended that students develop independent learning skills and attempt to resolve problems on their own before seeking help from teachers. For example, if students encounter challenges while writing a composition, they should first apply their existing English knowledge to address the issues before consulting the teacher if needed. Additionally, to sustain high levels of motivation and self-efficacy, students should be encouraged to participate in English language cultural activities both inside and outside of school.

(3) School administrators should regularly organize a variety of English-themed activities to boost students' motivation, enthusiasm, and self-confidence in learning English. These activities can help students become more motivated and self-assured in their language learning.

(4) Future researchers should also investigate the relationship between students' motivation, self-efficacy, and performance in Chinese and mathematics. These three subjects-Chinese, mathematics, and English-are key components of the primary school curriculum in China. Future research should also explore the perceptions of non-native English-speaking students regarding their English academic achievement and identify the factors that influence their self-efficacy in learning English.

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A Model for Developing Instructional Leadership of Heads of Learning Areas in Secondary Schools under the Regional Education Office No. 11

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ABSTRACT

The research aimed to 1) examine the conditions, needs, and components of instructional leadership of heads of learning areas in secondary schools under Regional Educational Office No. 11, and 2) develop a model to enhance instructional leadership of heads of learning areas in secondary schools, and 3) validate the effectiveness of the developed model. A Research and Development (R&D) approach was utilized in three phases. Phase I assessed conditions, needs, and components through relevant documents, research studies, in-depth interviews with scholars, and a survey of 360 heads of learning areas in the 2018 academic year; Phase II involved model construction and expert validation, while Phase III implemented the model with 24 heads of learning areas from three secondary schools. Data collection included unstructured interview forms, 5-rating scale questionnaires, and assessment forms, with analysis using frequency, percentage, mean, and standard deviation. The findings identified seven major instructional leadership components with 27 sub-components. Current instructional leadership behaviors were rated at a medium level ($\overline{X} = 2.64$), while expected level at the highest level ($\overline{X} = 4.64$). The highest-level need for improvement was identified and addressed. The developed model comprised principles, objectives, content, development processes, media and learning resources, and evaluation and measurement. The development process involved four approaches: a workshop, a practical application in real settings, participation in a professional learning community (PLC), and supervision and monitoring. The model was validated at the highest level of appropriateness, with a 45.29% improvement in instructional leadership among participants.

KEYWORDS: Development Model, Instructional Leadership, Heads of Learning Areas

1. Introduction

Education is crucial for developing quality human resources and shaping future leaders. Teacher development is key to improving education, as teachers directly impact student growth and overall educational quality (Office for National Education Standards and Quality Assessment, 2019). Effective teaching and leadership qualities are linked to students' academic success, with teachers' behaviors and teaching methods

significantly influencing learning outcomes. Teachers must not only have strong teaching skills but also positive behaviors to create a supportive learning environment (Stronge, 2013). Instructional leadership requires school administrators to manage teaching effectively and collaborate with teachers to meet educational goals. Teachers and colleagues help organize the teaching process to align with curriculum objectives. Davis & Thomas (1989) highlight that teachers should focus on classroom performance, while Prawang et al. (2008) stress the importance of expertise and high standards in academic management. However, teachers often lack support for enhancing methods, updating content, and exploring new educational media. Additionally, educational institutions may lack adequate supervision, quality assurance, and community engagement, with insufficient support for scholarly work and external collaboration.

This research aims to enhance instructional leadership among heads of learning areas, a critical factor in achieving work objectives. It also focuses on continuous and sustainable improvement to foster student learning, align with their roles and responsibilities, and advance the future development of schools.

2. Research Objectives

1) to examine the components of instructional leadership among heads of the learning areas in secondary schools under Regional Education Office No.11,

2) to construct and develop the instructional leadership model for heads of learning areas, and 3) to determine the effectiveness of the developed model.

3. Literature Review

3.1 Theory, Concept, and Related Research

Interest in instructional leadership surfaced in the 1980s in the U.S., driven by the Effective Schools Movement, which recognized school administrators as crucial for boosting student achievement (Edmonds, 1979). Initially viewed as mere managers, school leaders' roles focus on setting high standards and improving teaching quality. By the 1990s, reforms broadened their duties to include curriculum development and supporting teachers, with a strong emphasis on accountability. Research by Hallinger and Murphy (1986) and Leithwood, Harris, & Strauss (2010) demonstrated the substantial effect of leadership on student performance. Effective instructional leaders were shown to establish clear objectives, enhance teaching quality, and create a supportive learning environment. Contemporary studies continue to affirm the significance of instructional leadership in fostering collaboration and excellence, making it crucial for advancing student achievement. To quantitatively and qualitatively examine the components and the instructional leadership model for heads of learning areas in secondary schools under the Regional Education Office No.11, Thailand, the researchers employed the Research and Development (R&D) approach with three phases to determine the instructional leadership among heads of learning areas in secondary schools, including seven components with 27 sub-components drawn from various studies in international and Thai contexts (Prasit Kaewsri and others, 2005; OEC, 2007; Ministry of Education, 2009; OBEC, 2010; Charuphat Boonsong, 2013; Suntorn Sopakayang, 2013; Rachadaporn Pimpichai, 2013;

Krug, 1992; Weber, 1996; Edmonds, 1979, Hoy, & Alig-Mielcarek, 2005; Kelly, 2009; Leithwood, Harris, & Strauss, 2010). The model was drafted and confirmed by scholars of its appropriateness and then implemented with heads of learning areas within secondary schools under the Regional Education Office No.11, Thailand.

3.2 Research Conceptual Framework

The research conceptual framework aims to construct a model for developing instructional leadership for heads of learning areas in secondary schools under the Regional Education Office No.11 (REO 11) in Thailand, using a research and development (R&D) approach. The input includes the current conditions and needs for instructional leadership improvement, and the components of the instructional leadership model. The process follows three R&D phases to develop and refine the instructional leadership model. The output focuses on the assessment of conditions, needs, model components, and model effectiveness.

4. Research Methodology

The research employed a Research and Development (R&D) approach, with three phases. The following section outlined data collection and analysis including the population, sample, and research instruments.

Phase I was related to determining the components of instructional leadership of heads of learning areas in secondary schools under REO 11, identifying conditions and needs for instructional leadership improvement. This phase included three steps: Step 1: The researchers obtain information by examining relevant documents and research studies to determine the components of instructional leadership of heads of learning areas, instructional leadership models, curriculum development, learning management, a research and development (R&D) approach, professional development approaches for improving instructional leadership among heads of learning areas in secondary schools, conditions, and needs for instructional leadership improvement. Step 2: Nine scholars were interviewed, using unstructured interviews to review and confirm the components regarding instructional leadership among heads of learning areas in secondary schools, and development approaches. Step 3: A set of 5-rating scale questionnaires was employed to examine the components, the instructional leadership model, conditions, development approaches, and needs for instructional leadership improvement. Five experts validated and confirmed the questionnaire's congruence index. Content validation was conducted with a pilot group consisting of 24 non-sample heads of learning areas in secondary schools, yielding discrimination indices ranging from .40 to .82, with a reliability of .91. The statistics employed in this stage included percentage, mean, and standard deviation.

The population in this phase comprised 1,008 heads of learning areas from 126 secondary schools under REO 11. A cluster random sampling method was used to obtain the sample size. The total sample size in this step included 360 respondents, heads of learning areas from three secondary schools, selected through the Krejcie & Morgan sample size table. Phase II involved model construction and confirmation through scholars. This phase contained two steps: Step 1 drafted the model and created the model. The model was validated and confirmed by nine experts through in-depth interviews. Step 2 The model was created and adjusted based on the experts'

comments and feedback and validated for appropriateness. The seven volumes of handbooks were also adjusted and used as improvement guidelines on instructional leadership.

Phase III was related to model implementation. This phase employed the One-group Pretest-Posttest design and included two steps: Step 1 concerned the model implementation with 24 heads of learning areas from three secondary schools. Four approaches were utilized to develop instructional leadership: a two-day workshop, practical training (once a week for six hours over four weeks, totalling 24 hours), participation in a professional learning community (PLC), and a supervision and monitoring session held one week after the intervention. Step 2 involved completing the report on the instructional leadership model for heads of learning areas in secondary schools and preparing it for distribution to other secondary schools for further implementation.

5. Research Findings and Discussion

5.1 Research Objective 1: Examine conditions, development approaches, and components of instructional leadership of heads of the learning areas in secondary schools under REO 11.

The results revealed that: Current conditions regarding instructional leadership were rated overall at a medium level ($\overline{X}$ = 2.64). In contrast, the expected conditions reached the highest level ($\overline{X}$ = 4.64). When considering each component, the highest-ranking components of instructional leadership, from highest to lowest were Personnel Development (PD), Learning Atmosphere Creation (LAC), Efficiency of Leaders (EL), Curriculum Development and Learning Management (CDLM), and Vision and Learning Goals (VLG). The need for improvement in instructional leadership was identified from medium (PNI=0.69) to highest levels (PNI=0.85). The highest level of need for improvement included PD (PNI = 0.85), EL (PNI=0.82), and LAC (PNI=0.80). The four approaches, ranked by importance, were a workshop, a practical application, participation in a professional learning community (PLC), and supervision and monitoring. The components of instructional leadership of heads of the learning areas in secondary schools distributing seven components (27 sub-components) are detailed as follows:

5.1.1 Vision and Learning Goals. The first dimension involves heads of learning areas as instructional leaders shaping the institution's future and aligning its mission with goals for improving learner quality and outcomes. This aligns with Charuphat Boonsong's (2013) research, which identified key components of instructional leadership in Thai language groups as vision and learning objectives, including setting development guidelines, prioritizing learning, and establishing academic standards.

5.1.2 Plan Preparation for Educational Quality Development. The second dimension emphasizes preparing the educational quality development plans. This involves planning and decision-making, including selecting objectives, policies, projects, and methods to achieve those goals. It also encompasses activities related to future proposals, evaluating various proposals, and implementing procedures to ensure success in line with these proposals. The educational quality development plans include determining the mission, analyzing the internal and external environments, reviewing the mission, considering the organizing vision, setting strategies, creating a strategic plan, implementing the plan, establishing the evaluation methods, and developing the plans or projects. This is in line with Charuphat Boonsong 's (2013) study on developing instructional leadership

indicators of heads of Thai language subject groups in secondary schools. The results identified key components of instructional leadership in curriculum and teaching management as heads of learning areas are sources of academic information to ensure consistency and evaluation of curriculum and teaching resources, and to manage curriculum and teaching processes.

5.1.3 Curriculum Development and Learning Management. The third dimension focuses on curriculum development and learning management. This dimension includes developing learning experience plans or lesson plans through collaborative decisions involving external and internal personnel to meet school conditions and student needs. The joint planning, implementation, measurement, and evaluation are also implemented. The curriculum is central to educational management, providing direction to improve student quality. This involves translating the curriculum into practice by defining visions, goals, student competencies, students' desired characteristics, learning standards, and indicators, learning time structure, and measurement and evaluation criteria aligned with these learning standards. This includes preparing learning units according to the 2008 Core Curriculum (revised in 2017). The curriculum must comply with the Teachers Council regulations on professional standards and professional ethics, which require teachers to have competencies in curriculum development and management. Teachers should be able to analyze, create, improve, develop, and evaluate curricula (Secretariat Office of the Teachers' Council of Thailand, 2006). This finding was consistent with Ratchadaporn Pimpichai's (2013) research, which highlights curriculum development as a crucial aspect of teacher leadership. It underscores that students should independently seek and use information technology, focusing on acquiring accurate information, designing appropriate learning experiences, and effectively using technology. This includes active learning, integrating STEM Education, research-based learning, fostering creativity, and developing life skills.

5.1.4 Learning Atmosphere Creation. The fourth dimension focuses on managing a positive learning environment to enhance teaching and learning. This includes creating an engaging classroom atmosphere that fosters students' interest and motivation, ensuring a friendly and supportive atmosphere. Such an environment reflects the value of learning and promotes success. This is also in line with Murphy and Hallinger's (1985 Model) of instructional leadership. The model states that instructional leadership is expanded to include the school administrators' roles of defining the mission, managing instructional programs, and promoting school climate (Hoy, & Alig-Mielcarek, 2005).

5.1.5 Personnel Development. This dimension emphasizes empowering heads of learning areas to enhance their skills through training, seminars, study tours, knowledge exchange, experience creation, and self-training. This is consistent with the Office of the Basic Education Commission's (2010) core competencies, which include performance focus, service excellence, self-development, teamwork, and professional ethics. This is also in line with Rattiya Promsin's (2016) research further highlights self-development as key to improving work efficiency and leadership in education. Likewise, a model of instructional leadership developed by Hoy, & Alig-Mielcarek (2005) consists of three major elements including defining and communicating goals, monitoring and

providing feedback on the teaching and learning process, and promoting and focusing on the importance of professional development.

5.1.6 Efficiency of Leaders. The sixth dimension emphasizes effective leaders who lead organizations toward their objectives with integrity and ethical transparency services and prioritizing the needs of learners and stakeholders. This is consistent with the study by Sittichai Usaprom (2019). The study shows that heads of learning areas, through transformational leadership, play a crucial role in decision-making, planning, directing, and assigning tasks to meet objectives. In rapidly changing environments, strong leadership is essential for school success.

5.1.7 Educational Quality Assurance. The seventh component, Educational Quality Assurance, involves an ongoing process of evaluating educational institutions by assessment experts. This process ensures a continuing process to track progress of the educational institutional objectives and adherence to established standards. Each educational institution requires educational management and quality assessment, using the assessment results as data and information showing student development, progress, and academic success. These insights are crucial for supporting students in reaching their full potential and for enhancing the efficiency of teaching and learning in the future, as the National Education Act of 1999 stipulated internal and external quality assurance for institutions to conduct ongoing educational quality assessments focusing on students' concept of the Bureau of Educational Testing (National Institute of Educational Testing Service, 2020).

5.2 Research Objective 2: Develop the instructional leadership model for heads of learning areas in secondary schools under REO 11.

The developed model consisted of principles, objectives, contents, development processes, media, learning resources, and measurement and evaluation. The development process involved four approaches: a workshop, practical application, participation in a professional learning community (PLC), and supervision and monitoring. This is consistent with Soisuda Green (2020). She found that effective teacher leadership development in secondary schools involves principles, objectives, content, development processes, and evaluation. Key methods include workshops, practical training, professional learning communities (PLC), and supervision.

5.3 Research Objective 3: The effectiveness of the developed model.

The overall effectiveness of the model for developing instructional leadership among heads of learning areas was rated at the most appropriate level ($\overline{\mathrm{X}}$ = 4.78), with a progress index of 45.29 percent. The result was consistent with Soisuda Green's (2020) study. The effectiveness of the model for developing instructional leadership increased by an average of 60.70, with a progress value of 13.92 percent.

6. Conclusion and Suggestion

The model for developing instructional leadership for heads of learning areas in secondary schools under OER 11 provides a practical framework that school administrators can use as a guideline for enhancing instructional leadership among these leaders. The study revealed that the participants in the model showed

significant improvement in their instructional leadership skills. Therefore, it is recommended that this model be widely implemented in secondary schools to foster continuous professional growth, shifting the focus from traditional practices to the ongoing development of learners.

7. Acknowledgment

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Vertical and Horizontal Mismatches in Thailand and The Wage Penalty

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ABSTRACT

The Thai labor market experiences increasing challenges due to disruptive technologies and demographic shifts. Furthermore, the COVID‑19 pandemic outbreak has had a disruptive impact on Thailand's labor market, resulting in a loss of income and a reduction in working hours for workers. These effects are considered to be a cyclical factor of skill mismatch. This study aims to examine the incidence of vertical and horizontal mismatches and their impact on wages in Thailand before and during the COVID‑19 pandemic by ordinary least squares and pooled ordinary least squares, using data from the third quarter of 2018 to 2021 from Thailand's National Labor Force Survey. The findings suggest that the incidence of overeducation and field‑of-study mismatch continues to increase during the COVID‑19 pandemic in comparison to the two previous years. In contrast, there is a notable decline in the percentage of undereducated workers during the same period. Additionally, overeducated workers earn wage premiums, whereas undereducated and horizontally mismatched workers face wage penalties. The result also indicates that the COVID‑19 pandemic has significant negative (positive) effects on overeducated (undereducated) workers.

KEYWORDS: COVID‑19, Horizontal mismatch, Over education, Under education

1. Introduction

It is undeniable that human capital plays a vital role in promoting economic activity. In general, the shift of economic structure from agriculture to manufacturing and services relies on human capital development, including in Thailand, which is stuck in a middle‑income trap. The country's rapid growth in schooling over the past four decades and an education system that can enhance labor skills to match employer demand are critical factors in driving economic expansion. Disruptive technologies and demographic changes are pressing global labor markets from both the demand and supply sides, resulting in expanding skill gaps. These several factors cause countries around the world to deal with the disequilibrium of workforce skills in the labor market. Moreover, this imbalanced trend is expected to extend in the forthcoming future owing to the delayed adjustment of educational institutions and inadequate collaboration among stakeholders such as policymakers, the private sector, and academics.

However, the measurements of skill mismatch remain arguable among researchers as the term skill mismatch is very varied. Policymakers frequently produce the policy for improvement in skill mismatch without

mentioning its types, causing the problem to remain persistent over time. Nevertheless, the vast majority of studies on skill mismatch involve both vertical and horizontal approaches. The vertical mismatch refers to the surplus and deficit of human capital. Meanwhile, the horizontal mismatch is measured in terms of surplus human capital in major subject workers who have graduated (McGuinness et al., 2018). The developed economies and China are likely to lack high‑skill workers, while the shortage of middle‑skill workers appears to be an issue among developing economies (Dobbs and Madgavkar, 2014). Thailand is not in a better position, despite the fact that higher education has become more popular nowadays. Some empirical evidence suggests that vertical and horizontal mismatches are likely to be common and more important in developing economies, such as Thailand, Lao PDR, and Vietnam, rather than in advanced economies, such as the United States (Chua and Chun, 2016; Pholphirul, 2017; ILO, 2019).

In 2020, an outbreak of the COVID‑19 pandemic started, and there was a first confirmed case in Thailand in January. The impact of COVID‑19 on the labor market is not only limited to the reduction of hours worked and wage loss, but it is also relevant to the imbalance of skills in the labor market. Economic fluctuations are considered a cyclical causal factor of skill mismatch. On the one hand, only suitably matched work still remains during a recession; thus, the incidence of skill mismatch decreases with growth in average labor productivity. On the other hand, skill mismatch can increase as workers are likely to receive low‑paid jobs that do not match their qualifications, causing a rise in overeducation or over-skilling type of mismatch (Brunello and Wruuck, 2021).

2. Research Objective

(1) To analyse the incidence of vertical mismatch, over education and under education, and horizontal mismatch in Thailand before and during the COVID-19 pandemic.

(2) To investigate the impact of vertical and horizontal mismatches on wages before and during the COVID-19 pandemic based on the data from the Labor Force Survey.

3. Literature Review

The over education in Thailand appears to be more prevalent in Thailand, 47 percent between 2007 to 2009 (Paweenawat and Vechbanyongratana, 2014), and 34 percent in 2018 (Vandeweyer et al., 2020). In contrast to advanced economies, such as the United States, where over qualification is generally found to be less omnipresent than in developing Asia, which does not frequently demand advanced-skilled workers, the informal economic levels are the key element in comprehending the mismatch circumstances in developing countries. It is understandable that the incidence of over qualification is high where the share of the informal sector is large since individuals who completed tertiary education seem to be recorded as overqualified (Chua and Chun, 2016; ILO, 2019). This is aligned with Thailand's situation from previous studies (Paweenawat and Vechbanyongratana, 2014; Pholphirul, 2017; Vandeweyer et al., 2020).

Pholphirul (2017) found that social science is the most crucial area where vertical mismatch occurs, while horizontal mismatch is more prevalent in physical science degrees, mathematics and statistics, and computer science. On the other hand, health sciences and education have the lowest rate of both vertical and horizontal mismatches since these careers appear to require specific skills and licenses. This result is in line with a study by Vandeweyer et al. (2020), which determines that ICT and Arts and Humanities graduates in Thailand have the highest incidence of field‑of‑study mismatch, while the least prevalent field is health and welfare. Moreover, it is also emphasized that the horizontal skills mismatch in Thailand is still critical, at 37 percent overall, which is higher than 32 percent of OECD countries.

The impact of mismatches on wages is important to investigate since these kinds of mismatches bring about a negative effect on the earnings of workers, but in different ways (Kim, Ahn & Kim, 2016; Pholphirul, 2017). To detect the mismatch specification, Verdugo and Verdugo (1989) introduced the new dummy variables that indicate the existence of overeducation or undereducation among workers into Mincer's wage equation. The conventional method, ordinary least squares (OLS), is applied by many previous studies, which reach the same conclusion: workers who are overeducated would receive significantly lower wages compared to those who graduate from the same educational level but are well‑matched (Paweenawat and Vechbanyongratana, 2014; Comyn and Strietska‑Ilina, 2019; Vivatsurakit and Vechbanyongratana, 2021). On the other hand, Bunjusuph (2018) found the wage premiums by OLS estimators for overeducated workers in Thailand, and wage penalties for undereducation.

According to the horizontal mismatch, women freelancers seem to gain lower earnings than males, especially for females with children younger than 3 years (Shevchuk et al., 2015). This is in line with the findings in Thailand (Bunjusuph, 2018; Pholphirul, 2017), which reveal that the wage penalties for female workers who are horizontally mismatched are higher than for males.

4. Research Methodology

4.1 Population and Sample

This study used the data from the third quarter of 2018 to 2021 Thailand's National Labor Force Survey, which are collected by the National Statistical Office (NSO). The reason is that the third quarter, covering July to September, has the relatively low seasonal unemployment. The data consists of the socio‑demographic characteristics of individual respondents, including their educational background. However, the self‑employed workers and armed force occupations are excluded in this study in order to measure the vertical and horizontal mismatches and their wage penalties on employees. Moreover, for horizontal mismatch, only the workers with bachelor's degree and higher are only the main focus. The statistic information collected from (i) 40,375 respondents in 2018, (ii) 37,912 respondents in 2019, (iii) 39,894 respondents in 2020, and (iv) 39,465 respondents in 2021.

4.2 Research Instrument

4.2.1 Measurement of Vertical and Horizontal Mismatches

Firstly, the job analysis approach is applied for vertical mismatch, using information from the International Standard Classification of Occupations (ISCO) version 2008 and the International Standard Classification of Education (ISCED) version 1997. The occupations, according to ISCO‑08, are divided into 10 major groups, 43 sub-major groups, and 130 minor groups. The 1‑digit level of nine major occupations, excluding military occupations, is mapped by ILO (2012) with the levels of education defined by ISCED‑97. Those who have higher education than the requirement will be classified as overeducated, and those who have lower education than the requirement will be classified as undereducated.

Secondly, the objective method is used to measure the horizontal mismatch. This study applies the matching code developed by Montt (2017) to identify the field-of-study mismatch. The individual background of school attainment, showing the 8 major subjects of study defined by ISCED‑97 that employees graduated, is mapped with an appropriate occupation based on ISCO‑08 at the 3‑digit level. Thus, only workers with bachelor's or higher degree levels remain in the sample for horizontal mismatch analysis. Those who don't graduate from the appropriate field for jobs will be classified as a horizontal mismatch. However, legislators and senior officials (111) and elementary workers (961‑962) are excluded in Montt (2017). Consequently, legislators and senior officials (111) and refuse workers (961) are added after reviewing the suitable fields of study for these jobs, but other elementary workers (962) are still omitted as it is too general to specify the matching field of study.

4.2.2 Ordinary Least Square (OLS)

The regression representing the vertical and horizontal mismatches occupying Verdugo and Verdugo (1989)'s method, creating dummy variables to identify mismatches, can be written as equations (1) and (2), respectively.

$$lnW_i = \alpha_1 + \beta_1 {}_{OE_i} + \beta_2 {}_{UE_i} + \alpha_2 X_i + u_i \qquad (1)$$

$$lnW_i = \delta_1 + \gamma_1 {}_{HM_i} + \delta_2 X_i + u_i \qquad (2)$$

Where lnW_i is the natural logarithm of the monthly wage and OE_i denotes the dummy variable indicating the overeducated worker. The over education dummy equals to 1 if employee is overeducated and equals to 0 if employee is matched to the required level of education. UE_i is the dummy variable indicating the undereducated worker. If the level of educational attainment the worker acquires is less than the required education of the job, the under education dummy is equal to 1 and 0 otherwise. HM_i is the horizontally mismatched dummy which equals to 1 if the worker is mismatched by field of study, u_i is an error term, and X_i is a vector of individual characteristics, including experience and its squared (where experience equals to age that is subtracted by years of schooling and six), years of schooling, region, marital status (married and single), sector (private and state-owned enterprises), municipality, occupation, and industry.

Additionally, the region variable is a set of dummy variables divided into four areas: central, northern, northeastern, and southern, for which Bangkok is a reference. Occupation is classified into eight groups: (i) manager, (ii) professional, (iii) technician, (iv) clerk, (v) service worker, (vi) skilled agricultural, (vii) craft,

and (viii) machine operator, which elementary occupation is a reference. To classify the industry, this study followed Tangtipongkul (2015). A set of dummy variables for industry classification is divided into seven groups: (i) mining, (ii) utilities, (iii) construction, (iv) low-skill manufacturing, (v) high-skill manufacturing, (vi) low-skill services, and (vii) high-skill services, which agriculture is a reference.

4.2.3 Pooled Ordinary Least Squares (Pooled OLS)

The dummy variable to specify the years when coronavirus disease was prevalent is introduced in this section. Pooled OLS is required to analyze the effect of the COVID-19 pandemic on wages because it allows for the identification of the signification of the dummy variable representing COVID-19. The following equations represent the vertical and horizontal mismatches, respectively.

$$ln\,W_{it} = \alpha_1 + \beta_1 OE_{it} + \beta_2\,UE_{it} + \alpha_2 X_{it} + \alpha_3 OE_{it}COVID_{it} + \alpha_4 UE_{it}COVID_{it} + \alpha_{5\,female\,it}COVID_{it} + u_{it} \qquad (3)$$

$$ln\,W_{it} = \delta_1 + \gamma_{1\,HM\,it} + \delta_2 X_{it} + \delta_3\,_{HM\,it}COVID_{it} + \delta_{4\,female\,it}COVID_{it} + u_{it} \qquad (4)$$

Where $COVID_{it}$ is a dummy variable indicating the years during the COVID-19 outbreak which equals to 1 if year is 2020 or 2021 and 0 otherwise. The interaction terms of $COVID_{it}$ and mismatched variables are applied to capture the effect of the COVID-19 pandemic on mismatched workers.

5. Results and Discussion

5.1 The Incidence of Vertical and Horizontal Mismatches in Thailand

In general, the incidence of vertical mismatch slightly changed in 2020 and 2021 compared with the two previous years. The workers who are matched with the required educational level for their jobs are 53.72%, 54.07%, 55.03%, and 54.98% in 2018, 2019, 2020, and 2021, respectively. The incidence of overeducation rose to 23.98% in 2020 and 25.71% in 2021 from 22.93% in 2018 and 23.89% in 2019. However, the proportion of undereducated workers significantly fell to 19.30% in 2021 from 23.35% in 2018. Overall, the information suggests that the percentage of matched and overeducated workers gradually increased during the expansion of coronavirus disease, while the percentage of undereducated workers noticeably declined.

Matched male workers continued to increase from 52.50% in 2018 to 54.73% in 2021. The proportion of matched female workers peaked in 2020 at 56.44% but experienced a slightly decline to 55.28% the following year. The incidence of overeducated males and females grew by 2.40% and 3.28% to 22.39% and 29.57% in 2021 from 2018, respectively. On the other hand, the share of undereducation for both males and females constantly decreased by 4.63% and 3.45% to 22.88% and 15.15% in 2021 from 2018, respectively. This indicates that the incidence of matched and overeducated males and females slightly increased during the COVID-19 pandemic, whereas the proportion of undereducated males and females continuously dropped over the same period. Furthermore, the findings suggest that the incidence of overeducation is higher in females than males. Conversely, the issue of undereducation is more important for males than females.

The incidence of workers who are mismatched with the fields of study is 24.84%, 24.82%, 25.15%, and 24.21% in 2018, 2019, 2020, and 2021, respectively. Thus, there is a slightly increasing field-of-study mismatch in 2020 compared to the first two years before the COVID-19 pandemic started. Moreover, mismatched males reached a peak of 31.14% in 2019 and decreased to 29.86% in 2021. For females, the proportion of mismatched workers is the highest at 21.81% in 2020, slightly expanding by 0.65% from the previous year. In addition, it implies that the incidence of horizontal mismatch in males is greater than in females.

5.2 The Impact of Mismatch on Wages in Thailand

The results for vertical mismatch, as reported in Table 1, suggest that overeducated workers generally earn wage premiums of 11.79% to 13.57% from 2018 to 2021. The estimations for overeducated males are 10.45% to 13.07%, while the impact on overeducated females is 12.25% to 13.48% from 2018 to 2021. This result is in accordance with Bunjusuph (2018), who suggests that the positive impact on overeducation may result from the positive relationship between level of education and wage. On the other hand, the results for undereducation show that undereducated workers suffered wage penalties of 11.59% to 15.12% on average from 2018 to 2021. This negative effect of undereducation is also consistent with the findings by Mahy et al. (2015), Iriondo (2016), and Bunjusuph (2018). Mahy et al. (2015) discovered the fact that overeducated workers who are highly educated are more productive than their matched counterparts; therefore, workers who are overeducated (undereducated) receive higher (lower) wages compared to those who are well-matched with jobs. Moreover, undereducated males and females receive 6.90% to 10.02% and 17.29% to 22.29% less than their well-matched counterparts, respectively. Therefore, the empirical results indicate that the impact on mismatched females is likely to be greater than that on males.

Table 1 The Effects of Vertical Mismatch on Wages

Gender	Variables	2018	2019	2020	2021
All	OE	0.1357***	0.1210***	0.1179***	0.1318***
		(0.0080)	(0.0080)	(0.0079)	(0.0076)
	UE	-0.1512***	-0.1209***	-0.1159***	-0.1257***
		(0.0083)	(0.0084)	(0.0087)	(0.0087)
Males	OE	0.1307***	0.1069***	0.1045***	0.1227***
		(0.0117)	(0.0116)	(0.0112)	(0.0107)
	UE	-0.1002***	-0.0690***	-0.0743***	-0.0854***
		(0.0110)	(0.0112)	(0.0115)	(0.0113)
Females	OE	0.1348***	0.1292***	0.1225***	0.1286***
		(0.0107)	(0.0110)	(0.0111)	(0.0108)
	UE	-0.2229***	-0.1955***	-0.1729***	-0.1907***
		(0.0125)	(0.0126)	(0.0131)	(0.0136)

Notes: Robust standard errors in parentheses. ***$p < 0.01$ **$p < 0.05$ *$p < 0.1$.

Source: Authors' calculations

Table 2 illustrates the results of the horizontal mismatch on wages. Overall, the effects on wages ranged from 5.68% to 7.52% between 2018 and 2021. In other words, mismatched workers receive lower wages than those who are matched with fields of study for jobs (Kim, Ahn & Kim, 2016; Pholphirul, 2017; Bunjusuph, 2018). The impact on wages is also similar for males and females, resulting in 5% to 8.12% for males and 5.50% to 8.13% for females. This result suggests that during the same period, excluding 2018, mismatched females suffered wage penalties more than mismatched males, which is in line with Pholphirul (2017).

Table 2 The Effects of Horizontal Mismatch on Wages

Gender	Variables	2018	2019	2020	2021
All	HM	-0.0703***	-0.0568***	-0.0752***	-0.0625***
		(0.0108)	(0.0117)	(0.0109)	(0.0113)
Males	HM	-0.0812***	-0.0086	-0.0555***	-0.0500***
		(0.0179)	(0.0193)	(0.0179)	(0.0185)
Females	HM	-0.0550***	-0.0813***	-0.0770***	-0.0617***
		(0.0136)	(0.0147)	(0.0138)	(0.0143)

Notes: Robust standard errors in parentheses. ***$p < 0.01$ **$p < 0.05$ *$p < 0.1$.

Source: Authors' calculations

The results from equations (3) and (4) are demonstrated in Table 3. Regarding vertical mismatch, the findings represent that, in 2018 and 2019 before COVID-19 started, overeducated workers made 12.73% more than those with matching education. However, the wages of all overeducated workers during the spread of the COVID-19 pandemic decreased by 1 percent on average in comparison to the two years prior. This result aligns with the study by Wicaksono, Theresia & Al Aufa (2023). On the other hand, the estimations for undereducation show that undereducated workers earned 11.67% less than matched workers in the pre-COVID-19 period. Their wages increase by 1.74% in 2020 and 2021 as a result of the COVID-19 epidemic. The positive impact of the COVID-19 pandemic is consistent with the findings of ILO (2020) and Aina et al. (2023), which found that the outbreak has a favorable effect on the wages of workers in the labor market. However, rather than being the result of an actual increase in wages, the wage growth is due to adjustments to the structure of jobs as vulnerable workers leave the labor market (ILO, 2020). This is also consistent with a sharp decrease in the share of undereducation among older workers after the COVID-19 pandemic outbreak in Thailand.

For horizontal mismatch, the wage of mismatched workers is 3.13% lower than that of well-matched workers. However, the effect of the COVID-19 pandemic is unexpectedly not significant. Moreover, the COVID-19 pandemic also impacts the gender of workers. There is a positive impact for females during the spread of the COVID-19 pandemic, as their wages increase by 1.06% from the vertical mismatch model. In terms of the horizontal model, the wages of females rise by 1.75% over the two following years.

Table 3 Wage Penalties and Wage Premiums in Thailand, Pooled Ordinary Least Squares Regressions

Variables	Vertical Mismatch	Horizontal Mismatch
OE	0.1273***	
	(0.0058)	
UE	-0.1167***	
	(0.0058)	
HM		-0.0313***
		(0.0100)
COVID _OE	-0.0100*	
	(0.0057)	
COVID _UE	0.0174***	
	(0.0056)	
COVID_HM		-0.0138
		(0.0130)
COVID_female	0.0106**	0.0175**
	(0.0042)	(0.0071)

Notes: Robust standard errors in parentheses. ***$p < 0.01$ **$p < 0.05$ *$p < 0.1$.

Source: Authors' calculations

6. Conclusions and Suggestion

The purpose of this research is to examine vertical and horizontal mismatch situations in Thailand as well as the effects of vertical and horizontal mismatches on wages. Following the data from the third quarter of 2018 to 2021 of Thailand's National Labor Force Survey, the incidence of matched and overeducated workers gradually increased in 2020 and 2021 compared to two prior years. While the percentage of workers who are undereducated remarkably declined during the same period. For horizontal mismatch, nearly three‑quarters of workers are matched through 2020 to 2021; however, the field‑of‑study mismatch has marginally increased in 2020 as compared to the first two years prior to the outbreak of the COVID-19 pandemic.

The results for OLS and Pooled OLS represent the negative effect of undereducation on wages and the positive impact of overeducation on wages over the same years. For horizontal mismatch, the findings suggest that mismatched workers earn lower wages than their well‑matched counterparts. The results also imply that males with either vertical or horizontal mismatch are not as impacted as mismatched females.

The outbreak of the COVID‑19 pandemic has a significant effect on wages. Overeducated workers' wages decline during the COVID‑19 pandemic compared to the two years before. In contrast, the wages of undereducated workers increase during the same period. However, for horizontal mismatch, wages are not significantly impacted by the COVID-19 pandemic.

In terms of policy perspective, promoting lifelong learning can be an effective solution to deal with the concern of undereducated workers, particularly those with primary education, as this approach is critical for workers to preserve and enhance their abilities from a low‑skilled level to a high‑skilled level. The government

should encourage workers to have a proactive mindset towards learning, regardless of their age, and allocate funds and resources to alleviate the limitations and barriers for workers to participate in the lifelong learning system. In addition, learning programs must be structured to align with both present and future requirements that focus on the in-demand skills of the labor market.

Regarding the increasing incidence of overeducation in Thailand, it is important for the government to carefully design and reevaluate policies that provide incentives for educational attainment in tertiary education. In other words, there might be a surplus of college graduates, particularly in the fields of social science, humanities, languages, and arts. Therefore, the government should prioritize transforming the educational system from general education to vocational education, with an emphasis on developing skills that are particularly important to the job market.

The absence of alternatives and knowledge in the selection of the area of study leads to inaccurate decision-making, resulting in a horizontal mismatch. Initially, providing clear information and data when making decisions on further education is an essential role for the school. Additionally, the school should encourage students to enroll in a variety of courses in different subjects based on their interest in combining knowledge from various fields of study. This approach fosters the development of innovative ideas and allows them to work in diverse fields, thereby effectively addressing challenges arising from horizontal mismatch.

Moreover, the high proportion of overeducation and horizontal mismatch among young workers during the COVID-19 pandemic highlights the inadequacy of training provided by universities and colleges. Therefore, cooperation between academic institutions and the private sector can alleviate vertical and horizontal mismatches in Thailand. It is essential for the government to improve the facilitation of stronger collaboration between universities and the business sector in order to offer students the opportunity to gain practical work experience and skills through collaborative programs.

Finally, to effectively tackle the problem of vertical and horizontal mismatches in Thailand, it is necessary to encourage long-term partnerships between several sectors, including universities, the business sector, and the government. Policymakers should possess comprehensive data on the current trends in desired skills in the labor market. This will enable them to make better decisions and provide particular support to mediate specific challenges faced by different occupations and industries

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Education Resource Management by Educational Administrators Undergraduate Institutions in Hebei Province, People's Republic of China

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ABSTRACT

The objectives of this study are: 1) to investigate the perspectives of university administrators and teachers on the current state of educational resource management by university administrators in Hebei Province; and 2) to compare the perspectives of university administrators and teachers with different positions and educational backgrounds on the current state of educational resource management by university administrators in Hebei Province. The subjects of the survey are university administrators and teachers. The study was conducted using a sample of 426 participants, determined according to the sample size table by Krejcie and Morgan. A questionnaire survey method was used, and the overall reliability of the questionnaire was 0.986. Statistical data used in the data analysis include percentages, mean values, and standard deviations, and hypothesis testing was conducted using T-tests (independent samples T-tests).

The research results indicate that:

1) The perspectives of university administrators and teachers in Hebei Province on the state of educational resource management are generally at a high level.

2) When categorized by position, the perspectives of university administrators and teachers in Hebei Province on the state of educational resource management show differences overall and in various viewpoints. However, when categorized by educational background, there is no difference overall or in various viewpoints.

KEYWORDS: Educational Resource Management, Administrators, Higher Education

1. Introduction

Educational Resource Management: In the context of higher education, this refers to the planning, allocation, integration, and supervision of various educational resources within universities by university administrators. This management work is not merely limited to the simple distribution or utilization of resources but focuses on how to more effectively transform these educational resources into actual educational and academic outcomes. This process involves continuous evaluation of educational resources, strategy formulation, implementation, and feedback, with the goal of maximizing the quality of education, academic standards, and the university's contribution to society. It can be divided into the following aspects: human resources, financial resources, material resources, and management resources.

Administrators: This refers to individuals holding administrative positions in higher education institutions in Hebei Province, China. It mainly includes presidents, vice presidents, and deans. They play key roles in the daily operations, strategic planning, and resource allocation within the institutions.

Higher Education: This refers to regular higher education institutions in Hebei Province, China, that offer undergraduate and above education

The management of education to achieve the goals of an educational institution requires the use of educational resources as a key factor, and these resources must be adapted to the changing circumstances of societal lifestyles. This is particularly true during the rapid and severe spread of COVID-19 or coronavirus worldwide, which has brought about new ways of thinking, learning, communicating, practicing, and managing daily life. As a result, educational resources that rely heavily on technology and knowledge have become most relevant in the management of education in the new normal, both now and in the future (Thai PBS, 2020: 1).

Educational resources are various elements that help achieve the objectives of education management. Basic educational resources include human resources, financial resources, material resources, and management resources. In addition, educational resources also encompass expendable resources, such as time resources, and modern resources, like technology resources (Sumalee Sriputtarin, 2017: 140). Educational resource management refers to the effective and efficient utilization of educational resources, including educational personnel, educational budgets, local resources, educational media, facilities, and time in managing education (Huan Phinthuphan, 2018: 141).

Universities in Hebei Province still face several challenges in educational resource management, such as insufficient resources, uneven distribution, and low utilization rates. A common concern at the university level is how to effectively allocate and utilize educational resources, as well as how to improve the efficiency of resource utilization. However, there is a lack of systematic research on how administrators can effectively manage educational resources and the impact of such management models. Significant differences still exist across regions in the specific implementation process, which requires further exploration (Sun Ningning, 2017:33-34).

Based on the above, the author is interested in studying the current state of educational resource management by university administrators in Hebei Province. The aim is to provide a reference for university

administrators and relevant departments, and to serve as a basis for optimizing and developing educational resource management, thereby enhancing management effectiveness.

2. Research Objective

(1) To study education resource management by educational administrators undergraduate institutions in Hebei province, people's Republic of China

(2) To compare the educational resource management by school administrators in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of school administrators and teachers, classified by position status and educational qualifications

3. Literature Review

3.1 Theory, Concept and Related Research

University Management

Wang & Zhang (2021: 13-16) believe that university management is an important component of educational development. It is not only about experience and methods but also a rational understanding enhanced through practice. It is a science with a comprehensive theoretical system and rich experiential content. They emphasize that every task in a university is accomplished through effective management, and the work process is the management process. University management involves controlling the teaching order, curriculum design, and scheduling, as well as coordinating and systematically managing teaching content, teaching organization, and teaching processes.

Wang & Huang (2020: 233-234) believe that the process of university management is dynamic, cyclical, and continuous. It involves planning, implementation, inspection, evaluation, and summary. In school management, these processes help administrators promptly grasp key information about progress and quality at each stage of implementation, allowing for timely adjustments and optimization

Educational Resource Management

Qiao (2020: 48-49) states that educational resource management encompasses human resource management, student management, financial management, material resource management, and information resource management. He emphasizes the importance of a series of activities such as faculty employment, transfer and exchange, rewards and punishments, appointments and removals, training and assessment, salaries and benefits, promotion, retirement, and resignation. At the same time, he also focuses on student management, including their ideological and daily management.

Educational Resource Management in Higher Education Institutions

Ma (2018:42-55) argues that human resource management in higher education institutions includes recruitment management, training management, promotion management, performance management, and compensation management. He believes that effective recruitment requires clear goals and planning to ensure the recruitment of talent that meets the institution's development needs; training can enhance the capabilities and qualities of teachers; promotion and performance provide a good competitive development environment; and compensation management can increase personnel satisfaction.

Zhao, Li, & Yu (2021:34-35) suggest that modern higher education institutions should construct a systematic talent database in addition to traditional human resource management methods, and use this database to conduct targeted recruitment activities. Besides recruitment, they also emphasize the importance of career development and advancement for faculty and staff, advocating for the establishment of comprehensive training and promotion systems to show staff the potential for career growth.

Wang (2019:120-125) examined various aspects of financial resource management, including investment analysis, liquidity management, cost-benefit analysis, and long-term financial planning. He advocates that precise investment analysis can guide reasonable fund usage, good liquidity management helps stabilize cash flow, cost-benefit analysis ensures investment returns, and long-term financial planning aids in achieving the institution's strategic goals.

Xie & Li (2020:73-75) mention in their research that financial resource management should focus on fundraising and fund allocation. Fundraising is the cornerstone of institutional development; effective fundraising provides necessary funding for various projects. Proper fund allocation ensures that all departments receive sufficient resources to operate efficiently.

Chen (2022:171-176) focused on resource allocation, equipment maintenance, venue optimization, and safety and hygiene. He argues that reasonable resource allocation can maximize the use of materials, equipment maintenance ensures operational efficiency, venue optimization creates a good working and learning environment, and safety and hygiene are fundamental safeguards.

Xu, Qi & Liu (2023:53-58) indicate that education information technology resource management in Hebei Province has made significant progress. For example, building campus broadband networks and developing and using digital teaching resources have played important roles in improving the efficiency of educational resource utilization and the quality of education.

Chen (2024:149-150) mentions that a significant issue in the management of educational resources in Hebei Province is the lack of an effective education resource supervision mechanism. In some cases, due to the lack of effective supervision, educational resources may be wasted or misused, affecting their efficient use. The effectiveness of some resources is also not high, and some high-quality educational resources with research and teaching value have not been widely shared or fully utilized across the province. This limitation hinders the optimization and comprehensive utilization of educational resources to some extent.

Based on the research on the scope of educational resource management by Qiao (2020: 48-49), Lü (2019: 139-140), Dai (2023: 201-203), and others, as well as Zhao's (2019: 24-27) analysis of the current state of educational resource management in Hebei Province, the researcher has adopted this as the framework for the current study.

3.2 Research Framework

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┌─────────────────────────────┐              ┌─────────────────────────────┐
│ 1. Position Status          │              │ Educational resource        │
│    1.1 Administrator        │              │ management by school        │
│    1.2 Teacher              │              │ administrators in higher    │
│                             │              │ education institutions in   │
│                             │  ───────▶    │ Hebei Province, People's    │
│ 2. Educational backgrounds  │              │ Republic of China consists  │
│    2.1 Bachelor's Degree    │              │ of 4 aspects                │
│    2.2 Postgraduate Degree  │              │ 1. Human resources          │
│                             │              │ 2. Financial resources      │
│                             │              │ 3. Material resources       │
│                             │              │ 4. Management resources     │
└─────────────────────────────┘              └─────────────────────────────┘
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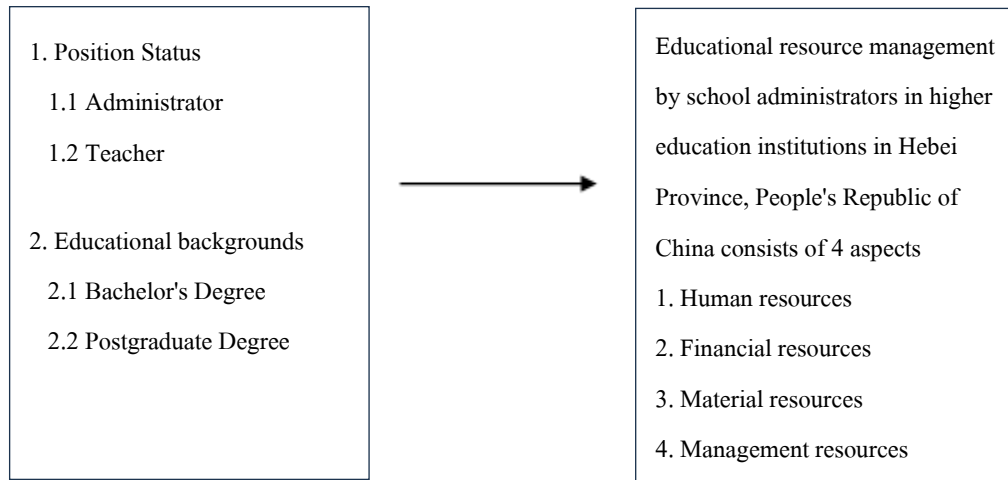
Figure 1 Research Framework

3.3 Research Hypotheses

1) Administrators and teachers have differing opinions regarding the state of educational resource management by school administrators in higher education institutions in Hebei Province People's Republic of China.

2) Administrators and teachers with different Educational backgrounds have differing opinions regarding the state of educational resource management by school administrators in higher education institutions in Hebei Province, People's Republic of China.

4. Research Methodology

4.1 Research Design

This research is a survey study on educational resource management, focusing on the perceptions of educational resource management by administrators in higher education institutions in Hebei Province, People's Republic of China, based on input from administrators and teachers.

4.2 Population and Sample

Population: The overall population of this study consists of 25,045 administrators and teachers from 19 higher education institutions in Hebei Province, including 145 administrators and 24,900 teachers.

Sample: The sample for this study was randomly selected from the overall population using the sample size standards provided by Krejcie and Morgan (1970: 608-610; cited in Prasit Suwannarak, 2012: 148-149). The total sample size is 426, comprising 50 administrators and 376 teachers. The sample was further refined through simple random sampling.

4.3 Research Instrument

The research tool used is a questionnaire designed in three sections:

Section 1: General information of the respondents

Section 2: Opinions on educational resource management

Section 3: Additional opinions and suggestions

4.4 Data Collection

The researcher requested an official letter of permission to collect data from the Graduate School of Buriram Rajabhat University. This letter, along with the questionnaire, was sent online to the administrators of higher education institutions who were part of the sample group. A deadline was set for the return of the questionnaires. In cases where the questionnaires were not returned by the specified time, the researcher personally followed up, ensuring that all questionnaires were eventually returned.

4.5 Data Analysis

The researcher analyzed the data from the questionnaire in three parts:

Part 1: General information of the respondents was analyzed using frequency distribution and percentages.

Part 2: Regarding the management of educational resources, the data was analyzed by calculating the mean and standard deviation. The opinions were compared based on status, position, and educational background, and analyzed using a t-test.

Part 3: The responses were synthesized, grouped into common themes, and analyzed using frequency distribution and percentages.

5. Research Findings

Table 1: The mean and standard deviation regarding the management of educational resources by school administrators in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and teachers, both overall and by individual aspects.

No.	Item	$\overline{X}$	S.D.	Interpretation
1.	Human resources	3.72	0.49	High
2	Financial resources	3.52	0.61	High
3	Material resources	3.53	0.62	High
4.	Management resources	3.26	0.63	Moderate
Total		**3.51**	**0.33**	**High**

From Table 1, it was found that the overall management of educational resources by administrators in higher education institutions, as evaluated by administrators and teachers, was at a high level ($\overline{X}$ = 3.51, S.D. = 0.33). When considering each aspect individually, human resources had the highest average ($\overline{X}$ = 3.72,

S.D. = 0.49), followed by material resources ($\overline{X}$= 3.53, S.D. = 0.62), and financial resources ($\overline{X}$= 3.52, S.D. = 0.61). The management aspect was at a moderate level, with the lowest average ($\overline{X}$= 3.26, S.D. = 0.63).

Table 2: A comparison of the educational resource management conditions of school administrators in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and teachers, categorized by position status, both overall and by individual aspects

The management of educational resources by school administrators in higher education institutions.	Position				t
	administrators		teachers		
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	
1. Human resources	3.84	0.39	3.70	0.50	2.39*
2. Financial resources	3.70	0.45	3.49	0.63	2.87*
3. Material resources	3.70	0.45	3.50	0.64	2.89*
4. Management resources	3.33	0.45	3.25	0.65	1.12*
Total	**3.65**	0.20	**3.49**	0.34	4.71*

*Has a statistically significant level at .05

From Table 2, it was found that the opinions of administrators and teachers regarding the comparison of the educational resource management situation by administrators in higher education institutions in Hebei Province differed both overall and in various aspects when categorized by job position.

Table 3: A comparison of the educational resource management conditions of school administrators in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and teachers, categorized by educational backgrounds, both overall and by individual aspects.

The management of educational resources by school administrators in higher education institutions.	Educational backgrounds				t
	Bachelor's Degree		Postgraduate Degree		
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	
1. Human resources	3.70	0..53	3.73	0.47	0.46
2. Financial resources	3.50	0.64	3.53	0.60	0.55
3. Material resources	3.51	0.65	3.53	0.61	0.37
4. Management resources	3.26	0.64	3.26	0.63	0.01
Total	**3.49**	**0.35**	**3.51**	**0.32**	**0.60**

From Table 3, it was found that the opinions of administrators and teachers regarding the comparison of the educational resource management situation by administrators in higher education institutions in Hebei Province, categorized by educational qualifications, did not differ either overall or in specific aspects.

6. Discussion

1) The management of educational resources by school administrators is generally at a high level due to China's educational reforms, which have been implemented to address emerging changes. These reforms include the introduction of new education laws specifically related to the allocation of educational resources, particularly human resources, with investments in teacher training, research, and other areas. These efforts have fostered a fair, efficient, and creative learning environment, as outlined in the process of drafting the country's "14th Five-Year Plan," which emphasizes the proper allocation of educational resources (The Ministry of Education of China, 2021: 62). Consequently, administrators are required to comply with these directives. In Hebei province, for example, the development of digital teaching resources and university internet networks has been advanced (Xu, Qi & Li, 2023: 53-58). As a result, both administrators and teachers express high levels of agreement, consistent with the findings of Yang & Lin (2015: 7-16) in their study on strategic planning for educational resource management. In their work, "Current Status and Strategies for Educational Resource Sharing in Higher Education in China," they clarified how to optimize the allocation and effective use of educational resources in higher education.

When examined by category, human resources rank highly, with the highest average score. This may stem from several key factors. First, universities have implemented effective recruitment strategies, attracting high-quality teachers and administrators. Second, opportunities for continuous professional development not only enhance teachers' professional skills but also foster career growth. Furthermore, a fair and transparent performance management system, along with reward and promotion mechanisms, has boosted teachers' motivation and loyalty. Human resource management encompasses recruitment, promotion, performance evaluation, compensation, and the management of talented personnel, employing comprehensive strategies that strengthen overall effectiveness through collaboration across various areas. These components interact to enhance the university's competitiveness and employee satisfaction (Cao & Xiang, 2018: 197-198). This aligns with Wang's (2023: 38-39) study on transparency strategies in management, which found that practices promoting fairness, transparency, and efficiency in school human resource policies significantly impact staff satisfaction by ensuring equal opportunities for all employees. This too was met with high levels of agreement.

2) The comparison of educational resource management categorized by overall and specific aspects of professional status reveals statistically significant differences at the 0.05 level. This is due to the differing roles of administrators and teachers. Administrators focus on strategic resource allocation aligned with institutional policies, while teachers concentrate on teaching efficiency, which caters to student needs, curriculum content, and instructional objectives. Consequently, there is a divergence in understanding roles, responsibilities, and objectives in the management of educational resources. In the case of university resource allocation in Hubei

Province, administrators distributed limited resources equitably, ensuring that teachers were adequately provided for without scarcity (Zhang, Niu & Zhen, 2022: 66-89). This resulted in differing perspectives between the two groups, consistent with Gao's (2020: 86-88) emphasis on meticulous oversight as a key factor in effective resource utilization. This oversight involves not only detailed record-keeping of resource usage but also regular monitoring and guidance to address any irregularities. Research has demonstrated that such meticulous oversight enhances real-time educational resource management, reduces the likelihood of inappropriate use, and improves resource management efficiency. In contrast, a comparison of educational resource management based on educational qualifications, both overall and in specific aspects, shows no significant differences. This can be attributed to standardized training and professional development provided to both administrators and teachers on effective resource management, fostering mutual acceptance of shared practices. This finding aligns with Hui & Lei's (2024: 148-150) research on leveraging performance outcomes to create positive motivation, which found no significant differences in perspectives related to educational qualifications. Their research on the positive motivational impact of performance indicators highlighted that appropriately setting and utilizing performance metrics can effectively motivate both teachers and administrators. This, in turn, enhances the efficiency and outcomes of educational resource utilization.

7. Suggestion

1) The research findings suggest that the area with the lowest average score in management concerns higher education institutions' focus on the maintenance and upgrading of information technology facilities. Higher education institutions should prioritize information backup plans and data recovery strategies.

2) With the lowest average score in human resource management pertains to the establishment of cross-departmental and cross-disciplinary collaborative mechanisms. Clearly define the goals and values of collaboration, promote the use of communication and collaboration tools, establish clear processes and responsibilities for cooperation, regularly conduct team feedback and evaluations, and provide cross-disciplinary and cross-departmental training

3) In the area of financial resource management, the lowest average score is associated with the implementation of financial transparency and public reporting systems. Establish clear financial transparency policies, enhance channels for the disclosure of financial information, hold regular financial disclosure meetings, improve the comprehensibility and transparency of financial information, and conduct regular audits and third-party supervision

4) In the material resource management, the lowest score is associated with the implementation of a digital campus plan aimed at enhancing the accessibility and sharing of information. Develop a comprehensive digital campus strategy, optimize information management systems, enhance network infrastructure, promote training on the use of digital tools, and introduce an information-sharing incentive mechanism

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Current Situations and Guidlines for Using Digital Technology to Manage Teaching Quality of Guangxi University, People's Republic of China

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ABSTRACT

The purposes of this study were to study the current situations and guidelines for using digital technology in managing teaching quality at Guangxi University, People's Republic of China. The sample used in the study were 321 lecturers from 13 faculties of Guangxi University. The tools used to collect data included questionnaires and semi‐structured interviews about the current situations and guidelines to the use of digital technology in managing the quality of teaching and learning at the university. The questionnaire consisted of 31 questions on a 5‐level rating scale with the total item correlation value between 0.336 ‐ 0.771 and the reliability of 0.944. In addition, the semi‐structured interviews were created from the use of questions that were from the 2 lowest mean scores in 3 aspects from questionnaire. Statistics used in data analysis included frequency, percentage, mean, standard deviation, and content analysis. The research results found that:

1) The overall and individual aspects of the current situations and guidelines for using digital technology in managing teaching quality at Guangxi University by lecturers were at a high level. The highest mean score was the production of textbooks and teaching materials, followed by learning management, and measurement and evaluation, respectively.

2) The guidelines for using of digital technology in managing teaching quality at Guangxi University. The development guidelines are as follows: 2.1) Production of textbooks and teaching materials ‐ Universities should increase incentives by supporting digital technology tools to stimulate publish and share textbooks and teaching materials of teachers, as well as provide training on the use of digital technology according to the needs of teachers, as well as raise awareness of security and privacy from the use of digital technology; 2.2) Teaching and Learning Management ‐ Universities should develop a teaching management system into an intelligent system by accelerating the creation of a smart teaching management platform to ensure systematic teaching and learning management. There is a complete amount of data to be used as a source of inquiry to increase the efficiency of teaching and learning management; and 2.3) Measurement and evaluation ‐ Universities should accelerate the improvement of the digital assessment system with standards. For use as a unified measurement and evaluation guideline. Fairness, transparency, efficiency, and accuracy and reliability to use the data to improve the quality of teaching in a timely manner.

KEYWORDS: Digital technology, Teaching quality management, Guangxi University

1. Introduction

In recent decades, the rapid advancement of digital technology has transformed various industries, with education being one of the most impacted sectors. Governments worldwide, including China, have recognized the importance of integrating digital technology into education systems to improve both teaching and learning outcomes. (Tan, 2024). Since 2001, China has implemented a series of national policies aimed at promoting the adoption of digital technology in higher education institutions. These policies have been designed to modernize education, enhance teaching quality, and ensure that students are equipped with the necessary digital skills to thrive in a globalized world. However, despite these initiatives, challenges remain in fully realizing the potential of digital technology, especially in teaching quality management. (Fu, 2024)

At Guangxi University, one of the key institutions in southern China, the application of digital technology in managing teaching quality is still developing. The university is actively pursuing strategies to improve the integration of digital tools into the core functions of education management. These include the production of textbooks and teaching materials, teaching management, and measurement and evaluation. However, the current situation presents several barriers that prevent the seamless adoption of these technologies. Issues such as limited access to digital infrastructure, insufficient training for educators, and the need for a more cohesive digital management system have been identified as critical areas of concern.

The use of digital technology in education management holds significant promise. For instance, the digital production of textbooks and teaching materials allows for the creation of dynamic, interactive, and up-to-date content that is accessible to both teachers and students. （Yamamoto, 2020) Furthermore, smart teaching management systems can streamline administrative tasks, improve student engagement, and offer personalized learning experiences through real‑time data analysis. Digital tools for measurement and evaluation also provide opportunities for more accurate and timely feedback, enabling continuous improvement in both teaching strategies and student performance. (Qu, 2024)

However, the gap between policy intentions and actual implementation remains a challenge. The successful use of digital technology in managing teaching quality is not solely dependent on the availability of advanced tools but also on the readiness and capability of educators and administrators to adopt these tools effectively. Research has shown that without proper training, support, and infrastructure, the benefits of digital technology in education cannot be fully realized. (Hu, 2024)

This study aims to investigate the current state of digital technology usage in managing teaching quality at Guangxi University, with a focus on identifying both the strengths and the areas that need improvement. By analyzing data from 321 lecturers across 13 faculties, this research will explore how digital tools are currently being used in three main areas: the production of textbooks and teaching materials, teaching management, and assessment and evaluation. Additionally, the study will propose guidelines to further integrate digital technology into these areas to enhance teaching quality at Guangxi University.

This research is not only timely but also critical in the broader context of China' s educational modernization goals. By examining the challenges and opportunities presented by digital technology in education,

this study will contribute to the ongoing efforts to optimize the use of digital tools in higher education, ultimately improving teaching quality and supporting the development of a more robust, modern education system in China.

2. Research Objectives

2.1 To study the current situations use for using digital technology in managing teaching quality at Guangxi University, People's Republic of China

2.2 To explore guidelines for integrating digital technology into the management of teaching quality at Guangxi University, People's Republic of China

3. Literature Review

3.1 Theory, Concept and Related Research

The theory applied in this research is based on the ideas of Liu Lei (2023: 85-90), which focus on enhancing the use of digital technology in education management to improve teaching quality. The study is divided into three key areas:

3.1.1 Production of Textbooks and Teaching Materials

The integration of digital technology in the production of textbooks and teaching materials offers numerous benefits. By utilizing digital tools such as multimedia, cloud computing, big data, and AI, universities can create dynamic, interactive, and customizable educational content that caters to the diverse needs of learners. Digital textbooks and materials can be continuously updated, ensuring that the content remains current and relevant. This approach also reduces production and distribution costs compared to traditional printed materials. (Gao, 2024)Additionally, the use of digital resources enhances accessibility, allowing both students and teachers to access materials anytime and from anywhere. Universities should also focus on ensuring the security and privacy of digital resources by implementing strict digital rights management (DRM) protocols and secure cloud storage solutions. (Wang, 2024)

3.1.2 Teaching Management

Digital technology plays a critical role in transforming traditional teaching management into a more efficient and intelligent system. By implementing smart teaching management platforms, universities can streamline various administrative and instructional processes. These platforms can integrate functions like student attendance, performance tracking, and personalized learning plans, enabling real-time monitoring and analysis of students' progress. With the help of AI and big data, teaching management can become more data-driven, providing educators with valuable insights to make informed decisions and adjust teaching strategies accordingly. (Zhang, 2023) Moreover, digital platforms foster collaboration between educators, allowing for the sharing of best practices and resources, ultimately improving the overall quality of education. Automation of routine administrative tasks also frees up educators' time, allowing them to focus more on teaching and mentoring students. (Ji, 2022)

3.1.3 Measurement and evaluation

The use of digital tools in measurement and evaluation has revolutionized how student performance is assessed. Digital assessment systems offer more flexibility, allowing for a variety of assessment types such as quizzes, assignments, and interactive projects. These systems provide instant feedback to students, helping them identify areas for improvement. (Da, 2024) Moreover, digital evaluation platforms can collect and analyze large volumes of data, making the assessment process more objective and accurate. AI‑driven systems can adapt to each student's learning style and pace, offering personalized feedback that fosters deeper learning. Additionally, digital assessments ensure greater fairness and transparency, as all students are assessed under the same criteria. Universities should work towards standardizing these systems to ensure consistent and reliable evaluations across departments. Finally, digital assessments can contribute to the continuous improvement of teaching methods by providing actionable insights into the effectiveness of instructional strategies. (Xiao, 2024)

3.2 Research Framework

Based on the relevant literature and comprehensive theoretical knowledge, the researcher has developed a conceptual framework for studying the situation and approaches for utilizing digital technology in teaching quality management at Guangxi University as shown below.
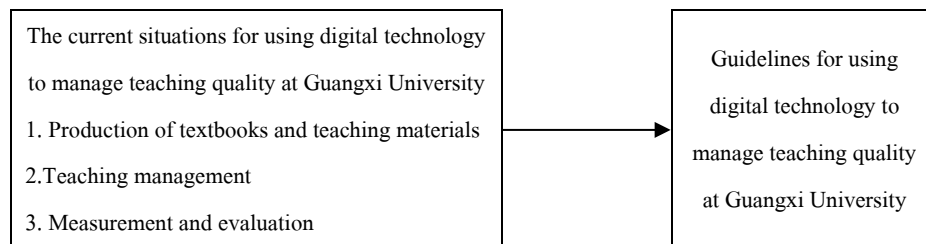
Figure 1 Research Framework

4. Research Methodology

4.1 Research Design

The research was conducted in the following two phases.

Phase 1: Analyzing the current situations for using digital technology to manage teaching quality at Guangxi University by using a questionnaire.

Phase 2: Investigating the guidelines for the use of digital technology in the management of teaching quality at Guangxi University by using a semi-structured interview.

4.2 Population and Sample

The population used in this research consisted of lecturers from Guangxi University across 26 faculties, during the first semester of the academic year 2024, totaling 1,945 lecturers.

The sample group for the first phase of the research included lecturers from Guangxi University for the academic year 2024, totaling 321 people. The sample size was determined based on Krejcie and Morgan's sample

size table (Krejcie & Morgan, 1970: 608-610; cited in Suwannarak, 2012: 148-149), followed by multi-stage sampling technique.

The sample group used in the second phase included three administrators from Guangxi University, each with no less than 10 years of experience in using digital technology, and three professors, each with no less than 10 years of experience in applying digital technology in teaching quality management.

4.3 Research Instrument

For the study on the current situations and guidelines for using digital technology in teaching quality management at Guangxi University, the instruments were used as follow :

1) A questionnaire with 31 items on a 5-Level Likert scale. The questionnaire was first piloted with 30 lectures and professors to assess its quality using Pearson's correlation coefficient, comparing it to the critical value of 0.306. The results revealed that the total item correlation coefficients ranged from 0.336 to 0.771, with a reliability coefficient of 0.944.

2) A semi-structured interview to the study aimed to explore the guidelines for digital technology in managing teaching quality at Guangxi University, People's Republic of China. Six interview questions were developed based on the two questions with the lowest average scores across all three areas. The interview data were then analyzed using content analysis techniques.

4.4 Data Collection

For this research, the data collection was conducted through questionnaire and interview: The researcher collected data on the conditions and guidelines of using digital technology in teaching quality management at Guangxi University.

4.5 Data Analysis

The researchers analyzed the data from the questionnaire and interview as follows.

4.5.1 Analyze the questionnaire, study the current situations for using digital technology in teaching quality management at Guangxi University, People's Republic of China by analyze it using mean and standard deviation. The criteria for interpretation of the questionnaire data were as follows (Srisa-ard, 2011):

Mean Range	Interpretation
4.51-5.00	The highest
3.51-4.50	High
2.51-3.50	Moderate
1.51-2.50	Low
1.00-1.50	The lowest

4.5.2 Analyze the interview, study the guidelines for using digital technology in teaching quality management at Guangxi University, People's Republic of China by using Semi-structured interviews were conducted with a smaller sample of faculty members. These interviews were focused on areas identified from the questionnaire as having the lowest mean scores. The interview data was analyzed through content analysis, where recurring themes and patterns were identified and categorized. This qualitative approach allowed for a deeper exploration of the challenges and opportunities related to the use of digital technology in teaching quality management. The interview responses were cross-referenced with the quantitative findings to provide a more

nuanced understanding of the data and to validate the conclusions drawn from the questionnaire results. By employing both quantitative and qualitative methods, the study ensured a robust and well-rounded analysis of the collected data, allowing for actionable insights to improve the use of digital technology in managing teaching quality at Guangxi University.

5. Research Findings

The research results found that:

5.1 The data on the current situations for using digital technology to manage teaching quality at Guangxi University, People's Republic of China. As shown in Table 1 and Figure 1

Table 1 Average and standard deviation about current situations for using digital technology to manage teaching quality at Guangxi University, People's Republic of China.

Aspects of using digital technology to manage teaching quality	Opinion Level			
	$\overline{X}$	S.D.	Meaning	Ranking
1. Production of Textbooks and Teaching Materials	3.95	0.75	High	1
2. Teaching Management	3.91	0.69	High	2
3. Measurement and evaluation	3.78	0.70	High	3
Total	**3.87**	**0.71**	**High**	

From Table 1, it can be observed that lecturers have generally high opinions regarding the application of digital technology in quality management at Guangxi University. Specifically, the aspect of "Production of textbooks and teaching materials" received the highest average score ($\overline{X} = 3.95$, S.D. $= 0.75$), followed by "Teaching management" ($\overline{X} = 3.91$, S.D. $= 0.69$). On the contrary, the lowest average score was given to "Assessment and evaluation" ($\overline{X} = 3.78$, S.D. $= 0.70$).
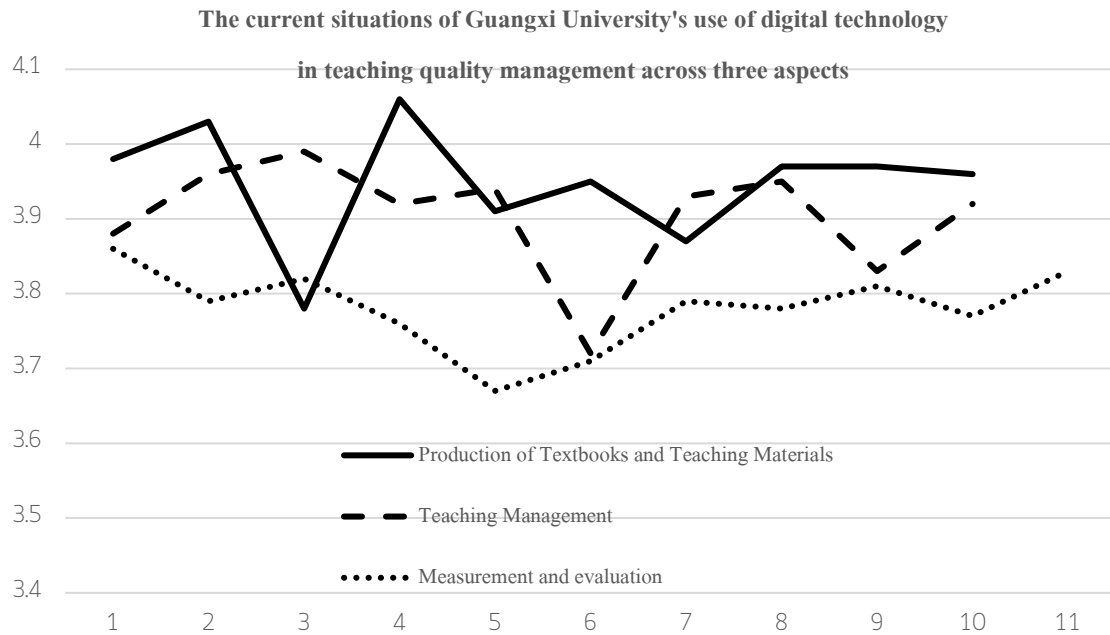
Figure 1 Comparative analysis of the results in three aspects of Guangxi University's

use of digital technologyin teaching quality management.

5.2 Guidelines for using of digital technology in managing teaching quality at Guangxi University. The development guidelines are as follows: (1) Production of textbooks and teaching materials; Universities should increase incentives by supporting digital technology tools to stimulate publish and share textbooks and teaching materials of teachers, as well as provide training on the use of digital technology according to the needs of teachers, as well as raise awareness of security and privacy from the use of digital technology. (2) Teaching and Learning Management; Universities should develop a teaching management system into an intelligent system by accelerating the creation of a smart teaching management platform to ensure systematic teaching and learning management. There is a complete amount of data to be used as a source of inquiry to increase the efficiency of teaching and learning management, and (3) Measurement and evaluation; Universities should accelerate the improvement of the digital assessment system with standards. For use as a unified measurement and evaluation guideline. Fairness, transparency, efficiency, and accuracy and reliability to use the data to improve the quality of teaching in a timely manner.

6. Discussion

6. 1 The production of textbooks and teaching materials received the highest average level of satisfaction, which can be attributed to the ongoing need for modern educational resources in a rapidly advancing digital age. The continuous development and update of these materials are essential for supporting effective teaching and learning. Digital textbooks and resources offer the flexibility to be updated in real-time and provide multimedia‑rich content that enhances student engagement. Additionally, the availability of cloud storage and

easy sharing of resources has streamlined the production process, making it more efficient and accessible. This finding aligns with Liu Lei's (2024) research, which underscores the importance of managing and developing high‑quality teaching resources to keep pace with technological advancements and new educational methods. Therefore, implementing appropriate digital tools and management practices can significantly enhance the production of textbooks and teaching materials, contributing to the overall advancement of higher education.

6.2 The use of technology in teaching quality management at Guangxi University, particularly in the area of assessment and evaluation, ranked the lowest compared to other areas. During interviews, participants highlighted that digital technology plays a significant role in assessment and evaluation and can greatly impact teaching quality. This may be because university faculty members lack the necessary skills in utilizing technology for teaching evaluation. This is consistent with Liu Kunlun's (2022: 291‑310) findings, which noted that many university instructors lack the skills and experience in using digital technology, leading to challenges in applying these technologies for teaching evaluation, especially in handling complex data analysis and assessment tools. This lack of digital skills significantly reduces the effectiveness of technology use. Ma Youbao (2021: 53‑57) pointed out that schools have insufficient investment in digital technology infrastructure, resulting in incomplete assessment systems and platforms. The absence of these platforms prevents faculty from effectively using digital tools for evaluation, limiting the overall advancement of assessment practices. Zhou Lihong (2017: 124‑128) stated that many schools lack systematic training in digital technology for faculty members, which prevents instructors from learning modern tools and evaluation methods. The lack of a training mechanism further hinders the effective use of digital technology in teaching quality evaluation. From the interviews, it was suggested that the application of digital technology in teaching quality management, particularly in assessment and evaluation, requires further development at the university level.

7. Suggestion

7.1 Production of Textbooks and Teaching Materials: Guangxi University should promote the transition to digital learning by establishing policies that support dedicated cloud platforms, creating mechanisms to encourage the sharing of teaching resources, and developing and enhancing cloud‑based storage platforms. A specific platform for sharing teaching resources should also be created. Additionally, the university should encourage faculty participation in the production and sharing of digital teaching resources, ensuring resource security and incorporating artificial intelligence technology to aid in resource management.

7.2 Teaching Management: Guangxi University should implement a comprehensive digital teaching management plan, supporting the use of tools such as online conferencing, paperless workflows, and document management and sharing systems to enhance the efficiency and flexibility of teaching management. Moreover, the university should leverage big data and artificial intelligence to foster intelligent teaching management, improving the efficiency of resource utilization and the quality of management.

7.3 Assessment and Evaluation: Guangxi University should establish unified digital assessment standards, promoting the use of online exam platforms and automated grading systems. Regular evaluations and

improvements to digital assessment strategies are essential to ensure fairness and effectiveness in the assessment process. Additionally, the university should employ big data analytics to enhance the accuracy of assessments and drive the complete development of a digital evaluation system throughout the institution.

8. Acknowledgement

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Good Management Agement Conditions For School Management Personnel In The Training of Kindergarten Teachers at Guangxi Vocational University People's Republicof China

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ABSTRACT

This study aimed to study and compare the current status of good management of kindergarten teacher training institution managers at Guangxi Technical University, People's Republic of China. The sample consisted of 239 teachers, who were selected from the Crejcie and Morgan table. Then, simple random sampling was used according to proportion. The research instrument was a questionnaire consisting of 2 forms: a checklist and a scale. The estimated reliability of the entire model was 0. 988. The statistics used for data analysis were percentage, mean, and standard deviation. The hypothesis was tested by t-test and F-test. When differences were found, pairwise comparisons were performed using the Scheffe method. The results of the research found that:

1) The training and management level of preschool teachers in vocational education institutions in Guangxi Province, People's Republic of China is relatively good.

2) When comparing the opinions of teachers from different universities in Guangxi Province on early childhood teacher training, there are no differences according to the overall educational level ranking.

KEYWORDS: Good Management; Training of Kindergarten Teachers

1. Introduction

Preschool development necessitates collaboration among government, parents, and others for a robust educational base. China's 2023 "Teacher Development Project to Strengthen Basic Education in the New Era"

project aims to boost preschool teacher training, professional growth, and teaching innovation for a tech-focused future, promoting long-term preschool education advancement (Li, 2023).

And the "Guidelines for Learning and Development of Preschool Education for Children Aged 3-6" setting learning goals and comprehensive development in morality, intelligence, and physical aspects, which aids in comprehending the fundamentals, learning traits, and development of 3-6 year olds, with proposals to enhance future teacher training quality, models, and tailoring to real-world scenarios (Cheng, 2022). Traditional teaching focused on academic training is evolving to meet diverse training needs, emphasizing adult learning characteristics and developing various teaching methods like case studies, on-site, collaborative, distance, and diagnostic teaching (Tian & Ge, 2023). Internet-based post-service training for kindergarten teachers is crucial for enhancing their professional quality but faces issues like lack of motivation and unclear training goals (Liang, 2022). A law has been established, supported by financial policies, to improve training, diversify methods, enhance supervision, and use technology for preschool education and teacher development in ethnic minority regions (Zhou, 2017).

Guangxi is an ethnic minority region with relatively backward economy and education, especially in early childhood education. However, there is a shortage and low quality of preschool teachers, which has affected the local education. It is urgent to strengthen the training of preschool teachers. Therefore, researchers will focus on studying the current situation and problems of preschool teacher training management for vocational college managers in Guangxi, aiming to provide reference for vocational college managers and relevant departments, and lay the foundation for optimizing preschool teacher training management.

2. Research Objective

(1) Based on the opinions of teachers, study the training and management of preschool teachers for the management personnel of vocational education institutions in Guangxi Province, People's Republic of China.

(2) According to the classification of teachers based on their educational background, compare the management of preschool teacher training for vocational education institution administrators in Guangxi Province, People's Republic of China.

3. Literature Review

3. 1 Theory, Concept and Related Research

Definition of training needs

Zhao Decheng, Liang Yongzheng, and Zhu Yuling (2010) clearly stated that training needs involve assessing trainees' current knowledge and abilities via methods like questionnaires and interviews to inform training design. Lin Xiaowen (2020) emphasizes that training needs are central to training quality management, representing gaps in teachers' professional development or educational challenges that can be addressed through learning.

Training Needs Attention Guideines

Zhang Wanyan（2016）suggests enhancing training attention by pre‑training surveys to set direction, improving course design and management during training, and post‑training follow‑up systems. Zhang Wengui （2020） emphasizes the importance of training needs analysis for quality assurance, recommending a multidisciplinary approach to clarify needs, diverse survey methods for effective results, and integrating explicit and implicit needs for sustainable teacher development.

Definition of training management model

Wei and Pang（2013）advocate for dynamic supervision and multi‑dimensional project evaluation, emphasizing effectiveness over student satisfaction. Zhang and Liu（2021）view training management as a dynamic, evolving system requiring continuous adjustment and innovation to meet changing needs and ensure training effectiveness, involving decision-making and resource management to achieve goals.

Training Management Model Guidelines

Hou Jianping (2016) emphasizes building a training management model that includes teachers, kindergartens, management institutions, and training organizations, focusing on the education department's role, kindergartens' training leadership, training institution management, and developing leaders with both professional and leadership qualities, while considering teachers' internal factors for professional growth. Shen Jiaxin (2019) suggests improving the training system for kindergarten teachers, enhancing training management with a focus on pre- and post-training evaluations, setting clear and operable training objectives, increasing the practicality of training content, and promoting diverse training forms with innovative methods.

Definition of training system

Lu Wei (2012) pointed out that the training system refers to the rules and procedures that all personnel and institutions related to training must follow for training teachers, mainly including training organization and functions, training content and form, training philosophy and procedures, and training guarantee mechanisms. Zhang Saiyuan (2013) proposed that the implementation of a training system characterized by independent selection, development competition, and project management has effectively promoted the training of preschool teachers.

Training System Improvement Guideines

Xu Yaosheng (2013) discusses enhancing the training system by introducing innovative teacher training concepts, reorganizing the training structure, establishing laws, defining government and institution roles, and refining training content and details. Song Jinjuan and Yan Zhili (2014) comparing China's system with those of the U.S., Germany, Australia, and Japan, recommend strategies for China's teacher training system improvement across legal, financial, training methods, content, industry collaboration, and supervision aspects.

3. 2 Research Framework

Independent variables	Dependent variables
1. Educational background	The training management of preschool teachers in Guangxi vocational colleges is divided into three areas ：
1. 1 Undergraduate	1 Training needs
1. 2 Postgraduate	2. Training model
	3. Training system
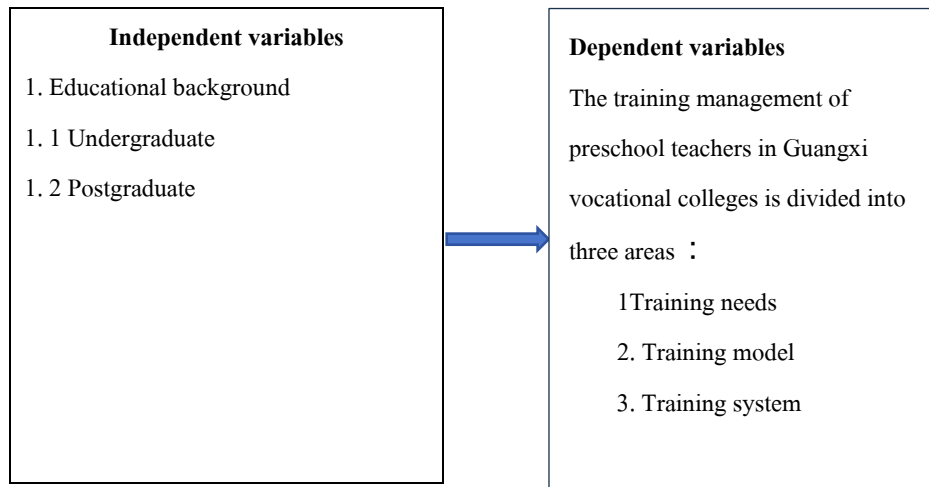
Figure 1 Research Framework

3. 3 Research Hypotheses

(1) The overall management level of administrators is high.

（2）Teachers with different educational backgrounds have different views on how to manage the kindergarten teacher training at Guangxi vocational colleges.

4. Research Methodology

4.1 Research Design

This research is a survey study on educational resource management, focusing on the perceptions of educational resource management by administrators in higher education institutions in Hebei Province, People's Republic of China, based on input from administrators and teachers.

4.2 Population and Sample

The participants include teachers from vocational colleges in Guangxi Province, People's Republic of China. The selected academic year is 2023, and the total number of participants is 11578 teachers from 16 institutions.

The sample group is randomly composed of participants. Based on Krejcie and Morgan's table (Krejcie&Morgan. 1970: 608‑610; cited from Prasit Suwanak. 2012: 148‑149), we determined the sample size and formed a sample group of 239 participants. Therefore, the total number of participants in the sample group is 239.

4.3 Research Instrument

The tool for collecting data is a questionnaire, which is divided into two parts to collect data:

The first part is the general information of the respondents, presented in the form of a list, including their educational background.

The second part focuses on the management of kindergarten teacher training for vocational college administrators in Guangxi, with a focus on three aspects: training needs, training management models, and institutional improvement. This is a 5-point rating scale, with a consistency index (IC) of 1.00 for each item. Its confidence level is 0.988, and the discriminative ability of each item and the total score of the test are between 0.544-0.889.

4.4 Data Collection

Researchers distributed a questionnaire via a QR code and link to 16 vocational colleges, achieving a 100% response rate from 239 teachers and staff.

4.5 Data Analysis

(1) Analyze the general information of the interviewee.

(2) Based on the opinions of teachers, analyze the data on the training and management of preschool teachers by educational institution managers in vocational education institutions in Guangxi.

(3) Based on the classification of teachers according to their educational background, a comparative analysis is conducted on the training and management of preschool teachers for school administrators in vocational education institutions in Guangxi.

5. Research Findings

5.1 The results of general information of the respondents are shown in the table.

Table 1 Number and percentage of general information of respondents

Educational qualifications	人数（人）	Percentage
Bachelor's degree	78	32. 64
Higher than bachelor's degree	161	67. 36
Total	**239**	**100**

Table 1 shows that 161 individuals, or 67.36%, held a bachelor's degree or higher, while 78 individuals, or 32.64%, had a bachelor's degree or lower.

5. 2 According to the opinions of teachers, the research results on the training and management of preschool teachers for management personnel in vocational colleges in Guangxi are shown in Table

Table 2 Situation of organizers of preschool teacher training in Guangxi vocational colleges

Good Management Agement	Opinion level			
	$\bar{x}$	S. D.	Translate	rating
1. Training needs	3. 24	. 88	medium	1
2. Training model	3. 22	. 89	medium	3
3. Training system	3. 23	. 89	medium	2
Total average	3. 23	. 87	medium	-

Table 2 shows preschool teacher training opinion metrics, with moderate management requirements (mean = 3.23, SD = 0.87). Training needs have the highest mean (mean = 3.24, SD = 0.88), the training system is average (mean = 3.23, SD = 0.89), and the training model is the least favored (mean = 3.22, SD = 0.89).

5. 3 The comparative results of training and management for management personnel and preschool teachers in vocational colleges in Guangxi are shown in Table 3; Teachers' opinions are classified based on their educational background.

Table 3 Comparison of management of Early Childhood Teacher Training Managers in Guangxi vocational colleges based on teachers' academic backgrounds

Good Management Agement	Education				t
	Bachelor's degree		Higher than bachelor's degree		
	X̄	S. D.	X̄	S. D.	
1. Training needs	3. 22	. 88	3. 24	. 87	-. 1. 67
2. Training model	3. 20	. 90	3. 22	. 88	-. 182
3. Training system	3. 23	. 93	3. 23	. 87	-. 014
Total average	3. 22	. 89	3. 24	. 86	-. 123

*It has a statistical significance of 0.05 level.

Table 3 reveals no variance in the overall educational level assessments by teachers from different Guangxi universities on preschool teacher training.

6. Discussion

1. Compare the views of teachers from various universities in Guangxi on kindergarten teacher training. There is no difference between the overall classification and individual classification. Because the vocational universities that offer kindergarten teacher training management are all public institutions, the training process is mainly carried out in accordance with national education policies, the needs of social development and the characteristics of national higher education institutions to adapt to regional and national economic and social development and internationalization trends, and perform tasks in accordance with training requirements.

2. Compare the opinions of teachers from different universities. In Guangxi, kindergarten teachers continue to be trained according to their academic level. The study found that the demand for preschool teacher training is the highest because it is adapted to the development trend of today's society. my country has made major reforms to the training model of kindergarten teachers, deeply understand the needs of teachers, create a variety of training forms, and carry out institutional changes as needed.

7. Suggestion

From the results of this study, the researchers made the following recommendations:

(1) Managers should establish an organizational structure for teacher training and establish a mechanism for obtaining feedback from kindergarten teacher training.

(2) We should study how to establish a standardized training model for kindergarten teachers.

8. Acknowledgement

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Leadership of Student Leaders in School of Animation and Digital Art, Under Hebei Academy of Fine Arts People's Republic of China

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ABSTRACT

The purposes of this study were to study and compare the opinions about leadership of student leaders in School of Animation and Digital Art, Hebei Academy of Fine Arts University People's Republic of China, classified by gender and major. The sample group used in the study included 852 students from 4 majors under the School of Animation and Digital Art. The sample size was determined using the Krejcie and Morgan table, and stratified random sampling was employed. The tool used for data collection was a 48-item questionnaire based on a 5-point Likert scale, with item discrimination value between 0.448-0.805 and the reliability of 0.979. Data were analyzed using percentage, mean, standard deviation, independent t-test, one-way ANOVA, and Scheffe's Method.

The results of the study were as follow: 1) Students' opinions regarding the leadership of student leaders were overall at a high level. When considered by aspect, the highest average was in coordination ability, followed by self-discipline and cooperation ability, and 2) The comparison of students' opinions on the leadership of student leaders in the School of Animation and Digital Art, Hebei Academy of Fine Arts University People's Republic of China, found that: classified by gender and majors, showed that both overall and individual aspects were significantly different at the .01 level, and the pairwise comparison of majors using Scheffe's Method indicated that the leadership of student leaders in the School of Animation and Digital Art, Hebei Academy of Fine Arts University People's Republic of China, as perceived by students in different majors, was significantly different at the .01 level, except between the Animation major and New Media Art major, where students' opinions did not differ.

KEYWORDS: Leadership of Student leaders, Student leaders, Animation and Digital Art.

1. Introduction

Operations of the Student Union in the New Era, the Student Union of the People's Republic of China stated that student leaders are the main organizations that lead students to learn independently, manage themselves, serve themselves, and conduct self-evaluation. Additionally, they act as a bridge and primary link between university administration and students. This highlights the significance of the role of students and the improvement of the university's internal administrative structure. Student leaders must uphold a student-centered approach, representing, serving, and supporting students. They represent the student body in operations to meet students' needs. The primary responsibility of student leaders is to cooperate and guide students to follow the path of socialism with Chinese characteristics under the leadership of the Communist Party. This is with the goal of becoming reliable and qualified builders and successors for socialism with Chinese characteristics. Moreover, student leaders must have confidence in their ideology, possess professional skills, and develop morality alongside their abilities to achieve well‑rounded progress. (Central Committee of the Communist Youth League. 2023: 1)

Developing the leadership qualities of student leaders is a crucial pathway to achieving student self-reliance in education and is key to fostering a positive atmosphere within the university. Strengthening the leadership capabilities of student leaders is a necessary measure for implementing comprehensive development concepts and enhancing creativity and innovation. Student leaders are a distinguished group within the university, and therefore, universities should focus on developing their leadership skills to fully leverage their personal influence. Student leaders can assist class advisors in managing classes, which is vital for the development of their abilities and professional spirit. (Zhou & Liu, 2020: 126)

Through this research, the study aims to study the leadership of student leaders at the School of Animation and Digital Art ,Hebei Academy of Fine Arts and provide recommendations to enhance the quality and effectiveness of student leadership. The primary objective of this research is to assess student leadership through five aspects: coordination ability, teamwork ability, self‑ discipline, adaptability, and innovation. Furthermore, this study compares students' perceptions of leadership abilities across different genders and academic backgrounds. The significance of this study lies in providing valuable insights for educational administrators on how to improve the cultivation of student leadership. Several suggestions are made, including enhancing leadership training programs, offering more hands-on opportunities, and utilizing mentorship systems to improve students' self‑discipline and adaptability. Through these measures, universities can better support the growth of student leaders and nurture future leaders with a strong sense of responsibility and innovation.

2. Research Objective

（1）To study the leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China.

(2) To compare the opinions of students the leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China, classified by gender and major.

3. Literature Review

3.1 Theory, Concept, and Related Research

This study focuses on examining the leadership qualities of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China, based on the framework of Zhou and Liu (2020: 126) across five key aspects as follows:

(1) Coordination Skills

(2) Collaboration Ability

(3) Self-discipline Ability

(4) Adapt Ability

(5) Creativity and Innovation

3.2 Research Framework

Based on the relevant literature and comprehensive theoretical knowledge, the researcher has established a conceptual framework for studying the leadership qualities of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China, as illustrated in the figure below.

Figure 1 Research Framework

3.3 Research Hypotheses

(1) Students of different genders have differing opinions on the leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China.

(2) Students from different major have differing opinions on the leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China.

4. Research Methodology

4.1 Research Design

This research is an exploratory study by using a questionnaire to find out the leadership of the student leaders then were analyze by mean and standard deviation. After collecting the questionnaires, the leadership of student leaders from the Animation and Digital Arts School at Hebei Academy of Fine Arts were compared based on gender and major. The data were classified by gender using an Independent Samples t-test, with the significance level set at .05. A one-way ANOVA was performed, with the significance level also set

at .05. If significant differences in the means were found in each aspect, Scheffe's Method was used to compare the differences between pairs.

4.2 Population and Sample

The sample group used in this research consists of 852 students enrolled in the first semester of the academic year 2024 from four different majors under the School of Animation and Digital Arts. The sample size was determined using Krejcie and Morgan's (1970: 608-610) standardized table, and the sampling was conducted using cluster sampling based on the major.

4.3 Research Instrument

Based on the information studied, design questionnaire questions covering the five aspects of leadership qualities of student leaders from the School of Animation and Digital Arts, Hebei Academy of Fine Arts: 1) Coordination Skills 2) Collaboration Ability 3) Self-discipline Ability 4) Adapt Ability 5) Creativity and Innovation. The questionnaire was tested (try Out) with 30 students from the School of Animation and Digital Arts, Hebei Academy of Fine Arts, People's Republic of China, who were not part of the sample group.

The reliability of the questionnaire was analyzed using the Alpha Coefficient, based on Cronbach's method, with a reliability threshold set at .70 or higher (Songsak Phusi-On, 2008: 50). The results showed a reliability score of .979, with a discrimination power ranging from 0.448 to 0.805.

4.4 Data Collection

4.1 The researcher requested a letter from the Graduate School of Buriram Rajabhat University to seek assistance in distributing questionnaires to collect data from the School of Animation and Digital Arts, Hebei Academy of Fine Arts, People's Republic of China.

4.2 The researcher submitted the request letter mentioned in point (1) to students belonging to the School of Animation and Digital Arts, Hebei Academy of Fine Arts, People's Republic of China, who are the sample group, along with the research questionnaires, and set a deadline for returning the completed questionnaires via online platforms.

4.3 The researcher personally collected the completed questionnaires, both in person and via the online response channel, upon the deadline, receiving a total of 852 questionnaires, achieving a 100% response rate.

4.5 Data Analysis

The data on the current situation of leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. As shown in Table 1 – 4
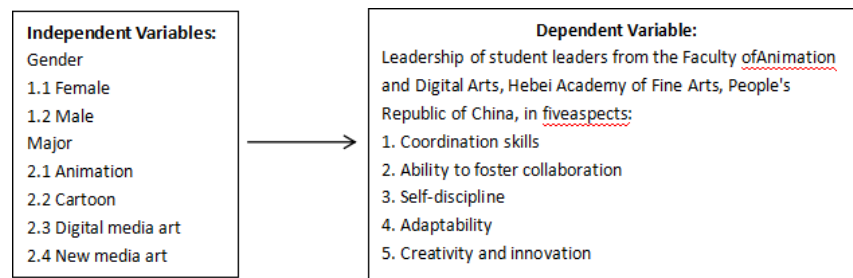
Table 1 Average and standard deviation about current situation of leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China.

The leadership of student leaders	Level of opinion			
	Mean	Standard Deviation	Meaning	Rank
1. Coordination Skills	3.76	0.77	High	1
2. Collaboration Ability	3.63	0.77	High	3
3. Self-discipline Ability	3.69	0.78	High	2
4. Adapt Ability	3.50	0.77	High	4
5. Creativity and Innovation	3.38	0.75	Moderate	5
Overall Average	**3.60**	**0.76**	**High**	

Form Table 1, it was found that: Overall, students' opinions on the leadership of student leaders were at a high level ($\overline{X}$ = 3.60, S.D. = 0.76). When considering each aspect, the average scores of Coordination Skills ($\overline{X}$ = 3.76, S.D. = 0.77), Self-discipline Ability ($\overline{X}$ = 3.69, S.D. = 0.78) Collaboration Ability ($\overline{X}$ = 3.63, S.D. = 0.77), and Adapt Ability ($\overline{X}$ = 3.5, S.D. = 0.77) were high. The average score of Creativity and Innovation ($\overline{X}$ = 3.38, S.D. = 0.75) was moderate.

Table 2 Results of comparison of opinions about leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. Classified by gender.

Aspect of the leadership of student leaders	Gender				t	P-value
	Male (n=434)		Female (n=418)			
	$\overline{X}$	S.D.	$\overline{X}$	S.D.		
1. Coordination Skills	3.83	0.73	3.68	0.81	2.81**	0.005
2. Collaboration Ability	3.69	0.72	3.56	0.80	2.57**	0.011
3. Self-discipline Ability	3.76	0.74	3.61	0.81	2.79**	0.005
4. Adapt Ability	3.57	0.73	3.43	0.81	2.65**	0.008
5. Creativity and Innovation	3.44	0.72	3.32	0.78	2.39**	0.017
Overall Average	**3.67**	**0.72**	**3.53**	**0.80**	**2.66****	**0.008**

** Statistically significant at the .01 level.

From Table 2, Comparison of student's opinion about leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. Classified by gender, overall different and when comparing each aspect, it was found that all aspect were significantly different at the .01 level.

Table 3 Results of One-way ANOVA tests of the opinions about leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. Classified by majors.

Aspect	Source Of Variation	df	SS	MS	F	P-value
1. Coordination Skills	Between Groups	3	35.74	11.914	21.509**	0.000
	Within Groups	848	469.71	0.554		
	Total	851	505.46	-		
2. Collaboration Ability	Between Groups	3	35.32	11.772	21.560**	0.000
	Within Groups	848	463.00	0.546		
	Total	851	498.31	-		
3. Self-discipline	Between Groups	3	36.40	12.132	21.568**	
	Within Groups	848	477.00	0.563		
	Total	851	513.40	-		
4. Adapt Ability	Between Groups	3	39.17	13.055	23.840**	0.000
	Within Groups	848	464.38	0.548		
	Total	851	503.55	-		
5. Creativity and Innovation	Between Groups	3	30.64	10.214	19.283**	0.000
	Within Groups	848	449.16	0.530		
	Total	851	479.80	-		
Overall	Between Groups	3	35.17	11.722	21.641**	0.000
	Within Groups	848	459.35	0.542		
	Total	851	494.51	-		

** Statistically significant at the .01 level.

From Table 3, Comparison of student's opinion about leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. Classified by majors, overall different and when comparing each aspect, it was found that all aspect was significantly different at the .01 level.

Table 4 Results of Scheffe's tests of the opinions about leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. Classified by majors.

Major	$\overline{X}$	Animation	Cartoon	Digital Media Arts	New Media Arts
		3.63	3.96	3.32	3.65
1. Animation	3.63	-	0.33**	0.31**	0.02
2. Cartoon	3.96	-	-	0.64**	0.31**
3. Digital Media Arts	3.32	-	-	-	0.34**
4. New Media Arts	3.65	-	-	-	-

** Statistically significant at the .01 level.

From Table 4, Comparison of student's opinion about leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. By using the Scheffe's method and comparing pairwise differences, it was found that all majors were significantly different at the .01 level, except for the Animation and New Media Arts majors, where the opinions of students were not different.

5. Research Findings

From the results of the current situation of leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. The researcher found the results as follows:

5.1 The students' opinions about the leadership of student leaders were overall at a high level. When considered by aspect, the highest average was in coordination ability, followed by self‑discipline and the ability to build cooperation

5.2 The comparison of the students' opinions on the leadership of student leaders in the School of Animation and Digital Art, Hebei Academy of Fine Arts University People's Republic of China, found that:

5.2.1 classified by gender, showed that both overall and individual aspects were significantly different at the .01 level.

5.2.2 classified by majors, showed that overall and individual aspects were significantly different at the .01 level, and the pairwise comparison of majors using Scheffe's Method indicated that the leadership of student leaders in the School of Animation and Digital Art, Hebei Academy of Fine Arts University People's Republic of China, as perceived by students in different majors, was significantly different at the .01 level, except between the Animation major and New Media Art major, where students' opinions did not differ.

6. Discussion

From the results of the current situation of leadership of student leaders from the School of Animation and Digital Arts at Hebei Academy of Fine Arts, People's Republic of China. The researcher discusses the results as follows:

6.1 The overall leadership qualities of student leaders are at a high level. This may be because student leaders often possess good communication, management, and coordination skills, which form the foundation for leading a team effectively. They are also service‑minded, socially responsible, and willing to face challenges while actively supporting both teachers and fellow students. In dealing with complex and rapidly changing environments, student leaders can quickly adapt and implement new approaches. Moreover, they not only focus on their own performance but also emphasize teamwork to achieve learning and working goals through collective effort. This aligns with Zhang's (2014: 129-130) view that student leaders play a crucial role in assisting fellow students, organizing activities, and managing resources. Zhou and Liu (2020: 126) also pointed out that student leaders must be flexible in adapting to various changes and adjust their working methods and strategies accordingly. Additionally, this is consistent with Yang's (2017: 3) findings that the primary mission of student leaders is to unite and guide most students to become morally and intellectually capable successors of socialism.

6.2 The comparison of students' opinions on the leadership qualities of student leaders, found that:

6.2.1 classified by gender, revealed significant differences overall. When analyzed by individual aspects, all areas showed statistically significant differences at the .01 level. This may be due to the different

expectations and education males and females receive during socialization, leading them to exhibit different leadership traits. Males tend to demonstrate stronger adaptability and creativity when facing challenges and pressure, and they often receive more support and resources within teams, enhancing their collaboration and coordination skills. In some cultures, males are also expected to be leaders and decision-makers, which influences their leadership behavior. This corresponds with Yang's (2017: 3) assertion that males display strong adaptability and problem-solving strategies during difficult times. Zhou and Liu (2020: 126) also noted that social support within teams is a key factor in why males exhibit better leadership, aligning with Li and Yang's (2024: 136-138) research, which found that cultural factors play a significant role in shaping gender roles and leadership expression.

6.2.2 classified by majors, showed statistically significant differences at the .01 level overall. When pairwise comparisons were conducted using Scheffe's Method, significant differences were found between all fields of study except for Animation and New Media Arts, where students' opinions did not differ. This may be due to the curriculum design and learning content in each field, which directly influence students' opinions and their participation in student leadership activities. This aligns with Zhang's (2014: 129-130) belief that differences in educational approaches directly affect students' leadership expression. Zhou, Liu, and Xu (2024: 46-51) also highlighted that students with strong professional qualifications and creativity become well-rounded personnel in the modern era. Chen and Li (2024: 285-288) stated that leadership among student leaders in universities does not stem from positional authority but rather from the pursuit of organizational values. Zhou and Liu (2020: 126) further noted that practical opportunities are crucial in developing students' leadership qualities, as they allow students to practice leadership in real-life situations. This is also consistent with Yang's (2017: 3) belief that the efficient use of resources is a key method for enhancing the capabilities of student leaders.

7. Suggestion

7.1 Conduct an in-depth analysis of the impact of various factors, such as gender, field of study, family background, and social networks, on the development of leadership qualities among student leaders at Hebei Academy of Fine Arts, while proposing appropriate intervention strategies.

7.2 Evaluate the effectiveness of the leadership training programs offered by Hebei Academy of Fine Arts, assessing their long-term impact on the development of students' leadership qualities and suggesting improvements to enhance their effectiveness.

7.3 Compare the effects of different academic backgrounds on the development of students' leadership qualities to provide foundational information for developing cross-disciplinary leadership training strategies in the future.

8. Acknowledgement

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A Study on Library Management by Educational Administrators in Vocational Colleges in Guangxi Province, People's Republic of China

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ABSTRACT

This study used a questionnaire survey to survey 375 teachers and 48 library staff in 24 higher vocational colleges in Guangxi. The survey content was about the library management situation of administrators in Guangxi higher vocational colleges. The research tool is a five-level questionnaire. The corrected item-total correlation (CITC) of the questionnaire is 0.438-0.823, and the reliability of the questionnaire is 0.978. Statistical analysis was mainly performed using mean and standard deviation (S.D.) and independent test. Library management content includes three aspects: 1) Literature resource construction; 2) Reader services; 3) Library resource management. The study found that the operability of the three aspects is high, among which reader services and library resource management are the highest, followed by Literature resource construction.

KEYWORDS: Higher vocational colleges, administrators, Library management

1. Introduction

The university library is a huge information storage room and the main supply base of educational resources for major universities. Its main function is to serve the teaching and scientific research of universities and plays an important role in university teaching activities and the information acquisition of teachers and students. Its rich collection of documents has a wide range of types, the information resources are highly comprehensive, and the knowledge spans a wide range. It can provide a strong guarantee for the teaching practice of colleges and universities and the teaching exchanges between various subjects. University library management

is an integral part of university teaching activities and an important carrier of teaching activities, providing a broad platform and knowledge basis for teaching exchanges in universities (Guo Lingyu. 2014: 101).

With the continuous development of higher vocational colleges, higher vocational college libraries, as important teaching resources, have gradually attracted the attention of college leaders and society. Funds and support for the daily operations of libraries have continued to increase, significantly improving the management level of libraries in higher vocational colleges in China (Wang Yingzi. 2018: 136).

Nevertheless, administrators of higher vocational colleges in Guangxi still face many problems in library management, which includes the lag in the construction of literature resources and being unable to keep up with the development of the college; obvious duplication of network database resources, failure to achieve resource co-construction and sharing; the hardware facilities of the library are not suitable for the development of the college; libraries generally face a lack of high-level professional talents; the library document information service level is low (Tang Yechen. 2018: 1598).

Therefore, the researchers will focus on studying the current situation and problems of library management by administrators of higher vocational colleges in Guangxi, aiming to provide reference for administrators of higher vocational colleges and related departments, and laying the foundation for optimizing library management.

2. Research Objectives

1) To study the library administration of educational institution administrators in vocational education institutions in Guangxi Province, People's Republic of China, according to the opinions of teachers and staff.

2) To compare the library management of educational institution administrators in vocational education institutions in Guangxi Province, People's Republic of China, according to the opinions of teachers and staff classified by position status.

3. Literature Review

3.1 Theory, Concept and Related Research

(1) Some researchers have provided relevant explanations regarding the scope of library work.

Ru Na (2015:82) pointed out that library services mainly include four parts: document collection, organization, collection, and service.

Ma Rong (2016:15) proposed that the management of university libraries is related to all aspects of the library, including library expenses, book usage, and book management. The management of university libraries involves integrating collection resources and providing readers with more information resources; secondly, it helps to establish a reasonable management system for the library, where the advantages of library staff can be fully utilized to provide readers with good cultural services and more high-quality services.

Zhang Xiaoying (2017:249) believes that library work mainly includes three aspects: book organization, content introduction, and service quality.

Zhu Hongmin (2017:58) pointed out that the main content of focusing on vocational college library work includes borrowing textual materials, providing learning venues, and supplying electronic materials.

Tan Xiaojun (2018:3-4) believes that there are three main objects of library management: human resource management, material resource management, and financial resource management. Human resource management includes library staff management and reader management. Material resource management includes library literature information management, library building and equipment management, and technical method management. Financial resource management refers to the management of various expenses and operating income of the library.

Wu Weici and Dong Yan (2019:167) believe that library work can be divided into two categories. One is information input work, which refers to the collection, organization, and preservation of documents, such as document collection, registration, classification and subject indexing, cataloging, document organization and preservation, also known as document resource construction work; the other type is information output work, which refers to the use and service of literature, such as borrowing, reading, literature promotion, reading guidance, reference consultation, literature retrieval and method guidance, network information navigation, etc., also known as user service work (reader service work).

Li Jie (2019:160) believes that the work of a library includes collecting, organizing, and storing books and literature materials. The library needs to provide high-quality services to a wide range of readers.

Wang Songyun (2020:4) pointed out that the main tasks of university libraries are: firstly, to construct physical collection resources and online literature information resources, and to carry out scientific management, maintenance, processing and sorting; secondly, the borrowing, transmission, retrieval and consultation of books and literature materials should be carried out to provide excellent services to readers; thirdly, to carry out scientific research information education to cultivate the academic information acquisition and literature database utilization abilities of teachers and students; the fourth one is to organize and coordinate the construction of educational resources and literature information in universities, achieving the co-construction, common knowledge, and sharing of literature resources.

Fu Bingyan (2021:2620) believes that the work of university libraries includes activities such as management and borrowing.

Li Yaqing and Tian Lingling (2023:44) pointed out that the goal of library work is to provide readers with literature resources and deliver literature resources from different disciplines and categories to readers. During the transmission process, libraries should utilize the advantages in knowledge reserves, literature construction, and practical applications to provide readers with the maximum service.

Based on the above research, the researchers have taken the construction of literature resources, reader services, and library resource management as the research framework for library management in vocational colleges in Guangxi, People's Republic of China.

(2) Definitions

Wu Weici and Dong Yan (2019:167) believe that the collection, organization, and preservation of literature, such as the collection, registration, classification, subject indexing, cataloging, organization, and storage of literature, are also known as literature resource construction work.

According to the comprehensive research, literature resource construction is the activity and process of library and information institutions to select, collect, organize, and manage all recorded information, knowledge, and their carriers through planning and coordination, in order to build a complete collection and storage system to meet the literature needs of their own units and the entire society.

Li Zhixiang (2019:60) believes that reader service work is a task that directly faces readers. It is a service activity that libraries use various forms to directly meet the needs of readers, including lending services, reading services, publicity and guidance services, copying services, consulting services, and topic tracking.

According to the comprehensive research, reader service is a service activity that libraries use in various forms to directly meet the needs of readers, including lending services, reading services, promotion and guidance services, copying services, consulting services and topic tracking, literature retrieval and method guidance, network information navigation, etc.

Tan Xiaojun (2018:3-4) believes that library management is an activity that follows the objective laws of library work, and reasonably allocates and uses library resources through planning, organizational coordination, command, and other means to achieve expected goals and meet users' knowledge and information needs. The objects of library management consist of three main parts: human resource management, material resource management, and financial resource management.

According to the comprehensive research institute, library resource management refers to administrators following the objective laws of library work, and through planning, organization, coordination, command and other means, reasonably allocating and using the human, material and financial resources of the library to achieve expected goals and maximize the satisfaction of users' information needs.

3.2 Research Framework
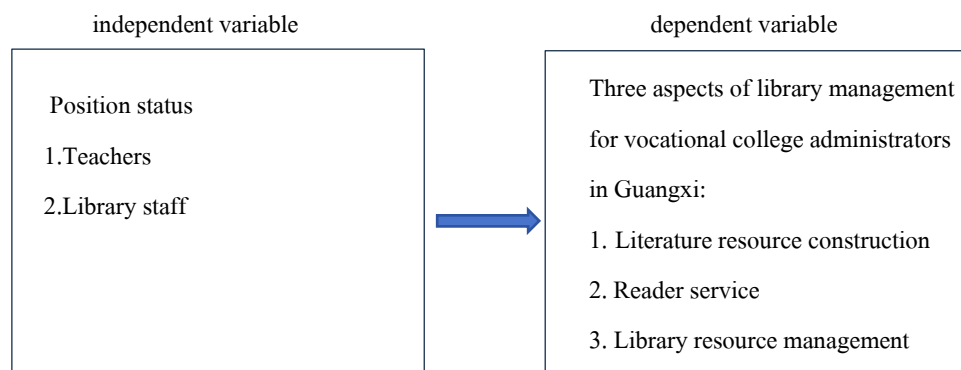
Figure 1 Research Framework

3.3 Research Hypotheses

1) Teachers and staff have different opinions on the library management of Vocational College Administrators in Guangxi.

2) There are different opinions among teachers and staff at different levels of educational management on the library management of Vocational College Administrators in Guangxi.

4. Research Methodology

4.1 Research Design

This research is a survey study on library management, focusing on the perceptions of library management by educational administrators in vocational colleges in Guangxi Province, People's Republic of China, based on input from teachers and library staff.

4.2 Population and Sample

The participants include teachers and staff in vocational institutions in Guangxi Province, People's Republic of China. The academic year chosen is 2023. The total number of the participants is 32,246, which can be further classified as 31,837 teachers and 409 staff. They come from 47 institutions.

Sample group is formed randomly from the participants. By determining the sample size according to the table of Krejcie and Morgan (Krejcie & Morgan. 1970 : 608 - 610 ; Cited in Prasit Suwanrak. 2012: 148 - 149), we formed a sample group the size of 380 people, classified as 375 teachers and 5 staff members. Due to the small number of staff members, a sample group which selected 2 officials from each institution was formed. There were 24 institutions. So a total of 48 officials were randomly assigned and stratified disproportionately. The total number of the participants in sample group was 423.

4.3 Research Instrument

The questionnaire is divided into 2 parts as follows.

Part 1: General information about position status of the respondents. It is in the form of a checklist (Check List).

Part 2: The library management of Vocational College Administrators in Guangxi, including three aspects: literature resource construction, reader service, and library resource management. It is a 5-level rating scale with a concordance index (IC) of 1.00 for every item. It has a confidence value of 0.978 and the discriminant power of each item and the total score of the test are between 0.438- 0.823.

4.4 Data Collection

The researchers conducted a questionnaire survey. They send a letter requesting assistance in distributing the questionnaire to the vocational institution of the sample group, vocational colleges, and attach a QR code and link. They divide the QR code and link into one set/one vocational college in the form of a download, until all 24 vocational colleges in the sample group are completed. 423 teachers and staff received responses, accounting for 100%.

4.5 Data Analysis

    1) Analyze general information of the respondents.

    2) Analyze data from studies on library administration of educational institution administrators in vocational education institutions in Guangxi, according to the opinions of teachers and staff.

    3) Comparative analysis of library management by school administrators in vocational education institutions in Guangxi, according to the opinions of teachers and staff classified by position status.

5. Research Findings

5.1 The results of general information of the respondents are shown in the table.

Table 1 Number and percentage of general information of respondents.

Position Status	Number of People	Percentage
1. Teachers	375	88.65
2. Library staff	48	11.35
Total	423	100

From Table 1, it is found that the majority of the sample respondents were teachers, totaling 375, accounting for 88.65 percent, and the rest were 48 library staff, accounting for 11.35 percent.

5.2 The results of research on library management of Vocational College Administrators in Guangxi are shown in Table 2, according to the opinions of teachers and staff.

Table 2 Mean and standard deviation of library management by Vocational College Administrators.

Library Management for Vocational College Administrators in Guangxi	Comment Level			
	$\overline{X}$	S.D.	Translate	Ranking
1. Literature resource construction	3.69	0.94	high	2
2. Reader service	3.81	0.98	high	1
3. Library resource management	3.81	0.98	high	1
Average total	**3.77**	**0.97**	**high**	-

From Table 2, it is found that the overall level of library management in vocational colleges in Guangxi is quite high according to the opinions of teachers and staff ($\overline{X}$ = 3.77, S.D. = 0.97). The average values of reader service and library resource management are the highest ($\overline{X}$ = 3.81, S.D. = 0.98, $\overline{X}$ = 3.81, S.D. = 0.98). The average value of literature resource construction is the lowest ($\overline{X}$ = 3.69, S.D. = 0.94).

5.3 The results of comparison of library management by Vocational College Administrators in Guangxi are shown in Table 3; the opinions of teachers and staff are classified according to job status.

Table 3 Comparison of library management by Vocational College Administrators.

Library Management for Vocational College Administrators in Guangxi	Position				t
	Teachers		Library staff		
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	
1. Literature resource construction	3.74	0.92	3.34	0.94	2.88*
2. Reader service	3.85	0.96	3.52	1.00	2.33*
3. Library resource management	3.83	0.96	3.61	1.06	1.50
Average total	**3.81**	**0.95**	**3.49**	**1.00**	**2.24***

*It has a statistical significance of 0.05 level.

From Table 3, it is found that the opinions of teachers and staff on the management of the library of vocational colleges in Guangxi are classified according to their job status, and the overall situation is different. It is found that there are significant differences in the construction of literature resources and reader services at the 0.05 level.

6. Discussion

1) The overall level of library management by administrators of vocational colleges in Guangxi, People's Republic of China is high. The reason is that administrators of vocational colleges in Guangxi have a clear understanding of the importance of libraries. They are willing to invest funds and resources in the construction of literature resources and service improvement, establish specialized teams to manage and operate libraries, actively introduce advanced library technology and facilities, prioritize reader needs, continuously improve library service content and quality, advocate cooperation and communication between libraries and other institutions, academia, and industry, share resources, attach importance to establishing a sound management mechanism, and allocate resources reasonably.

(2) By comparing the views of teachers and library staff on library management in vocational colleges in Guangxi, the overall average level of teachers is high, while the overall average level of staff is low. The reason is that teachers only focus on whether administrators can provide sufficient academic resources and a good research support environment, and pay less attention to the operational and management details behind them. On the contrary, as internal members of the library management system, library staff have stricter and more comprehensive requirements for the operation and management of the library. Moreover, library staff are directly affected by management strategies and are more sensitive to changes in management strategies.By comparing the views of teachers and library staff on library management in vocational colleges in Guangxi, it was found that there are significant differences in the construction of literature resources and reader services. The reason is that

teachers are more concerned about how academic resources support their teaching and research, while library staff are mainly responsible for the procurement, classification, and management of literature resources, emphasizing the evaluation from the perspective of overall resource management. There is no significant difference in library resource management, as there is a relatively standardized process and norms for library resource management, which reduces the influence of personal preferences and subjective judgments. At the same time, both teachers and library staff hope that library resources can be efficiently managed to ensure sustainable use of resources and maximize service efficiency. This common goal has led to a convergence of their views on resource management.

7. Suggestion

1) In terms of resource construction, attention should be paid to combining the characteristics of higher vocational education, taking into account the teaching needs of teachers, the learning needs of students, and the research needs at all levels. A framework structure for the construction of literature and information resources should be developed according to the actual situation of student quality cultivation, school professional settings, and research projects, forming a collection of resources with the characteristics of higher vocational education in our school. Strengthen communication and collaboration among librarians of each library, apply various advanced technologies, share network resources of university libraries, and avoid duplicate purchases.

2) In terms of service provision, conduct regular research to collect user feedback, study and understand readers' service needs. Utilize modern information technology to expand digital resources and provide remote services. Establish user profiles and provide personalized services. Provide regular professional training for library staff to increase interaction and guidance services with readers. Regularly hold seminars, lectures, book fairs, book sharing events, knowledge competitions and other reading promotion activities to provide a comfortable reading and research environment, in order to attract more readers to visit the library.

3) In terms of team building, develop a scientific and reasonable talent introduction plan, and introduce professionals from various disciplines such as computer, foreign language, and network technology that the library urgently needs. Provide continuous technical training and professional development opportunities for library staff to adapt to the needs of high-level information services.

8. Acknowledgement

Guangxi Preschool Teachers College for their willingness to inspect and correct the tools used for collecting information to meet quality requirements.

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The Administration of Student Affairs by The Management of Private Universities in Higher Education Institutions in Hebei Province, People's Republic of China

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ABSTRACT

The purpose of this study was to study and compare the satisfaction of student affairs services in private universities in Hebei Province, People's Republic of China, and the subjects of the survey were university administrators and teachers. The sample size was determined according to the Krejcie and Morgan table, a total of 331 people, and then a simple random sampling was performed according to the proportion. The study used a questionnaire survey. There were two types: checklist and rating scale. The overall reliability value of the questionnaire was 0.96. The statistics used in the data analysis included percentages, means, and standard deviations, and the hypotheses were tested by T-test (independent sample T-test).The research results show that:

1. The management of student affairs by the administrators of private universities in higher education institutions, overall and in every aspect, is at a high level.

2. The comparison of student affairs management by administrators of private universities in higher education, categorized by position status and overall Educational backgrounds, shows no significant differences across various aspects.

KEYWORDS: Student Affairs Administration, The executives of private universities, Higher education institution

1. Introduction

The management of student affairs in private higher education institutions will adopt the management model of student affairs from public higher education institutions. For example, in the Zhengcheng area, the management of student affairs is divided into various units, with the student president overseeing student affairs by coordinating and communicating directly with university administrators and the vice president responsible for student affairs. This office works collaboratively with the student team and reports the results of their activities to the university (Feng, 2021: 140). The scope of student affairs management includes: 1) basic information about students, 2) management of learning facilities and dormitories, 3) management of scholarships, 4) evaluation of outstanding students, and 5) management of loans or scholarships
(Wang, 2019: 207).

Here is the translation of the provided text into English: "There are 20 private higher education institutions offering undergraduate degrees and above in Hebei Province. The trend among students before entering higher education shows poor academic performance and lifestyle behaviors, as well as weaknesses in critical thinking. After enrolling in private higher education institutions, students often feel distant from home and family, requiring adjustment to a new environment. They lack confidence in learning and tend to be lethargic, and financial instability poses personal challenges for the students (Huang. 2018: 72). Additionally, the unique characteristics of student dormitories at each institution necessitate the development of policies and programs that align with the diversity in the education system. This aims to create an environment that fosters a learning framework that is understanding and enhances mutual comprehension among students from culturally diverse backgrounds, which will be essential for the operation of student affairs in private higher education institutions in Hebei Province (Zhao. 2021: 116).

2. Research Objective

2.1 To study the management conditions of student affairs by the administrators of private universities in higher education institutions in Hebei Province, People's Republic of China, according to the opinions of administrators and faculty members.

2.2 To compare the management of student affairs by the administrators of private universities in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and faculty, categorized by their position status and educational backgrounds.

3. Literature Review

3.1 Theory, Concept and Related Research

The concept of school administrators: The executives have a high level of responsibility in the areas of education, management, and services, which are essential for providing services and ensuring satisfaction for students and society. Promoting the quality of education and student learning is a crucial duty of university

executives to achieve quality educational outcomes and to serve as an excellent learning resource in the future. (Lv. 2015:261 and Kuang. 2015:59)

The concept of student affairs work: The student affairs and student administration are important components of university management and are a core concept in promoting the healthy growth of students. This encompasses the development of life skills and the transmission of important values in society. （Liang ＆ Xian .2018:51 and Xu. 2023:269）. The scope of student affairs management in this research consists of four areas: 1) Student leadership, 2) Scholarships, 3) Student dormitories, and 4) Student mental health (Wang, 2019: 207; Du, 2020: 259; Xu, 2020: 269; Xiang & Zhao, 2022: 83; and Qu, 2022: 23).

Related Research:

Jin（2021:192）conducted research on the management of student affairs in universities in accordance with the law. The research findings revealed that the awareness of the rule of law in managing student affairs in universities is a top‑down approach, starting from the design of laws, regulations, and the highest‑level policies of the country down to the establishment of specific management rules for student affairs in various universities, and further down to the general provisions for managing student affairs.

(Li. 2022:16) The research on the management process of student affairs found that the management of student affairs needs to be gradually adjusted in the implementation process. Additionally, universities need to utilize the internet system to facilitate the management of student affairs more conveniently and effectively.

3.2 Research Framework

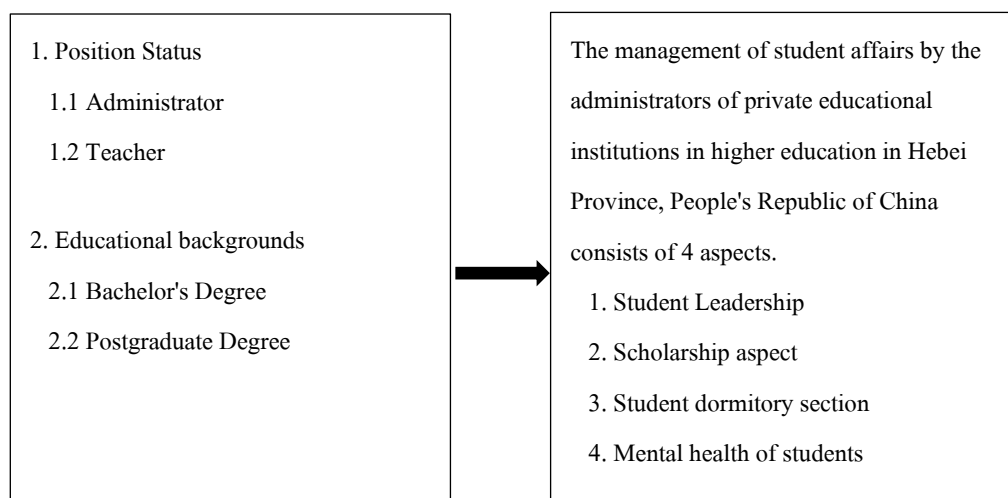| 1. Position Status	The management of student affairs by the administrators of private educational institutions in higher education in Hebei Province, People's Republic of China consists of 4 aspects.
1.1 Administrator	1. Student Leadership
1.2 Teacher	2. Scholarship aspect
2. Educational backgrounds	3. Student dormitory section
2.1 Bachelor's Degree	4. Mental health of students
2.2 Postgraduate Degree	

Figure 1 Research Framework

3.3 Research Hypotheses

1) The executives and faculty have differing opinions regarding the management of student affairs by the administrators of private universities in higher education institutions in Hebei Province, People's Republic of China.

2) The executives and faculty members with different educational backgrounds have differing opinions regarding the management of student affairs by the executives of private universities in higher education institutions in Hebei Province, People's Republic of China.

4. Research Methodology

4.1 Research Design

This research is a survey study on educational resource management, focusing on the perceptions management of student affairs by the administrators of private educational institutions in higher education in Hebei Province, People's Republic of China, based on input from administrators and teachers.

4.2 Population and Sample

1) Population: The population used in this study are teachers and administrators from private universities in Hebei Province, People's Republic of China. In the 2023 academic year, there are 711 administrators and 1616 teachers from 20 private universities in Hebei Province

2) Sample: The sample was obtained through random selection from the population, with the sample size determined according to the ready‑made table by Krejcie and Morgan (1970: 608‑610; cited in Prasith Suwanrak, 2012: 148‑149). A total sample of 331 people was obtained, consisting of 101 administrators and 230 teachers.

4.3 Research Instrument

1) The research instrument used is a questionnaire created by the researcher, divided into three sections: (1) General information of the respondents, presented in a checklist format; (2) Opinions regarding the management of student affairs by the administrators of private universities, presented in a 5‑point rating scale, which includes: very high, high, moderate, low, and very low; (3) Additional comments and suggestions, presented in open-ended questions.

2) Create and verify the quality of the tools used in the research by conducting a content validity check from experts, achieving an Index of Item Objective Congruence (IOC) of 1.00, and obtaining a reliability coefficient of the questionnaire equal to 0.96.

4.4 Data Collection

The researcher requested an official letter of permission to collect data from the Graduate School of Buriram Rajabhat University. This letter, along with the questionnaire, was sent online to the administrators of higher education institutions who were part of the sample group. A deadline was set for the return of the questionnaires. In cases where the questionnaires were not returned by the specified time, the researcher personally followed up, ensuring that all questionnaires were eventually returned.

4.5 Data Analysis

The researcher has conducted data analysis and processed it using statistical software as follows:

1) Analyze the questionnaire part 1, which contains general information about the respondents. Analyze using frequency distribution and percentages, and present the data in a table accompanying the essay.

2) Analyze Questionnaire Part 2: Opinions on the Management of Student Affairs by Private University Administrators. Analyze by calculating the Mean and Standard Deviation.

3) Compare the management of student affairs based on the opinions of administrators and teachers, classified by position status and educational qualifications, analyzed using the Independent t-test.

4) Additional comments and suggestions: Use synthesis to consolidate into the same issue, analyze with frequency values and percentages, and present in a table accompanying the essay.

5. Research Findings

Table 1: The average and standard deviation regarding the management of student affairs by the administrators of private universities in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and faculty, both overall and by specific areas.

No.	The administration of student affairs	$\bar{X}$	S.D.	Interpretation
1.	Student Leadership	4.18	0.59	High
2.	Scholarship aspect	4.19	0.61	High
3.	Student dormitory section	4.24	0.60	High
4.	Mental health of students	4.27	0.62	High
	Total	**4.22**	**0.56**	**High**

From Table 1, The executives and faculty members have opinions regarding the management of student affairs by the executives of private universities in higher education, which is overall at a high level ($\bar{X}$ = 4.22, S.D. = 0.56). When considering each aspect, all areas are at a high level. The aspect of managing students' mental health has the highest average ($\bar{X}$ = 4.27, S.D. = 0.62), followed by the management of student dormitories ($\bar{X}$ = 4.24, S.D. = 0.60) and the management of student funds ($\bar{X}$ = 4.19, S.D. = 0.61). The aspect of managing student leaders has the lowest average ($\bar{X}$ = 4.18, S.D. = 0.59).

Table 2: The comparison of the management of student affairs by the administrators of private universities in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and faculty, categorized by position status, both overall and by specific areas.

The administration of student affairs by the management of private universities.	Position				t
	administrators		teachers		
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	
1. Student Leadership	4.21	0.50	4.17	0.62	0.58
2. Scholarship aspect	4.25	0.48	4.16	0.65	1.70
3. Student dormitory section	4.31	0.52	4.20	0.63	1.40
4. Mental health of students	4.35	0.52	4.24	0.66	1.59
Total	**4.28**	**0.46**	**3.49**	**0.34**	**1.43**

From Table 2, The opinions of executives and faculty regarding the administration of student affairs by the executives of private universities in higher education, categorized by position status, show no significant differences overall and in each aspect.

Table 3: The comparison of the management of student affairs by the administrators of private universities in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and faculty, categorized by overall educational backgrounds and specific areas.

The administration of student affairs by the management of private universities.	Educational backgrounds				t
	Bachelor's Degree		Postgraduate Degree		
	$\overline{X}$	S.D.	$\overline{X}$	S.D.	
1. Student Leadership	4.14	0.70	4.20	0.52	0.86
2. Scholarship aspect	4.16	0.66	4.24	0.57	1.16
3. Student dormitory section	4.20	0.67	4.27	0.58	0.91
4. Mental health of students	4.19	0.71	4.32	0.56	1.85
Total	**4.28**	**0.63**	**4.26**	**0.51**	**1.30**

From Table 3, The opinions of administrators and faculty regarding the management of student affairs by the administrators of private universities in higher education, categorized by educational qualifications, show no significant differences overall and in specific areas.

6. Discussion

1) The management of student affairs by the administrators of private universities in higher education institutions, overall and in every aspect, is at a high level. The Student Affairs are any activities organized by the university to develop and enhance students in accordance with the university's identity. The main purpose of student affairs is to promote and support the comprehensive development of students in various aspects, including knowledge, learning skills, life skills, and essential skills for future employment, such as professional skills, communication skills, and English skills. Additionally, it aims to instill moral and ethical values, volunteerism, leadership, teamwork, adaptability, and interpersonal skills in students. This has led to a high level of agreement among administrators and faculty, in line with Suan Sunandha Rajabhat University. (2017: 6 and Qin & Miu, 2016: 163) Especially in the area of managing students' mental health, opinions are at a high level with the highest average. This may be due to the fact that most students experience mental health issues, ranging from frequent to constant stress, feelings of sadness, self-harm, suicidal thoughts, or even suicide, as evidenced by daily news both domestically and internationally. These issues significantly impact students' academic performance and daily lives. Therefore, it is important and necessary for university administrators to manage this area systematically and continuously, and to collaborate with relevant agencies to address and cope with the mental health problems that are likely to increase in the future. In accordance with (Gulinazar, Tian & Ye, 2003:108), it is suggested that

when new students enter the university environment for the first time, influences from their surroundings, economic status, culture, traditions, etc., tend to lead university students to have negative psychology and mental health issues. Analyzing the current situation and the factors that influence students' mental health literacy will help improve the prevention and resolution of mental health problems among students.

2）Compare the management of student affairs by the administrators of private universities in higher education institutions in Hebei Province, People's Republic of China, based on the opinions of administrators and faculty, categorized by overall position status and by specific areas without significant differences. This may be due to the fact that student affairs are any activities organized by the university. Therefore, the administration and faculty have responsibilities and participate in the management of the university's student affairs. In private higher education institutions, managing student affairs is one of the fundamental tasks that helps develop the institution (Zhao & Yang, 2020: 29-31). The management model for student affairs in public higher education institutions will be implemented. The management of student affairs will be divided into various units, with a student president overseeing student affairs. There will be direct coordination and communication with the university administration and the vice president for student affairs, who is responsible for student matters. This role will work collaboratively with the student team and report the results of their activities to the university. All faculty members will participate in student activities both inside and outside the classroom (Feng, 2021: 140), including in all processes that promote the creation of a safe environment and foster unity among students (Xu, 2022: 26).

When classified by the different educational qualifications of administrators and faculty, opinions do not differ significantly. This may be due to a shared goal in managing student affairs at private higher education institutions that offer undergraduate degrees and above in Hebei Province, where there is a tendency for students before entering higher education to exhibit poor academic performance and life behaviors, as well as weaknesses in critical thinking. After students enroll in private higher education institutions, they often feel distant from home and family, requiring adaptation to a new environment, lacking confidence in learning, and experiencing lethargy. Additionally, financial instability poses personal challenges for students（Huang, 2019: 72）. The unique characteristics of student dormitories at each institution necessitate collaboration in managing student affairs at private higher education institutions in Hebei Province (Zhao, 2021: 116). This represents a "student-centered" service approach that should be guided by a sense of responsibility in providing services: "For every student, for every student, and for every student" (Zhao & Patima, 2023: 65).

7. Suggestion

7.1 There should be a guideline for caring and a support system for students by collaborating with the public health service network in four areas: 1) Prevention and promotion of mental health issues 2) Care and assistance for at-risk groups and those with problems, along with referrals to network agencies 3) Building a strong and seamless network among parents, communities, and relevant agencies to work together 4) Creating continuity and sustainability through knowledge exchange in student support operations, with ongoing evaluation and monitoring

7.2 The factors affecting the success of student affairs management in private higher education institutions should be studied.

8. Acknowledgement

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Teacher's Perception of Chinese Language Teaching-related Classroom Instruction: Teacher's Voices

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ABSTRACT

This study aimed to: 1) investigate the classroom instruction (CI) used in Chinese language teaching (CLT); 2) explore the issues related to classroom instruction; and 3) identify ways to address these issues in an international school in Bangkok, Thailand. The study used the entire teacher population (N=35) as subjects, with 33 teachers returning the questionnaire. Additionally, eight Chinese teachers were purposefully selected for in-depth interviews. The questionnaire data were analyzed using average and standard deviation (SD), while the interview data were analyzed using Lichtman's Three Cs: codes, categories, and concepts.

The results are as follows: 1) Chinese teachers mainly used Chinese or English in instruction, with language tests and regular assessments. 2) Issues included poor lesson planning, lack of engagement, mismatched curricula, and outdated materials. 3) Suggested improvements involve understanding students' needs, setting clear rules, creating dynamic classrooms, and focusing on pair work for assignments.

Keywords: Teacher's Perception, Teaching, Teachers' Voices, Chinese Language Classroom

1. Introduction

Developing second language learners' practical abilities is one of the primary goals of foreign language instruction (Horwitz, 2020). The classroom serves as the primary venue for instruction, where environments are influential on student learning (Reutzel and others, 2000). Classroom instruction (CI) is important for students as it allows them to acquire the knowledge and skills necessary for education and future careers. It promotes understanding, supports student development, and ensures effective education (Lee and others, 2013). Pleasant CI fosters efficient and engaging learning experiences (Shi and others, 2020).

However, CI faces a variety of challenges that affect both educators and students. Problems include unexpected and unplanned controversial topics that impact teachers' responses and teaching methods. Prilla and others (2019) believe that classroom management issues are identified by both teachers and students, with

differences in perceptions of teacher behavior and its impact on the learning environment. Different management issues arise in actual teaching, which requires corresponding measures to address them. Additionally, Chinese language teachers' improper error correction methods and their disregard for cultural and cognitive style differences in learning activities can cause international students to feel overly stressed and unwilling to participate in classroom activities.

In summary, classroom instruction (CI) plays a crucial role in helping second language learners acquire essential knowledge and skills. This research focuses on the significant impact of CI on student outcomes, particularly in Chinese language instruction for international students, and explores ways to enhance teaching effectiveness and reduce learning barriers.

2. Research Objective

(1) To investigate the classroom instruction(CI) in Chinese language teaching. (2) To explore the issues that are related to classroom instruction(CI). (3) To find ways to address the issues.

3. Literature Review

3.1 Issues and Strategies Related to Chinese Classroom Instruction

Ewe and others (2021) emphasized that the lack of classroom management experience and the use of inappropriate textbooks for tertiary education have hampered Chinese language teachers teaching. Zhang and others (2022) mentioned that while translanguaging is commonly used by teachers, it also involves issues due to limited resources and the linguistic complexity of a TCFL classroom. He (2020) identified two major issues in Classroom Instruction: unreasonable time arrangements and a lack of motivation to learn. Many colleges and universities overlook the quality of Classroom Instruction, resulting in a decline in overall teaching standards (Kwok, 2017). Furthermore, for novice learners, sole reliance on a second language (L2) can hinder the optimal development of linguistic competency, which encompasses both speaking and writing skills (De la Fuente and others, 2022).

4. Research Methodology

4.1 Research Design

This study adopted mixed methods of quantitative and qualitative approaches. Quantitative data were collected through questionnaires distributed to volunteer teachers, while qualitative data were gathered via semi-structured interviews. The use of mixed-approach research provides a comprehensive understanding of the research difficulties and addresses complex issues that may not be fully quantifiable (McKim, 2017).

4.2 Population and Sample

Wells International School‑On Nut is a Grade 1–12 college preparatory school, offering the American curriculum in the heart of Bangkok. Over 500 students, representing 50 nationalities, populate Wells On Nut, creating a truly international environment. The population of the study was 33 Chinese teachers at Wells

International School- On Nut in Thailand. 8 Chinese teachers were purposively selected for in-depth interviews in the interview section.

4.3 Research Instrument

(1) Questionnaire

The following table shows the component sections of the questionnaire.

Table 1 Breakdown of the Component Sections of the Questionnaire

Sections	Questions
Personal Particulars	1. Gender 2. Years of Teaching Chinese 3. What language do you use when teaching your students?
Chinese Language Classroom Instruction	4. I can accurately determine the teaching focus according to the school's Chinese curriculum standards 5. I design lessons that get students to work in groups or pairs as often as possible. 6. Classroom lectures are my most commonly used method of Chinese classroom teaching. 7. I always check the pretest scores before class and adjust the lesson plan. 8. I always establish rules and order in the classroom to make classroom teaching orderly and efficient. 9. I am very good at integrating contemporary teaching techniques into classroom teaching. 10. I usually use classroom activities to capture students' interest. 11. I start with the class and then interact with individual students, answering their questions or asking them mine. 12. I often ask my students to work in small groups to prepare their presentations before finally presenting them to the class. 13. I always conduct Chinese proficiency tests on students regularly. 14. I always use a combination of qualitative and quantitative assessment techniques to evaluate classroom instruction. 15. I am satisfied with my current job and will continue to do so.
Issues related the Classroom Instruction	16. The Chinese teaching syllabus formulated by the school does not match the teaching needs. 17. The content of the Chinese teaching materials currently used is outdated and does not conform to current daily life. 18. Since I teach using multimedia, I frequently overlook writing on the whiteboard during class. 19. There isn't enough time in class for me to properly engage and tutor.

	20. I don't know enough about the students' cultural backgrounds to effectively communicate with them.
	21. Sometimes, due to numerous work tasks, there is insufficient preparation before class, resulting in confusing teaching content.
	22. Sometimes I focus too much on practice and ignore the explanation of key content.
	23. In my class, students often used tablets or mobile phones in the classroom.
	24. Insufficient preparation of students before class leads to poor classroom teaching results.
	25. Students' completion of Chinese homework is not high.
Ways to address issues related the Classroom Instruction	26. Students can post on chat forums to solve their Chinese learning problems.
	27. In classroom teaching, teachers need more time to prepare lessons to stimulate students' enthusiasm.
	28. The teaching materials are as close to current daily life as possible.
	29. We insist that students are the main body of teaching and teachers are the guides in the classroom.
	30. Evaluate classroom instruction based on the learning of all students in the class.
	31. When designing exercises for classroom education, the teacher's confidence is essential.
	32. Students will benefit from interactive group cooperation in the classroom when they are in groups of no more than five.
	33. Actively ask questions in class and complete assigned learning tasks with their classmates.
	34. Multiple forms of classroom instruction must be used.
Open-ended Question	35. What can be done to improve the classroom instruction?

(2) Interview

The semi-structured interview, a qualitative component of the study, was conducted one week after the questionnaire data were collected. The questions are as follows:

Table 2 Semi-Structured Interview Questions

1	Can you describe your experience with Chinese language teaching?
2	Do you think your lessons are practical?
3	Do you prefer to have students work in pairs or groups? Why? How often do you use this method?
4	What are the common factors that you think hinder effective classroom instruction?
5	How do you deal with insufficient classroom instruction activities?
6	What suggestions would you offer to other teachers to make classroom instruction more effective?

4.4 Data Collection

The data collection involved distributing 33 questionnaires via WeChat to 8 teachers, who participated in interviews. Audio recordings were made with participant consent, ensuring accuracy and verbal expression of discussions. The primary objective was to provide additional details and assurance regarding other datasets.

4.5 Data Analysis

Descriptive statistics were used to analyze the questionnaire data. Litchman's three cycles of analysis were used to analyze the interviewed data. The data were reduced into codes, categories, and concepts.

5. Research Findings

5.1 Results from Questionnaires

Table 1 shows the average score of 4.055 for Classroom Instruction which the highest mean was observed for maintaining classroom rules and order, while the lowest mean was for items 5 and 12. However, the most significant standard deviation was noted for item 6, indicating teachers do not adhere to single‑language‑based Chinese teaching.

Table 3 Descriptive Statistics of Chinese Language Classroom Instruction

	Item	Max	Min	Mean	SD	Interpretation
Chinese Language Classroom Instruction	Q4	5	1	4.09	0.606	High
	Q5	5	1	3.82	1.089	High
	Q6	5	1	3.85	1.108	High
	Q7	5	1	3.85	0.628	High
	Q8	5	1	4.39	0.424	High
	Q9	5	1	4.27	0.917	High
	Q10	5	1	4.24	0.684	High
	Q11	5	1	4.21	0.821	High
	Q12	5	1	3.82	0.806	High
	Q13	5	1	3.94	0.858	High
	Q14	5	1	4.15	0.856	High
	Q15	5	1	4.03	0.864	High
Average				4.055	0.805	High

Table 4 shows related to classroom instruction. The mean values for items 18‑25 are moderate, with areas such as interactive tutoring and material preparation that require improvement. The most significant standard deviation was found for Item 17, suggesting varying opinions among teachers regarding Chinese textbook content. The lowest mean was observed for item 18, indicating that teachers focus on multimedia technology and may ignore traditional teaching methods.

Table 4 Descriptive Statistics of Issues Related to Classroom Instruction

	Item	Max	Min	Mean	SD	Interpretation
	Q16	5	1	3.61	1.075	High
	Q17	5	1	3.52	1.266	High
	Q18	5	1	3.06	0.375	Moderate
	Q19	5	1	3.33	0.686	Moderate
Issues related to Classroom Instruction	Q20	5	1	3.09	1.167	Moderate
	Q21	5	1	3.33	0.489	Moderate
	Q22	5	1	3.15	1.166	Moderate
	Q23	5	1	3.18	0.985	Moderate
	Q24	5	1	3.21	0.815	Moderate
	Q25	5	1	3.06	0.514	Moderate
Average				3.24	0.853	Moderate

Table 5 shows teachers have a high perception of solutions to CI-related issues, believing these solutions can effectively improve CLT-related CI. They have a positive attitude towards these solutions and believe they can solve current issues.

Table 5 Descriptive Statistics of ways to address the issues related to Classroom Instruction

	Item	Max	Min	Mean	SD	Interpretation
Ways to address the issues related to Classroom Instruction	Q26	5	1	3.21	0.869	Moderate
	Q27	5	1	4.24	0.804	High
	Q28	5	1	4.33	0.716	High
	Q29	5	1	4.48	0.640	High
	Q30	5	1	4.33	0.806	High
	Q31	5	1	4.24	0.516	High
	Q32	5	1	4.15	1.020	High
	Q33	5	1	4.09	0.633	High
	Q34	5	1	4.42	0.538	High
Average				4.165	0.726	High

5.2 Results from Semi-Structured Interviews

This section shows the coded data arrangement from the semi-structured interview. They are presented below:

(1) Enjoyment in instruction

"International school students pay more attention to education and entertainment, so they learn some knowledge through activities." (Interviewee 1, January 2nd, 2024)

"I utilized a game popular among the Chinese, known as the carrot squatting game. I observed that they picked up the game quite quickly." (Interviewee 1, January 2nd, 2024)

"You need to prepare a variety of games and activities for them before class." (Interviewee 3, January 3rd, 2024)

(2) Students' interests

"Even though they didn't speak Chinese, they liked Chinese music."(Interviewee 2, January 3rd, 2024)

"One of the most important components of TCFL is that we first need to understand our pupils, why they want to learn Chinese, what personal interests they have."(Interviewee 7, January 9th, 2024)

"I found that even in a class with deficiencies in discipline, as long as my teaching content is a topic that interests students, they will still pay attention."(Interviewee 4, January 5th, 2024)

(3) Language media and multilingual teaching

"Some teachers speak both simple and mix Thai and English."(Interviewee 2, January 3rd, 2024)

"Mostly because I teach Chinese. That's why I try to explain it in Chinese 80% of the time."(Interviewee 4, January 5th, 2024)

As an English-speaking teacher in an international school in Thailand, I communicate with students fluently. (Interviewee 7, January 9th, 2024)

(4) The classroom environment and impact

"The final classroom provides a better learning atmosphere. Effectiveness exceeds even our expectations." (Interviewee 5, January 18th, 2024)

(5) The Chinese proficiency level of the students

"I will use English, or just the student's native tongue, if they have zero fundamental knowledge."(Interviewee 8, January 12th, 2024)

"I usually only use Chinese with children who have a certain foundation. For students who are just starting and lack the background, nevertheless, I speak in their language."(Interviewee 5, January 18th, 2024)

In conclusion, the findings from both the questionnaires and interviews highlight the strengths and areas for improvement in Chinese language classroom instruction (CI). While the overall effectiveness of CI is rated highly by teachers, certain challenges, such as inadequate lesson preparation and outdated teaching materials, remain. Teachers emphasize the importance of student-centered learning, dynamic teaching methods, and multilingual instruction to cater to diverse student needs.

6. Discussion

6.1 The main findings from Research Objective 1

First, findings indicated that teacher considered establishing rules and order to be highly necessary. For the study of classroom instruction, Chinese teachers' classroom management and communication methods are the main factors causing international students' classroom learning anxiety. Second, about teachers often use different teaching methods to attract students' interest. This is consistent with Zhu (2022), who found that educators must adapt their perspectives, advance their students' subjects, and proactively create circumstances that pique students' interests. Third, about the use of the medium language, most of the teachers would like to use English as the medium because international students speak English fluently, and easily communicate with them by English. Sometimes, the teacher uses Thai if the students are Thai. This is consistent with Zhang and others (2022). Finally, the findings of this study showed that the use of teaching technology of teachers. This finding aligns with the research conducted by Zhu (2022), all of whom support the integration of information technology in education and the use of current technology to promote the enjoyment of teaching.

6.2 The main findings from Research Objective 2

First, the findings of this study showed that this issue of a significant discrepancy between the Chinese teaching curriculum established by the school and the actual teaching requirements is of great concern. The language barrier, lack of classroom management experience, and inappropriate textbooks for tertiary education hampered their teaching. Second, most teachers were concerned with class time. The results of this study have a relationship with previous studies (Wilson, 2013), which found that the inadequate allocation of class time can have a detrimental impact on the overall effectiveness of teaching, thus causing significant worry among most teachers on the sufficiency of class time. Third, another serious problem in this study was that students often used tablets or mobile phones in the classroom. If teachers fail to highlight mistakes, students will not correct them. This situation similar to research by Attia and others (2017).

6.3 The main findings from Research Objective 3

According to the study, most teachers maintained that students are the main body of instruction and teachers are the guides in the classroom. During the teaching process, teachers should consider not only the overall context of the school but also the individuality of pupils and foster their sense of initiative (Zhong, 2015).

The findings of this study showed that in terms of preference for the type of classroom instruction, "multiple forms of classroom instruction must be used" was also one of the highest outcomes selected by teachers. This finding is in agreement with Zhou's (2022) findings that Chinese teachers instructing foreign students can employ diverse pedagogical approaches, there are numerous approaches to instructing Chinese characters. Most teachers think that prolonged utilization of a singular instructional approach will diminish pupils' enthusiasm for acquiring knowledge.

Most teachers were concerned with how the material of the textbook closely resembled everyday life. When determining the syllabus and textbooks needs to get teacher feedback so that the new syllabus and textbooks

become more realistic and easier to implement. Of course, teaching should not only focus on textbooks but also take students' needs and preferences into account (Yang, 2008).

7. Suggestion

(1) Teachers should focus on creating clear and consistent classroom rules while also enhancing communication techniques that reduce student anxiety. (2) To maintain high levels of student interest, educators should incorporate a variety of teaching activities, such as interactive, task-based, and experiential learning. (3) The findings revealed concerns over inadequate class time and the disruptive use of digital devices. To address these issues, teachers should be provided with better guidance on how to structure class time effectively, ensuring that sufficient time is allocated for both instruction and student engagement.

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Entrepreneurship Management Abilities of Vocational College Teachers in Henan Province, People's Republic of China

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ABSTRACT

This study aimed to synthesize and investigate the entrepreneurship management abilities of vocational college teachers in Henan Province, People's Republic of China. The research was divided into two phases. Phase 1 synthesized the entrepreneurship management abilities of vocational college teachers. The researcher studied 10 previous research works and related literatures. The research instrument was the frequency distribution comprehensive table. The previous research works and related literatures and questionnaire were analyzed by using frequency to find out the components of entrepreneurship management abilities which were at least of 60%. Phase 2 investigated the entrepreneurship management abilities of vocational college teachers. The samples were 200 students who study in two vocational colleges located in Henan Province, selected by using quota sampling technique. The research instrument was a set of questionnaires. The obtained data were analyzed by using mean and standard deviation. The results showed that the entrepreneurship management abilities of vocational college teachers in Henan Province, People's Republic of China included 4 components, namely: 1) Entrepreneurial skill; 2) Entrepreneurial knowledge; 3) Innovation thinking; and 4) Entrepreneurial motivation. The entrepreneurship management abilities of vocational college teachers in Henan Province, People's Republic of China were at a moderate level. These entrepreneurial management abilities can help vocational college teachers accurately assess their own entrepreneurship management abilities levels and provide certain reference standards for entrepreneurial ability training.

KEYWORDS: Entrepreneurial abilities; Entrepreneurial skill; Vocational college teachers

1. Introduction

The Chinese government has consistently been proactive in fostering the development of higher education teachers' capabilities and the progression of entrepreneurship education. The "Ordinary undergraduate course school entrepreneurship education teaching basic requirements（Trial）"（Ministry of Education, 2012）points out that the needs to improve students' social sense of responsibility, innovative spirit and entrepreneurial ability, promote students' entrepreneurial employment and all‑round development. The " On deepening institutions of higher learning opinions on the reform of innovation and entrepreneurship education"（General Office of the State Council, 2015）states the needs to improve the curriculum system for innovation and entrepreneurship education. "The Guiding Opinions of The General Office of the State Council on Further Supporting College Students' Innovation and Entrepreneurship "（General Office of the State Council, 2022）proposed to support college students to improve their innovation and entrepreneurship ability, support college graduates to start their own businesses and find employment, improve the quality of human resources, promote the all‑round development of college students, and realize more adequate and higher quality employment for college students.

In recent years, innovation and entrepreneurship education in colleges and universities in Henan province has developed rapidly, and great progress has been made in training entrepreneurship education teachers, entrepreneurship practice base, and college students' innovation and entrepreneurship competition. Institutions at all levels have formulated a number of measures to provide the policy support for them. "Notice on the Issuance of Administrative Measures for Innovation and Entrepreneurship Training Plan for College Students in Henan Province" (Henan Provincial Department of Education, 2020) emphasizes the strengthening of college students' innovation and entrepreneurship education, cultivate college students' innovative spirit and entrepreneurial ability, and better implement and manage projects. "Notice on Printing and Issuing Several Measures to Further Support College Students 'Innovation and Entrepreneurship in Henan Province"（Henan Provincial People's Government, 2022）proposed that we should implement the project to improve the ability and quality of innovation and entrepreneurship education among college teachers, improve the teaching ability of teachers' innovation and entrepreneurship education, and stimulate the vitality of innovation and entrepreneurship teachers in colleges and universities. "Supporting to promote the establishment of college students pioneer park guidance" （Henan province education department, 2023）points out that organization entrepreneurship education full‑time teacher training, employment entrepreneurship guidance teachers teaching skills competition, strengthen the provincial employment entrepreneurship guidance team construction, improve employment entrepreneurship guidance ability and level.

Although the innovation and entrepreneurship education in Chinese colleges and universities has made some progress, it has played a positive role in improving the quality of higher education, promoting the comprehensive development of students, promoting the entrepreneurship and employment of graduates, and serving the modernization of the country. However, there are some problems in the innovation and entrepreneurship teachers in vocational colleges. For example, the number of full‑ time teachers in

entrepreneurship education is insufficient. Innovation and entrepreneurship education in vocational colleges in Henan Province is dominated by campus teachers. Innovation and entrepreneurship education needs to integrate basic courses. However, innovation and entrepreneurship teachers are usually ideological and political teachers or industrial teachers, and it has not yet established a full-time innovation and entrepreneurship education teachers with multidisciplinary background. The staff structure is unreasonable. The main manifestation is that most innovation and entrepreneurship teachers are young, lack of teaching experience and practical experience accumulation, and have narrow discipline knowledge, which cannot meet the needs of multidisciplinary knowledge in innovation and entrepreneurship education.

Teachers need a multifaceted set of skills to enhance entrepreneurial management. On the basis of comprehensive analysis of Taylor curriculum design model, CBE capability‐based curriculum development model, curriculum development model of learning field, Taylor curriculum design model, project curriculum development model, DACUM model, additional model and ISD curriculum model, it is found that entrepreneurship education teachers in vocational colleges need to improve their knowledge in three aspects: technical knowledge, content knowledge and teaching knowledge. In the teaching of entrepreneurship education, teachers need to master the relevant knowledge of entrepreneurship technology, understand the subject knowledge and teaching methods of entrepreneurship education, and design and implement entrepreneurship education teaching in combination with these three fields. The purpose of this study is to explore the entrepreneurial components to enhance the entrepreneurial management ability of teachers. It provides a reference for optimizing the teaching method of entrepreneurship education management ability and improving the ability of instructors to apply entrepreneurship management. Liu（2022）conducted applied research on improving teachers' entrepreneurial ability, in which the current situation and challenges of entrepreneurship education for teachers in vocational colleges were studied, and corresponding solutions were proposed. However, some studies lack depth in examining the impact of technical knowledge, content knowledge and teaching knowledge on teachers in entrepreneurship education, as well as specific operational research methods and empirical data support. These gaps suggest the need for more in‐depth and specific research to better understand the quality of teacher education and the application of entrepreneurial skills

Based on the above significance, the researcher is interested in the research of entrepreneurship teaching ability of teachers in vocational colleges in Henan Province, people's republic of China. The expected findings will be guidelines for the design of more effective entrepreneurship management techniques for teachers in entrepreneurship education teaching methods for these teachers to improve the level of entrepreneurship education teaching qualifications.

2. Research Objective

（1）To synthesize the components of entrepreneurship management abilities of vocational college teachers in Henan Province, People's Republic of China

（2）To investigate the current situations of entrepreneurship management abilities of vocational college teachers in Henan Province, People's Republic of China

3. Research Methodology

This research was divided into two phases as follows:

Phase 1: Synthesizing the components of entrepreneurship management abilities of vocational college teachers

1. Data Source

The researcher studied the 10 documents, academic textbooks and previous studies related to the entrepreneurship, teaching and learning entrepreneurship, and entrepreneurial abilities of vocational college teachers both in domestics and overseas.

2. Research Instrument

The research instrument in this step was the documentary analysis form which includes the content summary.

3. Data Collection

The data were collected through the documents, academic textbooks and related research works from various higher education institution libraries and educational institutions in China and online data bases.

4. Data Analysis

The collected data were analyzed by using content analysis technique, and then summarize and organize those data according to the documentary analysis form.

Phase 2: Investigating the current situations of entrepreneurship management abilities of vocational college teachers

1. Population and Samples

The population included 480,100 vocational college students who study in 110 vocational colleges in Henan Province, People's Republic of China in academic year 2023.

The samples were 200 current students who study Innovation and Entrepreneurship Course from Nanyang Vocational College of Science and Technology in Henan Province, People's Republic of China. They were selected by using purposive sampling technique for choosing the vocational colleges, and quota sampling technique for choosing the students.

2. Research Instrument

The research instrument was a set of questionnaires asking about the current situation of teaching and learning entrepreneurship of vocational college teachers in Henan Province, People's Republic of China.
The questionnaire was divided into 3 parts: Part 1 - General information about the respondents; Part 2 - Opinions about teaching and learning entrepreneurship of vocational college teachers; and Part 3 - Problems on teaching and learning entrepreneurship of vocational college teachers.

The questionnaire was gradually constructed and submitted to the thesis advisors in order to check for the correctness and appropriateness. The questionnaire was edited and revised based on the thesis advisors' comments and suggestions. Then, the questionnaire was examined the validity by the five experts. After that, the researcher analyzed the Index of Item-Objective Congruence: IOC which is between 0.60-1.00 (Phatiyathanee.

2017: 167). The IOC value was 1.00. The questionnaire was tried out with 30 vocational college teachers, current students and graduates who are not the samples. Finally, the researcher analyzed the reliability of the questionnaire by using the Cronbach's Alpha Coefficient. The reliability of the questionnaire was 0.874.

3. Data Collection

The researcher sent the letter issued by the Graduate School asking for permission to collect the data. The researcher collected all data by herself. The survey was distributed to students using 'Wen juan xing,' China's largest online survey and test platform. Students accessed the questionnaire via their mobile phones and submitted their responses anonymously online.

4. Data Analysis

The data from the rating scale questionnaire were analyzed by using mean and standard deviation. The scores from the opinions about teaching and learning entrepreneurship of vocational college teachers in Henan Province were interpreted as the criteria below (Srisa-ard. 2013: 109).

Scale	Meaning
4.51-5.00	The highest level
3.51-4.50	High level
2.51-3.50	Moderate level
1.51-2.50	Low level
1.00-1.50	The lowest level

4. Research Findings

4.1 The Components of Entrepreneurship Management Abilities of Vocational College Teachers

The components of entrepreneurship management abilities of vocational college teachers in Henan Province, People's Republic of China are shown in Table 1.

Table 1 Components of entrepreneurship management abilities

Serial number	Competency	Hu Lingxia (2021)	Zhong Yurui (2022)	Zhou Shuangyan,Xie Ming (2022)	Xu Yongsheng,Dong Hui (2022)	Meng Zibo (2022)	Zhao Xinyue (2022)	Chen Fubo (2022)	Cao Yuhua,Wang Shubei (2022)	Gao Lili (2023)	Yang Rui (2023)	Frenquency
1	Entrepreneurship Skills	√	√	√	√	√	√	√	√	√	√	10
2	Entrepreneurship knowledge	√	√		√	√	√		√	√	√	8
3	Innovation			√	√	√		√		√	√	6
4	Entrepreneurship motivation	√		√	√			√	√		√	6
5	Entrepreneurship Experience		√		√			√		√	√	4
6	Entrepreneurship Intention		√	√			√					3
7	Practice	√				√					√	3
8	Entrepreneurship Resources	√							√			2
9	Entrepreneurship Spirit					√	√					2
10	Entrepreneurship Network								√	√		2
11	Business Capabilities							√	√			2
12	Cultural Level		√									1

From Table 1, based on the synthesis of the components of entrepreneurial management abilities combined with the comprehensive table of frequency distribution, only from more than 60% frequency value of the available data, the results show that the components of entrepreneurship management abilities of vocational college teachers included the following four important components:

1. Entrepreneurial skill refers to a high‑level comprehensive ability. According to the methods of psychology, education, sociology, and the basic principles of talent and entrepreneurship, we can divide "entrepreneurial skills" into general skills (including self‑control, learning ability, communication ability,

resilience, etc.）and professional skills（including planning ability, leadership ability, management ability, financial management ability, innovation ability, risk control ability, etc.）. Although various abilities have different positions and roles in the entrepreneurial process, they are all essential.

2. Entrepreneurial knowledge refers to the knowledge system and structure of individuals who have significance for the entrepreneurial practice process, mainly including professional knowledge, business management knowledge, comprehensive knowledge, etc. Only by systematically mastering the basic theories and skills of relevant disciplines can we lay a solid foundation for future entrepreneurship. Narrowly defined entrepreneurial knowledge refers to the specific knowledge applied to the entrepreneurial process, steps, methods, etc. For example, the choice of entrepreneurial opportunities for college students, the search for entrepreneurial opportunities, how to write a business plan, how to start a small enterprise, how to register for a T business, and how to obtain loans from banks. Entrepreneurship knowledge can reflect the cultural quality of entrepreneurs, and the higher the cultural quality, the higher the probability of successful entrepreneurship.

3. Innovation thinking refers to the thinking process of solving problems with innovative and original methods. Through this kind of thinking, one can break through the boundaries of conventional thinking, think about problems with unconventional or even unconventional methods and perspectives, propose unique solutions, and produce novel, unique, and socially meaningful thinking outcomes.

4. Entrepreneurial motivation refers to a motivating factor for entrepreneurs to take various risks to establish new businesses. The most common of these factors is independence, which means unwillingness to work for others. The other driving forces for entrepreneurship often vary depending on gender and country. For male entrepreneurs and business planners, money is the second most motivating factor; For female entrepreneurs, job satisfaction, sense of achievement, seizing personal development opportunities, and money are sequentially the motivating factors for them to start their own business. These second level entrepreneurial motivations partially reflect the work and family circumstances of entrepreneurs, as well as their social role idols.

4. 2 The Current Situations of Entrepreneurial Management Abilities of Vocational College Teachers

The current situation of entrepreneurial learning management abilities of teachers in vocational colleges in Henan Province, People's Republic of China in Table 2 below:

Table 2 Mean and standard deviation of entrepreneurship management abilities of vocational college teachers

Aspects of Entrepreneurial Ability	Opinion Level			
	$\overline{X}$	S. D.	Meaning	Ranking
1. Entrepreneurial Skills	3.60	0.96	High	1
2. Entrepreneurial knowledge	3.20	0.84	High	2
3. Innovative thinking	2.60	1.14	Moderate	3
4. Entrepreneurship motivation	2.25	0.89	Moderate	4
Total	**2.91**	**0.97**	**Moderate**	

As shown in Table 2, we find that the overall entrepreneurial management abilities of entrepreneurship education teachers in Henan Province of China are at a medium level ($\overline{X}$ = 2.91, S.D. = 0.97). When considering each aspect, the study found that aspects such as "entrepreneurial technology and entrepreneurial knowledge" were in the high level of innovation thinking and the middle level of entrepreneurial motivation. The highest average score was entrepreneurial knowledge ($\overline{X}$ = 3.60, S.D. = 0.96), followed by entrepreneurial technology ($\overline{X}$ = 3.20, S.D. = 0.84), innovation thinking ($\overline{X}$ = 2.60, S.D. = 1.14), entrepreneurial motivation ($\overline{X}$ = 2.25, S.D. = 0.89).

5. Discussion

5.1 The Components of Entrepreneurship Management Abilities of Vocational College Teachers

1. Entrepreneurial skill

Entrepreneurship teachers in vocational colleges should have high-level entrepreneurial skills that meet the requirements of Entrepreneurship education, and can effectively guide students in Learning and application of innovation and entrepreneurship. The finding is in line with Hu (2021), Xu (2022), Zhong (2022), Cao (2022), Meng (2022), Zhao (2022), Chen (2022), Gao (2023), Yang (2023).

2. Entrepreneurial knowledge.

Entrepreneurship teachers in vocational colleges should have the knowledge system and structure of individuals who have significance for the entrepreneurial practice process, mainly including professional knowledge, business administration knowledge, comprehensive knowledge, etc. This finding is in line with Jing Hu (2021), Xu (2022), Zhong (2022), Cao (2022), Meng (2022), Zhao (2022), Chen (2022), Gao (2023).

3. Innovation thinking

Entrepreneurship teachers in vocational colleges should pay attention to the knowledge reserve in the field of solving problems with innovative and original methods, and need to break through the boundaries of conventional thinking, propose unique solutions, and produce novel, unique, and socially meaningful thinking outcomes. This finding is similar to Hu (2021), Xu (2022), Zhong (2022), Cao (2022), Meng (2022), Zhao (2022), Chen (2022), Gao (2023), Yang (2023).

4. Entrepreneurial motivation

Entrepreneurship teachers in vocational colleges must have the ability to establish entrepreneurship project, participate in enterprise practice, and provide technical services for the society. This finding is in line with Hu (2021), Xu (2022), Zhong (2022), Cao (2022), Meng (2022), Zhao (2022), Chen (2022), Gao (2023), Yang (2023).

5. 2 The Current Situations of Entrepreneurial Management Abilities of Vocational College Teachers

The overall entrepreneurial learning management ability of lecturers in higher vocational colleges in Henan, China is at a medium level. Entrepreneurial technology and entrepreneurial knowledge are at a high level, and innovation awareness and entrepreneurial motivation are at a medium level. The reasons for this phenomenon include that Henan is in the middle level of China's economic development, and the entrepreneurial resources are limited. In addition, vocational college teachers pay attention to theoretical knowledge but ignore practical ability, weak entrepreneurial awareness, and incomplete training mechanism of entrepreneurial teachers may hinder the development of entrepreneurial learning management ability. According to Meng (2022), at present, most teachers in higher vocational colleges still lack innovation consciousness and understanding of creative consciousness. Gao (2023) believes that some teachers have weak awareness of "mass entrepreneurship", weak willingness to learn, and insufficient practical ability of "mass entrepreneurship". The training mechanism of "mass entrepreneurship and innovation" teachers is not perfect. The results are consistent with those of CAI (Li, 2020; Li, 2021; Liu, 2022).

The weak teaching staff of entrepreneurship education in higher vocational colleges in Henan, China, is one of the main reasons that hinder the learning and management ability of entrepreneurship. Li (2020) believes that the main reasons for the shortage of teachers of innovation and entrepreneurship education include the complicated subject background of teachers. Most of the entrepreneurship teachers are part‑time teachers, and some teachers lack the subject background and knowledge structure related to innovation and entrepreneurship, and their professional level needs to be improved. The structure of entrepreneurship education teachers is not balanced, and the entrepreneurship teachers lack a reasonable analysis of students and a professional perspective to lead students to carry out entrepreneurial practice. Many teachers lack practical experience in innovation and entrepreneurship and are unable to provide students with real innovation and entrepreneurship cases and experience sharing. This aligns with the research findings of Hu (2021), Zhong (2022), Cao (2022), Meng (2022), Zhao (2022), Gao (2023), Yang (2023).

The growth system of entrepreneurship education teachers in higher vocational colleges in Henan, China is not perfect. The reasons for the imperfect training system of entrepreneurship education teachers in higher vocational colleges are mainly the unsystematic training system of entrepreneurship education teachers, the imperfect management system of entrepreneurship education teachers, the incomplete construction of the Internet + teacher education system, and the serious shortage of school‑running resources of teacher education

institutions（Meng, 2022）is consistent with the results of Li (2020), Cao (2022), Chen (2022), Zhong (2022), Yang (2023).

6. Research recommendations

6.1 Recommendations for the Application of the study findings

Introduce teachers with project research and development or enterprise experience to teach, and train them as the "main force" of entrepreneurship education, so as to improve the cohesion and stability of the teachers in innovation and entrepreneurship education. Select young teachers with enterprise experience or high professional level to serve as innovation and entrepreneurship teachers, and provide opportunities for further study and training to encourage their practical ability.

6.2 Suggestions for further studies

Improve the teaching ability of entrepreneurship education teachers strengthen the responsibility and mission of teachers, mobilize teachers' subjective initiative. Carry out innovation and entrepreneurship education courses teaching and training to improve teachers' teaching ability. Further research should also focus on considering how to encouraged teachers in higher vocational colleges to start their own businesses, to strengthen the contact with enterprises, open up the conversion channel between teachers and the outside world.

7. Acknowledgement

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Developing Academic Administration Guidelines to Enhance Critical Thinking Skills of Rural Students of Xing Qun Primary School, China

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ABSTRACT

The objectives of this research were: 1) To investigate the current situation of academic administration about critical thinking skills in the rural area. 2) To construct the academic administration guidelines to enhance critical thinking skills in the rural area. The respondents in this research were 275 students and 44 administrators and teachers obtained through stratified random sampling at Xing Qun Primary School, China. The research instrument employed in this study was two questionnaires with 25-30 questions for 5 rating scales. The instrument quality was evaluated for the Index of item objective congruence scores by the 3 specialists. The information and data collected were analyzed through the quantitative research method and presented in terms of frequency, percentage, mean and standard deviation.

The findings indicated that: 1) problems and needs of academic administration guidelines of enhance critical thinking skills in the rural area at the moderate level 2) The current situation of academic administration was at the low level. The academic administration guidelines to enhance critical thinking skills in the rural area has comprised of 5 parts; namely, 1) Academic administration curriculum planning refers to the management of course setting, course structure and class time regulations 2) Curriculum development includes four steps: diagnosis, design, implementation and evaluation 3) Instruction management the management functions of planning, organization, coordination and control. The administrative departments of education and schools shall jointly undertake the work of instruction management 4) Supervision and instructional improvement should be carried out to improve the quality of education and training, and 5) Evaluation of academic affairs on the standards

and quality assessment include teaching management and an important means to improve teaching quality and school-running efficiency. In order to improve teaching quality, strengthen teaching management and facilitate teaching quality evaluation.

KEYWORDS: Academic Administration Guidelines, Critical Thinking Skills, Rural Students

1. Introduction

In recent years, the context of policy, cultivating students' critical thinking ability is in line with the needs of the current educational curriculum reform. Through strengthening the school's educational administration, providing rural students with a systematic teaching and learning environment and promoting the diversification of teaching methods, it can effectively promote the cultivation of students' critical thinking ability. In the theoretical background, educational theorists put forward the theoretical model and training approach of critical thinking (Li,Chen & Xiang,2023) which provides theoretical guidance for this study. In practice, there are still many difficulties and challenges in the cultivation of rural students' critical thinking ability, because before the early years of China, critical thinking was not in the mode of curriculum in school education. There is no systematic, normative and reasonable training of students' critical thinking. Lack of critical thinking education system to cultivate students, generally easy to think set, lack of clear argument. Therefore, this study aims to build a guide for improving rural students' critical thinking ability in educational administration, taking Xing Qun Primary school as the research object, in order to provide feasible and effective practical exploration for the reform of education management in rural schools. By studying the background factors of politics, policy, theory and practice, this study will provide important references and suggestions for the cultivation of rural students' critical thinking ability, which is of great significance for promoting the development of rural modernization education and students' all-round development.

2. Research Objective

(1) To investigate the current situation of academic administration about critical thinking skills in the rural area.

(2) To construct the academic administration guidelines to enhance critical thinking skills in the rural area.

3. Literature Review

3.1 Theory, Concept and Related Research

3.1.1 Academic Administration

Academic Administration Jobs in academic administration include executive and non-executive positions. Executive positions include department chair, dean, senior research officer, provost, and president. These jobs generally require advancement through the academic ranks to a tenured position. Although some non-executive jobs involve laboratory work, many do not. Non-executive jobs are generally not on the tenure track (Komaroff, 2019, p499-500).

3.1.2 Critical Thinking Skills

Critical thinking as Judgment, a skeptical and provisional view of knowledge, a simple originality (Overlapping with creative thinking) (Di & Yu Dangxu,2014).

Problem solving is the ultimate intent of critical thinking for many scholars who study the phenomenon. Critical thinkers typically (Zhang,2019) acknowledge personal limitations, see problems as exciting challenges, have understanding as a goal, use evidence to make judgments, are interested in others' ideas, are skeptical of extreme views, think before acting, avoid emotionalism, keep an open mind and engage in active listening.

3.1.3 Rural Students

The technical definition of rural school is in line with our general understanding of rural areas; They are characterized by geographic isolation and small population size. All schools are divided into four districts based on size, population density and geographical location. The National Center for Education Statistics (NCES) defines these areas in its "urban Center" classification system based on the distance of schools from cities. The four regional categories used by NCES's Urban Center Classification System (NCES locale Classifications and Criteria,2022,p1) are urban, suburban, urban, and rural.

The growth environment of rural students is different from that of urban students, so they are different in knowledge background, attitude towards problems and way of thinking to deal with problems. In order to find out the factors that restrict the development of rural students' thinking, we need to start from the source first, which is conducive to teachers pointing at students' thinking shortcomings and trying to make up for them (Shen,2020,p201).

3.1.4 Rural Area

Rural area has multiple attributes such as nature, society and economy, and is a special area with multiple functions such as production, life, politics, ecology and culture. Countryside and city are interrelated, promote each other and develop together, constituting the main space of human activities (Zhang, 2019).

3.2 Research Framework

Input	Process	Output
1. The current situation of academic administration about critical thinking skills in the rural area; 2. Concept of academic administration to enhance critical thinking skills in the rural area.	1. Investigating the current situation of academic administration about critical thinking skills in the rural area; 2. Constructing the academic administration guidelines to enhance critical thinking skills in the rural area.	1. Data and information concerning the current situation of academic administration about critical thinking skills in the rural area; 2. The academic administration guidelines to enhance critical thinking skills.

Figure 1 Research Framework

4. Research Methodology

4.1 Research Design

In this article divided 2 parts.

Quantitative Method was used for part 1 for investigate the current situation of academic administration about critical thinking skills in the rural area.

Quantitative Method was used for part 2 for construct the academic administration guidelines to enhance critical thinking skills in the rural area.

4.2 Population and Sample

The population of this study was 870 students and 48 school administrators and teachers at Xing Qun primary school in China in the 2022‑2023 academic year. The sample included a total of 275 students and 44 administrators and teachers by used stratified random sampling technique (Yamane,1970)

4.3 Research Instrument

In this research, a questionnaire was employed for the data collection. The questionnaire was divided into 2 groups; namely, 1) students and 2) teachers and administrators.

For this part the questionnaire was evaluated for the Index of Congruence scores (IOC scores) by the three specialists. Each question in the questionnaire evaluated with the range of IOC 0.67 to 1.00 was employed meeting for this research. Cronbach's Alpha coefficient was evaluated the questionnaire reliability index 0.98.

Based on the results of the questionnaire survey, summarizing the current situation of academic administration to enhance critical thinking skills in the rural area and generate interview form.

4.4 Data Collection

The questionnaire distribution and collection period were estimated to span approximately 1 month.

4.5 Data Analysis

Descriptive statistics involving frequency, percentage, mean and standard deviation. The researchers conducted 275 students from a target group of primary schools in China. Based on the perspectives of the 8 administrators and 36 teachers, the researcher conducted thematic categorization and summarize the findings into the guidelines for academic administration to enhance critical thinking skills of rural students.

5. Research Findings

To investigate the current situation of academic administration about critical thinking skills in the rural area.

Table 1: The current situation of academic administration guidelines of enhance critical thinking skills in the rural area of students

No.	Questions	$\bar{X}$	S.D.	Level of problems and needs
	Problems: Critical thinking skills -- Observation			
1	When things get tough, others expect me to keep working on them.	3.07	1.188	Moderate
2	If I find a problem in class, I will bravely raise my hand and discuss it with the teacher.	2.91	1.176	Moderate
	Critical thinking skills -- Analysis			
3	Would you rely solely on your own experience to make a judgement?	3.06	1.096	Moderate
4	I often think and analyze the right and wrong of practice and experience in study or life.	2.50	1.062	Moderate
	Critical thinking skills -- Inference			
5	I will only look for facts that support my opinion, not facts that oppose it.	2.81	1.218	Moderate
6	I like to find out how things work, for example by collecting data and making conclusions myself.	2.65	1.150	Moderate
	Critical thinking skills -- Communication			
7	In a group discussion or face-to-face communication, if a person's opinion is considered incorrect by others, you will choose not to listen to what he/she has to say next.	3.09	1.245	Moderate
8	I can keep talking about a problem, but I don't care if it's solved.	3.07	1.203	Moderate
	Critical thinking skills -- Problem-solving			
9	I am good at dealing with problems in an organized way.	2.46	1.040	Low
10	Solving problems is fun.	2.38	1.166	Low
	Total	2.60	1.120	Moderate
	Need			
1	Your current learning environment limits your thinking.	3.20	1.265	Moderate
2	Teachers often do not give enough time for reflection and discussion.	3.08	1.219	Moderate

No.	Questions	$\overline{X}$	S.D.	Level of problems and needs
3	In study and life, everything follows the instructions of teachers and guardians, do you think it is reasonable?	3.04	1.292	Moderate
4	Because your parents are more sensible, you can often take control of your own life.	2.72	1.243	Moderate
5	Do you think brainstorming group discussions will help you generate new ideas about problems?	2.54	1.156	Moderate
Total		2.62	1.160	Moderate

According to table 1 presents the results of students' problems and needs of academic administration guidelines of enhance critical thinking skills are a "Moderate" level in the rural area. It is indicated that:

Problem for the dimension of observation it shows that students' things get tough, others expect them to keep working on them. $\overline{X}$= 3.07, S.D.=1.188.

Problem for the dimension of analysis it shows that students rely solely on their experience to make a judgement. $\overline{X}$= 3.06, S.D.=1.096.

Problem for the dimension of inference it shows that students will only look for facts that support my opinion, not facts that oppose it. $\overline{X}$= 2.81, S.D.=1.218.

Problem for the dimension of communication it shows that students discuss a matter with their family or friends, they disagree, most of their family or friends agree on this matter, will they choose to agree. $\overline{X}$= 2.81, S.D.=1.250.

Problem for the dimension of problem-solving it shows that students are good at dealing with problems in an organized way. $\overline{X}$= 2.46, S.D.=1.040.

For the need of critical thinking skills for students, it shows that administrators and teachers' current learning environment limits your thinking. $\overline{X}$= 3.20, S.D.=1.265. Follow by the questions show that teachers often do not give enough time for reflection and discussion. $\overline{X}$= 3.08, S.D.=1.219. In study and life, everything follows the instructions of teachers and guardians, whether teachers think it is reasonable. $\overline{X}$= 3.04, S.D.=1.292.

Table 2: The current situation of academic administration of students

No.	Questions	$\overline{X}$	S.D.	Level of problems and needs
	Problems: Academic administration curriculum planning			
1	How confident are you in your ability to incorporate activities that promote critical thinking into the curriculum planning process?	2.39	0.784	Low

No.	Questions	$\overline{X}$	S.D.	Level of problems and needs
2	Would you be interested in collaborating with colleagues to develop resources or strategies for enhancing critical thinking in curriculum planning?	2.30	0.795	Low
Curriculum development				
3	Do you need effective strategies to integrate critical thinking skills into your curriculum development?	2.16	0.805	Low
4	Would you be interested in participating in professional development workshops specifically focused on integrating critical thinking skills into curriculum development?	2.16	0.745	Low
Instruction management				
5	Are you satisfied with the teaching facilities and environment of the school when you teach?	2.57	0.846	Moderate
6	Are you satisfied with the school's rules and regulations?	2.48	0.628	Low
Supervision and instructional improvement				
7	Does the teaching supervisor (administrator or colleague) conduct classroom observations once a day?	2.50	0.849	Moderate
8	Immediate feedback will be provided online or offline after classroom observations.	2.36	0.967	Low
Evaluation of academic affairs on the standards and quality assessment				
9	Do schools have specific educational standards or frameworks to guide the improvement and assessment of rural students' critical thinking skills? (For example, education standards, rural education initiatives)	2.77	0.859	Moderate
10	Do you believe the current assessment methods effectively capture students' critical thinking abilities?	2.75	0.943	Moderate
Total		2.27	0.791	Low

According to table 2 presents the results of the academic administration situation of academic administration guidelines of enhance critical thinking skills are a "Low" level in the rural area. It is indicated that:

Problem for the dimension of academic administration curriculum planning, it shows that how confident are you in administrators and teachers' ability to incorporate activities that promote critical thinking into the curriculum planning process. $\overline{X}=2.39$, S.D.$=0.784$. Follow by the questions show that the administrators and

teachers are interested in collaborating with colleagues to develop resources or strategies for enhancing critical thinking in curriculum planning. $\overline{X}$=2.30, S.D.=0.795.

Problem for the dimension of curriculum development, it shows that the administrators and teachers need effective strategies to integrate critical thinking skills into your curriculum development. $\overline{X}$= 2. 16, S.D.=0.805. Follow by the questions show that the administrators and teachers are interested in participating in professional development workshops specifically focused on integrating critical thinking skills into curriculum development. $\overline{X}$=2.16, S.D.=0.745.

Problem for the dimension of instruction management, it shows that the administrators and teachers satisfied with the teaching facilities and environment of the school when you teach. $\overline{X}$=2.57, S.D.=0.846. Follow by the questions show that the administrators and teachers satisfied with the school's rules and regulations. $\overline{X}$=2.48, S.D.=0.628.

Problem for the dimension of supervision and instructional improvement, it shows that the teaching supervisor (administrator or colleague) conduct classroom observations once a day. $\overline{X}$= 2.50, S.D.=0.849. Follow by the questions show that Immediate feedback will be provided online or offline after classroom observations. $\overline{X}$= 2.36, S.D.=0.967.

Problem for the dimension of evaluation of academic affairs on the standards and quality assessment, it shows that the schools have specific educational standards or frameworks to guide the improvement and assessment of rural students' critical thinking skills (For example, education standards, rural education initiatives). $\overline{X}$= 2.77, S.D.=0.859. Follow by the questions show that the administrators and teachers believe the current assessment methods effectively capture students' critical thinking abilities. $\overline{X}$= 2.75, S.D.=0.943.

6. Discussion

6.1 To investigate the current situation of academic administration to enhance critical thinking skills in the rural area.

The results of the academic administration problems and needs of academic administration guidelines of enhance critical thinking skills are at a "low" level in the rural area. The stable "double-base" education in rural areas is easy to form superstitious authority and develop a set of thinking. The lack of critical thinking leads to excessive learning burden, loss of interest in learning, static old knowledge and hindering the generation of new knowledge. The essence of this kind of double-base education is that students have strong adaptability and weak creativity in their future development (Zhou Wen, & Li Jiliang,2024)

The results of students' problems and needs of academic administration guidelines of enhance critical thinking skills are at a "moderate" level in the rural area. In China, the research content focuses on the cultivation of critical thinking of college students, and there are few studies on the cultivation of critical thinking ability of primary and secondary school students (Xue & Lu,2019, p63-64).

6.2 To construct the academic administration guidelines to enhance critical thinking skills in the rural area.The content planning of the three units focuses on solving the needs of administrators teachers and

students , which is mainly reflected in innovative teaching methods, strengthening professional fields, learning and life guidance, and cooperation between families and schools. The citations and data references listed in the "Developing Academic Administration Guidelines to Enhance Critical Thinking Skills of Rural Students of Xing Qun Primary School, China " are all from cutting-edge methods in the third field of enhancing critical thinking skills of rural students education.

7. Suggestion

Schools administrators need to fully understand the problems and needs of rural students and teachers.

For the research of this article, we can further study the STEAM education concept in the future, and study how to establish an interdisciplinary system to cultivate the critical thinking of students in rural areas.

Users of the academic administration guidelines of critical thinking skills for rural students of Xing Qun Primary School, China need to receive pre-use training for implementation.

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Fostering Global Citizenship: Examining Sustainability and Cultural Awareness in Online Learning among Thai University Students through UK Environmental Perspectives

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ABSTRACT

This study examined the impact of UK environmental frameworks on Thai university students' understanding of sustainability in the context of global citizenship. Employing a qualitative research design, the study utilized in-depth interviews with 19 Thai university students and a focus group consisting of 6 participants to analyze the effect of online learning on students' attitudes, subjective norms, and perceived behavioral control regarding sustainability and intercultural competence. The findings indicated that exposure to UK-based environmental management strategies significantly enhanced students' environmental literacy and fostered pro-environmental behavior within their local communities. Moreover, engagement with culturally diverse narratives through digital platforms promoted critical self-reflection and cultivated a global perspective, which were essential components for the development of a global citizenship identity. This research highlighted the potential of online learning as a medium for facilitating cross-cultural dialogue, suggesting that the integration of culturally diverse content into educational curricula could enrich learning experiences and better equip students to address complex global socio-environmental challenges.

KEYWORDS: Sustainability; Cultural Awareness; Online Learning

1. Introduction

In an increasingly interconnected world, higher education served as a critical catalyst for advancing global citizenship and promoting sustainability. The United Nations Sustainable Development Goals (SDGs) underscored the necessity of cultivating global citizenship to address complex socio-environmental issues (UNESCO, 2015). This study examined the influence of UK environmental frameworks on Thai university students' conceptualization of sustainability within this context.

Existing literature indicated that online learning platforms significantly enhanced opportunities for international collaboration and cross-cultural interactions, thereby increasing student engagement with global challenges (Kirkwood & Price, 2014; Farkas, 2019). Such platforms provided avenues for students to engage with diverse cultural narratives, thereby enriching their educational experiences and fostering critical reflexivity (Dempsey et al., 2018). The Theory of Planned Behavior (TPB) served as a useful framework for understanding how attitudes, subjective norms, and perceived behavioral control shaped students' perceptions and behaviors regarding sustainability (Ajzen, 1991, Bosnjak, Ajzen & Schmidt, 2020).

Employing a qualitative methodology, this research utilized semi-structured interviews to explore how exposure to UK environmental frameworks enhanced Thai students'comprehension of sustainability and appreciation of cultural diversity. Preliminary findings suggested that such exposure not only increased environmental awareness but also nurtured a global perspective that was essential for developing a robust global citizenship identity (Bennett et al., 2019). This study highlighted the potential of online platforms to facilitate cross-cultural exchanges and advocated for the integration of culturally diverse content in academic curricula to better prepare students for engaging with multifaceted global socio-environmental issues.

2. Research Objective

(1) To examine how engaging with UK environmental frameworks collaboratively influenced Thai university students' understanding of sustainability within the context of global citizenship

(2) To investigate Thai university students' perceptions of the role of online learning in enhancing cultural awareness and fostering a global citizenship identity.

3. Literature Review

3.1 Theory, Concept and Related Research

Sustainability in Higher Education

Sustainability has emerged as a critical priority in higher education, driven by the urgent need to address global environmental challenges. According to the United Nations, sustainability encompassed a holistic framework that integrates environmental, social, and economic dimensions to ensure a balanced and equitable future (UNESCO, 2015). Universities held a pivotal position in promoting sustainability, as they educated future leaders, conducted relevant research, and engaged in community outreach activities (Leal Filho et al., 2019).

Recent studies underscored the significance of embedding sustainability principles into university curricula to cultivate students' understanding of ecological responsibility and global stewardship (Bennett et al., 2019; Lozano et al., 2017). Such curricular integration encouraged students to adopt sustainable practices and engage in actions that contribute to environmental conservation within their local and global communities. Through education and advocacy, higher education institutions played a transformative role in advancing sustainability goals and prepared students to become informed and proactive global citizens.

Global Citizenship

Global citizenship encompassed a profound understanding of global issues, alongside a commitment to addressing these challenges through responsible and ethical actions (Dempsey et al., 2018). As globalization continued to reshape educational landscapes, cultivating global citizenship among students has became an increasingly critical objective. This concept entailed recognizing the interconnectedness of societies, embracing cultural diversity, and actively engaging in efforts to promote social justice (Oxfam, 2015).

Empirical research indicated that education geared toward fostering global citizenship equipped students with the essential skills needed to address complex socio-environmental challenges, including critical thinking, empathy, and intercultural competence (Hahn, 2018; Leask, 2015). Within this framework, sustainability and global citizenship were intrinsically linked, as responsible global citizens advocated for sustainable practices and policies that contribute to environmental preservation and societal well-being.

Online Learning and Cultural Awareness

The advent of online learning platforms transformed educational accessibility, fostering greater opportunities for cross-cultural exchange and engagement. These platforms facilitated interactions among students from diverse backgrounds, thereby enhancing cultural awareness and enriching the overall educational experience (Kirkwood & Price, 2014). Empirical research suggested that online learning served as a powerful medium for cultivating global citizenship by exposing students to a variety of cultural narratives and perspectives (Farkas, 2019; Leask, 2015).

Integrating culturally diverse content into online curricula not only enriched students' educational experiences but also fostered critical reflexivity and a nuanced understanding of complex global issues (Dempsey et al., 2018). By leveraging digital technologies to connect students with international viewpoints, educators promoted deeper engagement with transnational environmental challenges and ensured that pedagogical practices aligned with broader sustainability objectives (Kirkwood & Price, 2014; Leal Filho et al., 2019

Applying Sustainability, Cultural Awareness, Global Citizenship, and Online Learning to the Theory of Planned Behavior

The convergence of sustainability, global citizenship, and online learning presented unique educational opportunities that enriched student perspectives. Collaborative learning experiences that transcend cultural boundaries were instrumental in fostering a shared understanding of sustainability and reinforced students' identities as global citizens (Fien, 2002). Empirical evidence suggested that exposure to diverse environmental practices not only enhanced comprehension of sustainability concepts but also promoted pro-environmental

behaviors within local communities (Leal Filho et al., 2019), thereby nurturing a sense of belonging to a global community committed to addressing environmental challenges.

While the Theory of Planned Behavior (TPB) was widely employed to examine sustainability-related behaviors (Bamberg & Correia, 2021; Floyd et al., 2000), its application in the context of online learning remained underexplored. Most existing research concentrated on traditional educational settings, thus overlooking the potential influence of online platforms on students' attitudes, subjective norms, and perceived behavioral control. This study aimed to fill this research gap by investigating how online learning environments shaped Thai university students' attitudes toward sustainability and cultural awareness, ultimately supporting their development as global citizens.

| Attitudes: Online Learning Environment Shaping students' attitude | Subjective Norms: Encourages and engagement to the sustainability and cultural awareness | Perceived Behavioral Control: Students' beliefs about their ability to engage online learning environment prepares students to take action | Intention to develop as global citizenship Attitudes, subjective norms, and perceived behavioral control influence the intention to develop as global citizens. |

Figure 1 Research Framework developed from TPB Model from Ajzen (1991)

This study highlighted the pivotal role of higher education in promoting sustainability and global citizenship through the integration of innovative online learning approaches. By incorporating diverse cultural perspectives and environmental frameworks, universities were better positioned to equip students with the necessary skills to navigate complex global challenges. Furthermore, the research examined the impact of UK environmental frameworks on enhancing Thai university students' understanding of sustainability and global citizenship, demonstrating how exposure to international environmental practices elevated students' awareness and fostered more informed and responsible actions.

4. Research Methodology

4.1 Research Design

This research utilized a qualitative design to investigate the connections between online learning environments, sustainability, and cultural awareness among university students in Thailand. The emphasis was on collecting comprehensive insights into students' experiences, attitudes, and perceptions related to their interaction with UK environmental frameworks via online learning.

4.2 Informants

The study informants comprised 19 Thai university students who participated in online learning environments focused on sustainability and cultural awareness. In addition, a focus group consisting of six members was established to facilitate in-depth group discussions. Participants was selected using purposive sampling to ensure a diverse range of perspectives, considering their varying levels of experience with online learning related to sustainability.

4.3 Research Instrument

Qualitative data were collected through semi-structured interviews and focus group discussions. The interview protocol included open-ended questions designed to explore students' attitudes toward sustainability, their level of cultural awareness, and their experiences within online learning environments. The focus group discussions facilitated collaborative dialogue, providing deeper insights into collective experiences and shared perspectives. The list of interview and focus-group questions was developed based on a thorough review of the literature and comprised open-ended questions to elicit rich, detailed responses from participants.

4.4 Data Collection

Data collection involved conducting comprehensive interviews with 19 Thai university students from 2 universities to explore their personal experiences and perspectives. In addition, a focus group comprising six Thai university students was convened to enrich the dataset through interactive discussions and shared reflections. All interviews and focus group sessions were audio-recorded, transcribed verbatim, and analyzed using thematic analysis to identify key patterns and insights.

4.5 Data Analysis

Qualitative data were analyzed using thematic analysis, which involved systematically coding the transcripts to identify emergent themes related to students' experiences and perceptions (Braun & Clarke, 2006; Nowell et al., 2017). This approach illuminated how online learning influenced students' attitudes toward sustainability and contributed to their development as global citizens. The analysis provided insights into the interplay between educational experiences and the cultivation of global citizenship, particularly in the context of sustainability education.

5. Research Findings

This section presents the findings derived from qualitative data collected through in-depth interviews with 19 Thai university students and a focus group comprising 6 participants. The data were analyzed using thematic analysis, which identified several salient themes related to students' experiences with online learning, sustainability, cultural awareness, and their development as global citizens. The results were interpreted through the lens of the Theory of Planned Behavior (TPB), providing a theoretical framework for understanding how students' attitudes, subjective norms, and perceived behavioral control influenced their intentions and behaviors within the context of sustainability education and global citizenship.

5.1 Engagement with Sustainability

According to the Theory of Planned Behavior (TPB), students' attitudes toward sustainability were significantly influenced by their participation in the food waste poster competition. Many participants reported increased self-reflection on their own food waste practices, as exemplified by one student who noted, "I learned a lot about how much food is wasted every year and how poor people face the repercussions" (Participant #2). This heightened awareness suggested a positive shift in attitudes toward sustainable behaviors, which was essential for fostering the intention to engage in sustainable practices.

5.2 Cultural Awareness and Learning Experience

The focus group discussions emphasized the critical role of cultural exchange in shaping students' perceptions of sustainability, aligning with the subjective norms component of the Theory of Planned Behavior (TPB). Participants highlighted that collaborating with peers from diverse cultural backgrounds enriched their understanding of various sustainability practices. One student expressed this sentiment, stating, "I gained a lot of different perspectives from students of each nationality, which helped broaden my views and knowledge" (Participant #2). Exposure to a variety of cultural narratives fostered supportive norms that encouraged deeper engagement with sustainability concepts, ultimately enhancing students' identities as global citizens.

5.3 Online Learning Environment

The online learning environment played a pivotal role in facilitating student engagement and collaboration, which subsequently enhanced their perceived behavioral control. Participants noted that digital platforms enabled them to connect with peers and faculty, thereby fostering a sense of community despite the physical separation. One participant commented, "I appreciated seeing how everyone was working hard to create a good poster and learn" (Participant #1).

The online format provided students with essential tools and resources to adopt sustainable practices. The motivation to raise awareness about sustainability was evident, as one participant remarked, "We wanted to show people what it is like to waste food and how important it is" (Participant #4). However, challenges such as time zone differences created barriers to effective collaboration. As one participant observed, "The barrier is the time conflicts… the time slot is very tight" (Participant #6). Such obstacles negatively impacted perceived behavioral control and may influence students' intentions to engage further in global citizenship activities.

5.4 Development of Global Citizenship

The findings indicated that participation in the project positively influenced students' intentions to develop as global citizens, consistent with the Theory of Planned Behavior (TPB). Many participants reported an increased sense of responsibility toward sustainability, as reflected in one student's remark: "As a global graduate, I should be responsible and fair; everything you do has an impact, even a little one" (Participant #5). This demonstrated a shift in mindset, wherein positive attitudes, supportive norms, and enhanced perceived behavioral control collectively contributed to students' growth as global citizens.

Moreover, engagement with UK environmental frameworks through online learning significantly enhanced Thai university students' understanding of sustainability and cultural awareness. The study underscored

how students' attitudes, subjective norms, and perceived behavioral control shaped their intentions and behaviors, highlighting the transformative potential of collaborative online learning in fostering global citizenship. These findings contributed to the discourse on sustainability education and underscored the importance of cultural exchange in cultivating responsible global citizens.

6. Discussion

6.1. Influence of Online Learning on Attitudes

The research findings demonstrated that the online learning environment played a pivotal role in shaping students' attitudes toward sustainability. Participants noted that their interactions with diverse materials and engaging content significantly influenced their perspectives on environmental issues. These findings corroborated previous studies that highlighted the effectiveness of online education in cultivating positive attitudes toward sustainability (Kirkwood & Price, 2014; Farkas, 2019). Exposure to meaningful and contextually relevant content encouraged students to adopt a proactive stance on sustainability, thereby enhancing their understanding of its importance within a global context.

6.2. Subjective Norms and Cultural Awareness

The research findings indicated that subjective norms—defined as perceived social pressures to engage in sustainable practices—were reinforced through interactions within online learning environments. Participants reported that collaborative projects created a supportive atmosphere that emphasized cultural awareness, enhancing their willingness to adopt sustainable behaviors. This observation was consistent with the findings of Dempsey et al. (2018) and Leask (2015), which suggested that collaborative learning fostered an appreciation for diverse viewpoints, thereby promoting a more inclusive understanding of global citizenship. As students engaged in discussions and projects that presented various cultural perspectives on sustainability, they developed an appreciation for diversity, which was a crucial component in their progression as global citizens.

6.3 Perceived Behavioral Control

Another significant finding of this study was the influence of perceived behavioral control on students' intentions to engage in sustainable practices. The online learning environment provided students with the necessary tools and resources, thereby enhancing their sense of self-efficacy in contributing to sustainability initiatives. Participants reported that the digital format enriched their learning experience by allowing them to access information and collaborate with peers and faculty irrespective of geographical constraints. These findings aligned with the Theory of Planned Behavior (TPB), which posited that higher perceived behavioral control led to stronger intentions to perform a given behavior (Ajzen, 1991; Bamberg & Möser, 2007). Consequently, students who felt empowered and equipped with relevant resources were more likely to adopt sustainable behaviors and actively participate in global citizenship.

6.4. Development of Global Citizenship

The integration of sustainability and cultural awareness into the online learning framework was pivotal in cultivating global citizenship among Thai university students. Participants reported a heightened sense of responsibility and commitment to sustainable practices, indicating a transformation in their self-perception and identity as global citizens. These findings were consistent with Hahn's (2018) research, which underscored the critical role of education in fostering a sense of global responsibility and stewardship among students. By engaging with sustainability topics and diverse cultural narratives, students were better equipped to address complex global challenges, thereby enhancing their capacity to contribute meaningfully to a more sustainable and interconnected world (Leask, 2015; Leal Filho et al., 2019).

6.5 Implications for Education

This study emphasized the educational potential of online learning environments in fostering global citizenship by encouraging academic institutions to leverage digital platforms. Integrating diverse cultural perspectives and sustainability topics into curricula significantly enhanced students' understanding and engagement, equipping them with the requisite skills to address complex global socio-environmental challenges (Kirkwood & Price, 2014; Leal Filho et al., 2019). The findings highlighted the critical role of online learning in shaping Thai university students' attitudes toward sustainability and cultural awareness—both of which were essential components of global citizenship. By examining the relationships between attitudes, subjective norms, and perceived behavioral control, this research offered valuable insights for educators seeking to design more impactful learning experiences that promote sustainability and nurture a sense of global citizenship among students (Ajzen, 1991; Dempsey et al., 2018).

7. Suggestions

(1) Future research could explore how students from diverse cultural backgrounds perceived sustainability and global citizenship within online learning environments. Such studies could provide valuable insights into how cultural differences influenced students' understanding and engagement with these topics, potentially identifying specific pedagogical approaches that resonated across varied cultural contexts.

(2) Further research should examine the effectiveness of online learning environments focused on sustainability across different educational systems, such as those in Western and Asian contexts. Comparative studies would help elucidate how systemic and cultural variations impacted the delivery and reception of sustainability education, offering recommendations for optimizing curriculum design and instructional strategies in different regions.

8. Acknowledgement

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Developing Management Guidelines of English Listening Self-Practice Proficiency for Graduate Students Majoring in Educational Administration and Leadership at Dhonburi Rajabhat University

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ABSTRACT

The objectives of this research were: 1) to explore the problems and needs of English listening self-practice proficiency for graduate students majoring in Educational Administration and Leadership, and 2) to develop management guidelines for English listening self–practice proficiency for graduate students majoring in Educational Administration and Leadership. The respondents were 161 graduate students, obtained through a random sampling technique. The research instruments employed in this study were questionnaires and a set of questions for semi-structured interviews. The data were analyzed through content analysis and descriptive statistics.

The findings indicated that: 1) the problem and needs of English listening self-practice proficiency for graduate students majoring in educational administration and leadership at Dhonburi Rajabhat University were at a "high" level. 2) English listening self-practice Proficiency consisted of five units; namely, Support from Administrators in Developing Students' English Listening Proficiency, Factors Affecting Hearing, Know your Listening Level, How to Choose Listening Materials, and Correct Steps for Listening Practice. All five units were evaluated by the 3 specialists in terms of suitability and correctness, meaning the developed management guidelines for graduate students were acceptable and could be used for English listening self-practice for graduate students.

KEYWORDS: Management guidelines, English listening self-practice proficiency, Graduate students

1. Introduction

Due to the need for learning, English has become an indispensable tool for accessing information and improving grades. However, due to various reasons, low English levels have become a major obstacle to students' improvement and progress. Because of that, we need to formulate management guidelines, to deal with various problems we encounter in English language learning and listening. Listening is the most important part of language learning and the only entrance for input. If you can't hear or understand, you can't express yourself effectively.

Listening is the most difficult point in English learning. The difficulty of listening lies in that it is an abstract sound that disappears in an instant. The sound is invisible and traceless, and it flashes by, and it does not allow you to stop and think carefully and translate. Therefore, although many people have learned English for a long time, they feel terrified when they hear English. But as long as you practice repeatedly, your listening skills will improve. Listening is the key to English learning and the most challenging part. If you can make a breakthrough in listening, your English level will be greatly improved. English is a very important language in daily life as well as in studies, and you can see English everywhere. English is also a particularly important subject in learning and self-improvement. Listening is one of the most important skills in English language learning (Gilakjani & Sabouri, 2016, pp. 123-133).

In English learning, listening, speaking, reading, and writing as the four major parts of English learning a prerequisite for English learning, which determines the ability to learn English and the ability to express oneself, in these four parts, listening is the main way to learn to the audio, determines the pronunciation and intonation Listening intensively is quite important to understand the language form of the text as we have to understand both the lexical and grammatical units that lead to form meaning (Saha & Talukdar, 2008, pp. 193-206). In today's society, English is becoming more and more important. With the help of developing technology, English has been playing a major role in many sectors including medicine, engineering, and education (Ilyosovna, 2020, pp. 22-24). English learning is divided into listening, speaking, reading, writing, etc. People often attach great importance to English reading, writing, and speaking, but ignore the important role of listening in daily communication and education. Listening, although important, has long been neglected in second language learning, research, teaching, and assessment. Yildirim & Yildirim (2016, pp. 2094-2110) conducted a research project titled "the importance of listening in language learning and listening comprehension problems experienced by language learners", the result indicated listening plays a significant role in daily communication and educational process. Listening comprehension is essential in the learning process, especially for EFL students. However, the students still tend to have problems in listening comprehension that hinder their learning performance. (Adi & Rosalina, 2022, pp. 12-25). Effective communication depends on how competently a person can use the skills (Ali, 2020, pp. 90-112). As a non -English mother tongue, most students cannot be interested in English learning, and they will not pay more attention to the listening learning of English.

2. Research Objectives

(1) To investigate problems and needs of English listening self-practice proficiency for graduate students majoring in Educational Administration and Leadership at Dhonburi Rajabhat University.

(2) To develop English listening self-practice proficiency for graduate students majoring in Educational Administration and Leadership at Dhonburi Rajabhat University.

3. Literature Review

3.1 Theory, Concept, and Related Research

Management is the process of planning, organizing, directing, and controlling resources, activities, and people within an organization to achieve specific goals. It involves coordinating and overseeing all aspects of the organization, including human resources, finance, operations, and strategy. Effective management involves a combination of technical skills, interpersonal skills, and decision-making abilities. Fayol (2016) in his book "General and Industrial Management" mentioned that "Management plays a very important part in the government of undertakings: of all undertakings, large or small, industrial, commercial, political, religious or any other". It shows the importance of management.

A management guideline can provide quick and easy reference materials to help. People learn knowledge, solve problems, and improve efficiency. The management guideline is an indispensable reference book for people in various fields. Although management guidelines may have a limited impact, this does not affect its ability to serve as a norm to guide behavior and measures. "Although published guidelines alone may not alter individual practice patterns, it is hoped that these guidelines will serve as a foundation for internal guideline development." (Khatcheressian et al. 2006, pp. 5091-5097).

An English management guideline can help students to learn English systematically and progressively. Students can start with the basic concepts and then move on to more advanced levels of complexity. Students can also review the topics that they have learned and check their progress. (Saunders, 2013, p. 13) mentioned in his article English Language Development: Guidelines for Instruction. American Educator that many resources, such as theory, ELD standards, practitioner experience, and published programs, might provide such guidance.

Guideline provides a comprehensive examination of policy, practice, research, and theory related to English language teaching (ELT) in international contexts. Cummins & Davison (2007, p. 2). International management guideline of English language teaching (Vol. 15). Springer Science & Business Media. Management guidelines in Applied Linguistics provide comprehensive overviews of the key topics in applied linguistics Hyland, & Shaw (2016, pp. 1-615). The Routledge management guideline of English for academic purposes.

As a common language for international communication, English can build bridges between people from different countries and regions. Whether it is business negotiations, academic seminars, or international cooperation, listening to English can effectively help people understand each other's intentions and needs more accurately. Avoid misunderstandings due to language barriers. In the twenty-first century, the entire world has

become narrow, accessible, sharable, and familiar for all the people living on this earth as English is used as a common language even though there are some variations in habits, cultures, traditions, regions, and idiosyncratic aspects. (Rao, 2019, pp. 65-79).

However, improving English listening skills cannot be achieved overnight. This requires continuous learning and active practice. Overcoming problems with pronunciation, accent, and rhythm may take more work, especially if English is not your first language. Fortunately, modern technology provides English language learners with many useful features, such as online courses. Multimedia learning resources help develop listening skills for speech recognition applications. English songs affect improving listening skills for English students. The study of Afriyuninda & Oktaviani's study, (2021, pp. 80-85) showed a positive relationship between the uses of the English language.

3.2 Research Framework

Input	Process	Output
1. Problems and needs of English listening self-practice for Graduate Students. 2. Concepts and Theories related to English listening self-practice proficiency and guidelines for graduate students.	1. Explore the problems and needs of English Listening Self-practice for Graduate Students. 3. Develop English Listening Self-Practice Proficiency Management Guidelines for Graduate Students. 4. In-depth interview to evaluate and adjust self-practice English listening program by 3 experts.	1. Information and data concerning problems and needs of English listening self-practice for graduate students. 2. English listening self-practice proficiency and guidelines for graduate students.

Figure 1 Research Framework

4. Research Methodology

4.1 Research Design

This study used a mixed method: quantitative and qualitative methods.

4.2 Population and Sample

This research was conducted at graduate school of Dhonburi Rajabhat university. The population was 268 students majoring in Dhonburi Rajabhat University.

In this research project, the sample was 161 students (Yamane, 1973, p. 887). The respondents were collected through the random sampling technique.

4.3 Research Instrument

For the investigation of the problems and needs, a questionnaire was employed. In addition, a set of questions for the focus group discussion meetings were also used. The questionnaire was evaluated for its validity through the index of item-objective congruence (IOC). Each question in the questionnaire had an IOC ranging from 0.67 to 1.00 In addition, the reliability of the questionnaire was evaluated through Cronbach's Alpha coefficient which was found at 0.82. (Cronbach, 1951, pp. 297-334).

4.4 Data Collection

For the investigation of problems and needs, the researchers themselves collected the data and information from the sample group online via email. Moreover, the focus group discussion meeting was set to recruit comments, ideas, and suggestions for the correctness and improvement of the management guidelines.

4.5 Data Analysis

1) For the investigation of problems and needs, the data and information collected were analyzed, interpreted, and then presented in terms of frequency, percentage, mean, and standard deviation (S.D.). The five-point Likert rating scale was used to evaluate the level or degree of the respondents' needs and problems. For the rating reference table of the five-point Likert rating scale, see Table 1.

2) For the correctness and improvement of the management guideline, the ideas, suggestions, and comments of the 3 specialists obtained from the focus group discussion meetings, were analyzed and then used to correct and improve the contents of the management guideline.

Table 1 Rating reference table

Weight/Scale	Mean Range	Interpretation
5	4.51-5.00	Highest
4	3.51-4.50	High
3	2.51-3.50	Moderate
2	1.51-2.50	Low
1	1.00-1.50	Lowest

Table 2 Problems of English Listening Encountered by Graduate Students

Items	n=161 $\overline{X}$	S.D.	Level of problems
1. You are not confident in English	3.58	0.45	High
2. You find it hard to calm down and improve your English listening.	4.62	0.44	Highest
3. Online English listening resources are more abundant but hard to screen out qualified teaching materials.	4.66	0.44	Highest
4. English listening sometimes causes you to slow down your learning tasks.	4.00	0.68	High
5. English listening problems create some limitations in interacting with teachers.	4.34	0.45	High
Total	**4.24**	**0.49**	**High**

Table 2 shows that students face some problems at a high level. These problems need to be solved. For example, they face the problem of difficulty in studying calmly. There are many English listening learning resources on the Internet but they have difficulty finding suitable ones. These problems affect their listening ability. Learn and improve themselves and further influence their studies.

Table 3 Needs of English Listening Self-Practice for Graduate Students

Items	n=161		Level of needs
	$\overline{X}$	S.D.	
1. You need to get more English listening training materials.	4.65	0.60	Highest
2. You need to improve your English listening self-practice to help you in your English review.	4.59	0.60	Highest
3. You need English listening self-practice management guidelines to avoid mistakes.	4.44	0.65	High
4. You need to improve your English listening ability to help you interact with classmates and teachers in class.	4.45	0.51	High
5. You need to evaluate your listening progress promptly so that you can adjust your study plan promptly.	4.37	0.43	High
Total	**4.50**	**0.56**	**High**

Table 3 shows that most students need English listening self-practice at a high level. They need more English listening training materials as they want to improve their English listening self-relationship in English practice. They also need effective English listening self-practice, and they want English listening self-practice to be more flexible. The needs are what they urgently need at the moment.

Table 4 The five chapters of the contents of the management guidelines for English listening self-practice proficiency for graduate students and the Index of item objective congruence (IOC)

Topics/contents	IOC
Chapter 1: Support from Administrators in Developing	
English Listening Proficiency	
1.1 Problem Analysis	1.00
1.2 Role of the Administrators and English Teachers in Promoting English Listening Proficiency for Graduate School	1.00
Chapter 2: Factors Affecting Hearing	
2.1 Vocabulary for Educational Administration	1.00
2.2 Pronunciation Rules	1.00
2.3 Grammatical Structure	1.00
2.4 Context Information	1.00
2.5 Attention and Mentality	1.00

Topics/contents	IOC
Chapter 3 Know Your Listening Level	
3.1 Assessment criteria for listening level	0.67
3.2 Testing methods for listening level	1.00
3.3 Analysis and reflection on the listening level	1.00
Chapter 4 How to Choose Listening Materials	
4.1 Principles of difficulty of listening materials	1.00
4.2 Principles of types of listening materials	1.00
4.3 Principles of sources of listening materials	0.67
4.4 Recommended list of listening materials	0.67
Chapter 5 Correct steps for listening practice	
5.1 Question review skills	1.00
4.2 Forecasting skills	1.00
4.3 Tracking skills	0.67
4.4 Question-Answering Techniques	1.00
4.5 Review skills	1.00

5. The Summary of in-depth interview with the three experts

After interviews with specialists, it was found that they put forward relevant and constructive management opinions and suggestions. In terms of management, especially self-management, students should establish self-goals and formulate clear study plans. It is essential for self-practice English listening. At the same time, they pointed out that clear study plans and goals can help students be more motivated to persist in practice instead of blindly practicing listening.

6. Discussion

This research was conducted on the difficulties and needs encountered by graduate students at Dhonburi Rajabhat University in Thailand, and management guidelines were created based on their problems and needs, which will benefit graduate students at Dhonburi Rajabhat University. They can use this research as a reference to improve their English listening and practice English listening self-practice according to the management guidelines and improve their listening level.

Students have various problems and needs. They need to improve their English listening skills. This is necessary. They can improve through self-practice in English listening and combine it with management guidelines training. Students feel that English listening courses are diverse in resources and materials, but it is difficult to improve their English listening skills. Besides, they find it hard to calm down to improve their English listening skills. These problems are at the level "highest. This may be because the sources, contents, and forms of online English listening resources vary, making it difficult for learners to judge which resources are reliable, useful, and suitable. Although online English listening resources are more abundant, they cannot screen out

qualified teaching materials to learn English. Students feel that listening to English is difficult, and they are not confident in English. This corresponds to the study of Huda, M.C., Janattaka, N. & Prayoga, N. A. (2023, pp. 794-804), who stated that online resources for the English language are vital for students, and can help them overcome the challenges of improving students' proficiency level in English.

In order to solve related problems, students should abide by and listen to the teacher's opinions and suggestions, and conduct scientific and reasonable English listening self-practice in conjunction with this management guideline to improve the current English level and weak English listening self-practice. Students study actively and use their spare time to practice English listening self-practice. According to their actual situation, they designate reasonable plans and practice step-by-step and down-to-earth English listening self-practice to improve their English listening level. Students find it hard to calm down and improve their English listening the problem level is the "highest" This may be because the sources, contents, and forms of online English listening resources vary, making it difficult for learners to judge which resources are reliable, useful, and suitable for them. Students feel that online English listening resources are more abundant but hard to screen out the qualified teaching, at the level "highest". This may be due to a lack of sufficient motivation, interest, and confidence to learn English listening. The results show that they are hard to calm down and improve English listening.

The self-practice method may provide an effective way for students to develop their English oral communication skills successfully (Lajuni & Chin, 2007, pp. 14-20).

Most students think they need to get more English listening training materials. Their demand level is at the "highest" level, which shows that this is an urgent problem that needs to be solved. They urgently need management guidelines to make up for their shortcomings in English listening skills, to adapt to the English teaching at Dhonburi Rajabhat University, and to improve their grades.

Students need English listening self-practice for after-class review, and their demand level is at the "highest" level.

After reviewing the literature, it was found that many scholars' opinions can be corroborated. Students have weaker learning abilities. Most of the graduate students are teachers or other industry personnel who have been working for a long time. Their purposes are to obtain professional titles or promotions to obtain a better salary level; however, most of them have poor English backgrounds, resulting in limitations in their learning progress and acceptance of new knowledge, so that class progress is slow. Their English proficiency is limited. English language proficiency is associated with academics (Stephen & Jordaan, 2004, pp. 42-53). Many people do not review and use English after graduation or even work because they have no work needs. This is a problem. As a result, their English professional ability has declined. Some students have a low foundation in English. In addition, they have not used English for many years, and their English level is worrying. This further affects the quality of their learning and the performance of teachers' teaching skills.

7. Suggestions

1) Administrators and teachers should seek truth from facts, analyze specific problems in detail, and find suitable solutions according to different situations. More importantly, students should improve their level rather than mechanically implement plans based on books.

2) In terms of teachers implementing management policies, they can encourage students and establish a reward system, such as setting some small goals and giving themselves some rewards every time they complete a goal. This can motivate students to keep up their listening practice. In addition, using collective learning methods, such as setting up English study groups or participating in English corners, so that students can supervise each other, encourage each other, and make progress together. Regularly organize some listening competitions or activities to provide students with opportunities to demonstrate their listening skills, and also to stimulate their interest and motivation in learning.

3) The need to create management guidelines for English listening self-practice for graduate students of Dhonburi Rajabhat University is high. Most students think they need to get more English listening training materials at the "highest" level, which shows that this is an urgent problem that needs to be solved. They need more English listening practice materials, and then improve their English level through self-practice in English listening. English listening and speaking are also essential in English learning (Liu & Chu, 2010).

8. Acknowledgement

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Room 3:

Liberal Arts

An Analysis of Intercultural Communication of Thai Ship Port Staff
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ABSTRACT

Cruise tourism operates worldwide, and passengers from different countries visit various ports of call during their cruise, making it imperative for ship port staff to be fluent in English and communicate effectively across cultures. However, there is a lack of study regarding the intercultural communication of Thai ship port staff. This study sought to determine the level of intercultural communicative competence among Thai ship port staff. The study employed intercultural communicative competence frameworks developed by Barrett et al. (2013) and Byram (2020). The data collection covered a four-month period, from April to July 2024, with a sample of 400 crew members from Thai ports of call through an online intercultural communicative competence test. All test items were validated by cruise experts to ensure appropriate operational contexts. It was found that their intercultural communicative competence was moderate in terms of attitude and skills. However, their knowledge and understanding, and action were considered low. This study yields pedagogical implications for educational institutions countrywide to make intercultural communication mandatory, in order to equip their graduates with effective intercultural communication. Furthermore, this study offers practical recommendations for the Thai government and business sectors to improve the intercultural communication of current and potential ship port staff.

KEYWORDS: intercultural communication, Thai ship port staff, cruise tourism

1. Introduction

Cruise tourism has experienced substantial growth in the 21st century, with a marked increase in the global number of cruise passengers (Sun et al., 2011). As a result, cruise manufacturers have constructed additional cruise ships to meet the substantial demand, resulting in a rise in employment prospects within the cruise sector. The global cruise business can be broadly categorized into two primary sectors. The initial category encompasses onboard operations, wherein crew members have diverse roles such as waiters, housekeepers, butlers, bartenders, and casino personnel, among others. The crew members function in a diverse ethnic setting, aiding cruise passengers from numerous different backgrounds. Consequently, these crew members must exhibit a high degree of English fluency and show strong multicultural communication abilities (Nomnian, 2014). The second sector examined in this study pertains to port-of-call operations, where cruise ships berth at piers in many foreign locations, allowing passengers to disembark and explore local attractions. Since cruise passengers are permitted to visit ports of call, ship port staff must deliver services to cruise passengers during embarkation and disembarkation.

In recent decades, intercultural communication has received significant attention from experts in applied linguistics, English communication, and hospitality (Deardorff, 2006; Gibson & Zhong, 2005). Nonetheless, the majority of scholars emphasized intercultural communication pedagogy, encompassing curriculum creation and the education of students and teachers (Hsu et al., 2017). For instance, King and Bailey (2021) examined the intercultural communication of international students in U.S. higher education, Mikkonen et al. (2020) analyzed teachers' experiences of intercultural communicative competence while mentoring nursing students in Finland, and Ou and Gu (2020) investigated the intercultural communication practices of international and Chinese students. Due to the predominant emphasis on education in these studies, contemporary intercultural communication research within professional contexts is deemed inadequate (Inkaew, 2016).

In Thailand, while there is a greater volume of intercultural communication studies today than in previous decades, many of these studies concentrate on pedagogical contexts. Notable examples include Phongsirikul and Thongrin (2019), who examined students' attitudes towards their intercultural learning experiences in English classes; Wattanavorakijkul (2020), who assessed the intercultural sensitivity of Thai university students engaged in work and travel programs in the U.S.; and Nomnian and Jhaiyanuntana (2020), who explored the intercultural communication challenges and strategies of Thai undergraduate hotel interns.

Nonetheless, there exists a paucity of research regarding intercultural communication in workplaces in Thailand. Inkaew (2016) examined the degree of intercultural communicative skills among hotel front office personnel in Thailand.

Anantamongkolkul et al. (2019) examined the utilization of intercultural competency by local Thais to meet the requirements of long-term international tourists. Semchuchot et al. (2021) examined the multicultural sensitivity of Thai flight attendants during interactions with Muslim passengers. Consequently, research on intercultural communication within professional settings remains insufficiently examined. The literature review on studies in Thailand indicated a scarcity of research regarding cruise crew people. Multiple studies have

highlighted the behaviors of cruise passengers and the expansion of ports of call (Thangthong, 2011; 2016; 2017; Cheewatragoongit et al., 2018; Esichaikul et al., 2019; Thangthong et al., 2019; Thangthong & Khuanmuang, 2020; Khuanmuang, 2022). Nonetheless, none of them investigated the intercultural communicative competence of dock officials. Since ship port staff members act as the primary ambassadors of the firm, interacting directly with passengers from many cultural backgrounds, therefore, their intercultural communicative competence is worth exploring.

2. Research Objective

To evaluate the level of intercultural communicative competence among Thai ship port staff

3. Literature Review

Intercultural component model

The Intercultural Component Model, developed by Barrett et al. (2013), provides a framework to enhance intercultural communication in multicultural contexts. This approach consists of four categories of intercultural competence: attitude, knowledge and understanding, skill, and action. Barrett et al. (2013) posited that action may be the most crucial component. The other three components will not yield results without action from individuals. In other words, numerous individuals often exhibit attitudes, knowledge, understanding, and skills as intercultural communicators. Nevertheless, they may be reluctant to engage in intercultural actions. Consequently, all four components must be implemented and executed through actions anytime individuals face intercultural settings (Barrett et al., 2013). The Council of Europe (2009) has affirmed that action is a vital element in attaining a high level of intercultural communication skills.

Attitude

The primary domain is attitude. Individuals with a robust intercultural disposition celebrate the diversity of cultures, perspectives, and social customs. Utilizing the objective-based approach (Byram, 2020), the five objectives for evaluating the attitudes are: (1) to celebrate cultural diversity, perspectives, and social practices; (2) to show respect for individuals with differing cultural characteristics; (3) to demonstrate open-mindedness, curiosity, and a desire to learn about new cultures.

Knowledge and understanding

The second domain pertains to knowledge and comprehension. Individuals possessing profound knowledge and comprehension of several civilizations endeavor to grasp the authenticity of various cultural expressions. Utilizing the objective-based approach (Byram, 2020), the five objectives for evaluating the knowledge and understanding of Thai ship port staff are to assess their comprehension (1) of the authenticity of diverse cultures; (2) of the awareness regarding various perceptions of their own or other cultures; (3) that the expression of ideas in one's own or other languages may impact individuals from different cultures differently.

Skills

The third domain pertains to skill. Individuals adept in navigating intercultural interactions can effectively decentralize their egos. They are receptive to listening to and contemplating others' perspectives. The objective-based approach (Byram, 2020) delineates five objectives for evaluating the proficiency of Thai ship dock staff: (1) managing intercultural exchanges by diminishing their ego; (2) acquiring information regarding their own and other cultures.

Action

The final domain is action. Individuals proficient in intercultural communication proactively seek opportunities to interact with individuals from diverse cultures. Utilizing the objective-based approach (Byram, 2020), the five objectives for evaluating the actions of Thai ship port staff are: (1) identifying opportunities to engage with individuals from diverse cultures; (2) interacting appropriately and respectfully following the cultural norms of those they engage with; (3) collaborating with individuals holding differing viewpoints, beliefs, or practices to reach consensus during shared activities.

4. Research Methodology

4.1 Participants

The population in this study comprised Thai ship port staff employed in service-related roles under contract with two licensed port agencies in Thailand. Due to the indeterminate population of ship port staff contracted through these agencies, a minimum of 400 respondents was necessary to achieve 95 percent dependability of the findings, as determined by Cochran's sample size formula (Cochran, 1977). Consequently, 400 random informants participated in this study.

4.2 Instruments

Upon examining the literature, the authors identified the Intercultural Competent Model (Barrett et al., 2013) as the most appropriate framework for evaluating intercultural communicative competence. Nevertheless, certain modifications were implemented for application in the context of Thai ship port staff. The adaption of each questionnaire item was based on grounded data obtained from pilot interviews with ten Thai ship port staff. This enabled the authors to acquire insights into the operational activities and daily life professionals in this context. The question items were thereafter provided with diverse intercultural scenarios relevant to the setting of Thai ship port staff. This was executed to extract the respondents' subconscious intercultural communicative competence based on the objective-based approach (Byram, 2020).

Upon completion of the customized questionnaire, each item was evaluated by three recruiting managers from cruise line services to ensure appropriate content. The questionnaire was conducted in Thai to eliminate potential language difficulties. The Thai version questionnaire was proofread by two university instructors specializing in English-Thai translation to guarantee linguistic clarity and comprehensibility. Furthermore, the reliability of the scale was assessed for each domain of the Intercultural Component Model (Barrett et al., 2013). The questionnaire's reliability exceeded 0.8, considered an excellent level. Consequently, the scale was deemed adequate (Ursachi, Horodnic & Zait, 2015).

The survey comprised two sections. The initial section comprised items pertaining to the respondents' demographic information. The second section consisted of 20 items designed to evaluate their intercultural communicative competence. Five-point Likert scales (Likert, 1932) ranged from 1 to 5. The responses were rated as follows: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree). Five traits were categorized under each of the four domains of the Intercultural Component Model (Barrett et al., 2013): attitudes (items 1-5), knowledge and understanding (items 6-10), abilities (items 11-15), and actions (items 16-20).

4.3 Data Collection

The data collection took place from April to July 2024 through online surveys disseminated to Thai ship port personnel employed by Thai port agencies. The link to the online survey was distributed via email to randomly selected responders, with assistance from the human resources personnel of both agents. The participants were notified that their answers would not influence their job performance. Furthermore, they were not required to disclose their personal information. Their responses will remain confidential.

4.4 Data analysis

The initial segment of the survey was examined using frequencies and percentages to ascertain the background of the participants' intercultural communicative competence. The data from the survey's second section was analyzed utilizing the Statistical Package for the Social Sciences (SPSS) software. The survey findings were analyzed using means and standard deviations to assess the respondents' intercultural communicative competency levels. Criteria for levels of intercultural communicative ability were established in five tiers based on the mean scores for data interpretation. 1.00-1.80 = "extremely low," 1.81-2.60 = "low," 2.61-3.40 = "moderate." 3.41-4.20 = "high," while 4.21-5.00 = "very high."

5. Research Findings

The initial section of the online survey encompassed respondents' demographic information. A total of 295 male respondents (73.75%) and 105 female respondents (26.25%) were identified. Their ages ranged from 29 to 55 years. A majority of 202 respondents (50.50%) had been employed by the organization for a duration of 6 to 10 years. The subsequent section of the online survey assessed participants' intercultural communicative competence according to the four categories of the Intercultural Component Model (Barrett et al., 2013) - attitude, knowledge and understanding, skill, and action. The results are presented as follows.

Table 1 Overall Intercultural Communicative Competence

Qualities	Means	SD.	Interpretation
Attitude	3.21	1.25	moderate
Knowledge and understanding	2.54	0.92	low
Skills	2.90	1.54	Moderate
Action	2.26	1.15	low

Table 1 illustrates that Thai ship port' overall intercultural communicative competence was low to moderate. Although their attitude and skills were considered moderate, the attitude received a higher score. In contrast, skills and action were considered low. Table 2 shows the qualities within each domain: items 1-3 represent attitude, items 4-6 portray knowledge and understanding, items 7-9 reflect skills, and items 10-12 index action.

Table 2 Intercultural Communicative Competence Based on All Qualities

Items	Situations	Means	SD.	Interpretation
1	I think it is natural to offer services to male travelers before female ones.	3.25	1.45	Moderate
2	I think the elderly traveling alone is rather natural.	3.15	1.12	Moderate
3	Handling travelers from countries I do not know always makes me study the cultures of those countries.	3.33	1.06	Moderate
4	I understand that North American travelers could be Asians and might not speak English fluently.	2.42	1.45	Low
5	Speaking English with a Thai accent is distinctive, and I enjoy listening to various accents from non-native English speakers.	2.58	1.36	Low
6	When Jewish or Muslim travelers are on board, I understand they require particular meals and spaces to carry out their rites.	2.64	1.54	Moderate
7	I will not touch certain foreigners' heads as, in terms of respect, they may believe like many Thais that the head is the highest point in the body.	2.91	0.95	Moderate
8	I won't speak Thai with my Thai coworkers when a foreigner is close by.	2.85	1.12	Moderate
9	Learning about global and local cultures is just as important as it will help me interact with others naturally.	2.95	0.78	Moderate
10	I would not explain Thai culture to a traveler who dropped a Buddha image they purchased from a gift store on the ground.	2.23	0.87	Low
11	I handle disabled passengers the same way I treat regular passengers.	1.95	0.95	Low
12	I will not discuss topics that are sensitive to travelers from countries experiencing political unrest.	2.60	1.24	Low

The data in Table 2 reveals that Thai ship port staff possessed a moderate level of intercultural communicative competence in terms of their attitude (mean score = 3.21). Their competence was ranked the highest in their attitude towards broad-mindedness, curiosity, and willingness to learn about new cultures. The findings showcase the participants' knowledge and understanding of intercultural communication. It was found that they had a low level of intercultural communication knowledge and understanding in general (mean score =

2.54). Additionally, the participants' level of intercultural communicative competence in terms of skills was found to be moderate (mean score = 2.90). The data also points out that their skill in finding information about their own and other cultures obtained the highest mean score of 4.49. Lastly, the data demonstrates that the participants possessed a low level of intercultural communicative competence in terms of their action (mean score = 2.26).

6. Discussions

To reach the objective: "to examine the level of intercultural communicative competence of Thai ship port staff," the four domains of the Intercultural Component Model (Barrett et al., 2013) were measured. The participants' attitude towards intercultural communication was moderate in terms of glorifying diversity of cultures, viewpoints, and social practices. Many of them believed that female passengers should receive services before males. However, in male-dominated cultures, males are known to receive privileges, including services, before females. By contrast, the participants were competent in terms of attitude towards being broadminded, curious, and willing to learn about new cultures as well as to tolerate practices that seem ambiguous and inconsistent in different cultures. This shows that their level of attitudinal intercultural communicative competence was inconsistent, probably because they had no formal education of intercultural communication. This affected to some degree the way they perceived different intercultural occurrences.

When it comes to actions, Thai ship port staff's intercultural actions scored the lowest among the four domains of the Intercultural Component Model (Barrett et al., 2013). Their action in appropriate and respectful interaction according to the culture of the people they were interacting with scored the lowest in the action domain. Many of them agreed to explain to their passengers the inappropriateness of placing a souvenir Buddha image on the floor. This shows that the participants did not respect the passengers' cultures in they regarded the Buddha image they had bought from a gift shop as a souvenir. This also indicates that many Thai ship port staff members were unsure about their actions although they were competent in their intercultural knowledge and understanding. Such findings confirmed the results from Phongsirikul and Thongrin (2019) who discovered that despite Thai students' positive attitudes towards their intercultural communication learning, they were hesitant to put their knowledge into action. This can possibly be explained that Thais seem to be collectivists. Thus, they were afraid to make mistakes among their group members. Simply put, their collectivism affected their actions. By contrast, the findings in this study were opposed to those by Semchuchot et al. (2021) who explored how Thai flight attendants conversed with Muslim passengers. They found that these flight attendants knew which topic was interculturally sensitive or appropriate to talk to Muslim passengers. Thus, they were confident to converse with these passengers. This is probably because many international airlines provide flight attendants with intercultural communication training. Therefore, they have the confidence to act interculturally.

The intercultural communication skills of Thai ship port staff were low when it came to their skill in finding information about their own and other cultures and their skill in interpreting and synthesizing information about their own and other cultures. Such notions support the results of Anantamongkolkul et al. (2019) who found that when the local Thais were skillful in intercultural communication, they were able to be aware of the different

perceptions and practices of long-stay international tourists. They were also able to synthesize other cultures with their own. All in all, although their overall intercultural communication skills were considered high, they can improve their skills in terms of decentralizing their ego and embracing new cultures as well as adapting themselves when they encounter intercultural situations. This was affirmed by Ou and Gu (2020) who found when students were well equipped with intercultural communication training, multicultural-aware students were more skillful in linguistically adapting themselves to multicultural situations better than local-minded students. By contrast, such findings were different from those by Nomnian and Jhaiyanuntana (2020) who found that Thai undergraduate hotel trainees had difficulties implementing their skills to discover new cultural knowledge and interact with international hotel guests. This could be because the participants were much more experienced in the multicultural atmosphere than undergraduate hotel trainees. This shows that the participants had the potential to excel in this domain if they had received proper intercultural communication education. Once they are formally trained, they could have more consistency in all the five attributes of the skill domain to some extent.

Thai ship port staff's knowledge and understanding of intercultural communication was low. To explain, their knowledge and understanding of the authenticity of different cultures were moderate. Many of them were unaware that passengers from North America may be of Asian descent and may not speak English fluently. Also, they scored low in terms of their knowledge and understanding that people of different cultural orientations may have their own ways of beliefs and practices. Many of them were unaware that Jewish or Muslim passengers need special meals and special places to perform their rituals when they are aboard. To explain such a phenomenon, their intercultural communication knowledge and understanding were inconsistent probably because they learned by themselves at the workplace and through their private life. As a result, they might have been unsure about what was right or wrong. Such notions support the findings by Inkaew (2016) who also discovered that Thai hotel front office workers were the most ignorant in their knowledge and understanding of intercultural communication. Consequently, the participants should be provided with formal instructions regarding intercultural communication, so that they can learn systematically and gain more confidence when they encounter intercultural exchanges.

6.1 Suggestions and Implications

The study's findings yield multiple recommendations for future studies. While the findings of this study can be generalized due to the quantitative research approach, employing a qualitative design that utilizes interviews and observations to gather data may produce compelling results. Secondly, given that most participants in this study had been employed as Thai port workers for six to ten years, subsequent research could focus on individuals with less experience, such as trainees or students specializing in cruise service operations. As these novices are about to enter the cruise service business, their intercultural communication skills require investigation. Thirdly, the scenario presented for each questionnaire item in this study represented only one of the several options within the setting of Thai ship port personnel. Subsequent research may modify these conditions to ascertain if the outcomes would vary. Lastly, the survey was conducted without incorporating the perspectives of cruise passengers and stakeholders. Future studies may incorporate these into their analyses.

Given that intercultural communicative ability in a professional environment, particularly within the cruise service industry, remains underexamined in Thailand, the results of this study contribute academically by addressing this gap in the literature. English language educators ought to incorporate multicultural communication into their instructional practices. The study's findings indicated that intercultural communication should be compulsory for all students, not alone for those majoring in language and tourism. This is due to the fact that professionals in the cruise tourism sector possess interdisciplinary educational backgrounds. This study presents professional implications for current and prospective Thai ship port staff to contemplate and equip themselves for this culturally varied workplace. This study may provide a framework for cruise line recruitment agencies, educators, and stakeholders in Thailand to develop effective training programs.

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Impacts of Geographical Indications on Memory Retention

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ABSTRACT

Recently, Department of Intellectual Property (DIP) of Thailand has proposed the key concepts of Geographical Indication (GI), and subsequently, released the comprehensive list of GI products throughout the country ("One Province, One Geographical Indication") to add value to the agricultural products and traditional knowledge of particular geographical areas. Based on theoretical framework of how human brains encodes, or mentally program, this GI concept has, to some extent, changed the landscape of local marketing, to niche marketing with the GI products as local mementoes. However, what if there is an area where Geographical Indication is absent? This study elucidates the connections between Geographic Indication and its impacts on memory retention of the customers, or even brand salience. For this purpose, Ranong province where GI product is absent, was selected. As the province itself is renowned for its rich variety of chemosensory products, the study also examined the extent to which the sensory experience alone could achieve the prominence level of activation in the customer's memory. Following a pilot study, all participants (N=120) were recruited and an anonymous online survey was adopted, from April to May 2024. An analysis of variance (ANOVA), with a 95% confidence interval (CI), was used for analysis, followed by Fisher's post-hoc analysis. The results confirmed the impacts of GI on memory retention, and suggested how chemosensory products could be developed further to benefit tourism sectors and the field of advertising and marketing of the province.

KEYWORDS: Advertising, Marketing, Geographic Indication

1. Introduction

Human memory retention has been predisposed to local mementoes. That being said, local mementoes are not simply being a tangible reminder of physical location as its magical ability supplants the then-experience it brings along. Theoretically, human cognitive process, in its simplest form, involves learning, memory retention and recall, with sensory experience among the major contributors to language development (Wang, Y., 2023), and with the connection between multisensory information and memory retention (Quak, M., London, R., & Talsma, D., 2015). Hence, in tourism industry, it is not surprising to find gustatory delights have always been linked to an increase in travel satisfaction and positive word of mouth (Stone, M., Soulard, J., Migacz, S., & Wolf, E., 2017), and foods are often regarded as ideal mementoes of memorable local food consumption experiences (Suhartanto, D., Dean, D., Sosianika, A., & Suhaeni, T., 2018), and it is not uncommon to find today's tourism competitive markets grappling this concept to attract

tourists while garnering commodifying culture into tourist destinations (Agarwal, R., & Kariyapol, T., 2018; Coŝkun, G., 2021; Nurhadi, I., Sumarti, T., Dharmawan, A., & Damanhuri, D., 2022; Wang, D., Liu, A., Cheung, C., 2024).

In Thailand, for instance, a recent case of Phetchaburi province becoming the latest addition to have earned the UNESCO Creative Cities Network title, following its predecessors renowned as a city of gastronomy activity, including Bangkok, Chiang Mai, Phuket and Sukhothai, has not only introduced several local foods to the public, but also deliberately combined its delectable cuisine with the savory, sweet, and tangy flavors with the exploration of the various attractions, namely, the storytelling of food (Maya, K., Yomsithat, R., Hiran-Akkharawong, I., Thimthong, S., Masavang, S., &Dangsungwal, N., 2023). However, to a certain extent, the studies elucidating the connections between the types of mementoes and its impacts on memory retention of individual experiences towards a destination remain nascent.

2. Research Objective

(1) To elucidate the connection between tourist attractions and local products and memory retention towards Ranong province

(2) To further explicate the aforementioned relationship and the extent such impressions could be developed when certified as Geographic Indication

3. Literature Review

3.1 Theory, Concept and Related Research

The conceptual framework of this study draws upon the theoretical underpinnings and recent contributions regarding the research studies on the impact of words in shaping mental inferences; on the olfactory and gustatory sensations towards autobiographical memory; and on place attachment theory.

Firstly, the rationale behind the memory retention of the participants towards the words (each memento) to elicit mental inferences in the survey requires a substantial agreement on the study of memory processes of humans to recall and retain specific details from their past. In this field of study, despite large individual differences in memory performance, several studies investigating the connection between the word imageability and autobiographical memory have been reporting the semantic features of words plays a prominent role in the memory retention performance (Dickerson, B., & Eichenbaum, H. ,2010); Caplan, J., & Madan, C. ,2016; Xie, W., Bainbridge, W., Inati, S., & Bake, C. (2020); Ballot, C., Mathey, S., & Robert, C. ,2021). While studies focusing on word imageability continue to be predominant, accumulating evidences modulating the connection between chemosenses and memory retention, with the links between the olfactory and gustatory cognition and evocative memories beyond basic sensory processing (Larsson, M., Willander, J., Karlsson, K., Arshamian, A., 2014; Race, E., 2016;Haj, M., Gandolphe, M., Gallouj, K., Kapogiannis, D., & Antoine, P., 2018; White, T., Danguin, T., Olofsson, J., Zucco, G., & Prescott, J., 2020; Farruggia, M., Pellegrino, R., &Scheinost, D., 2022). Although several studies suggest different types of information might be relinquished over time, at different rates, as the memory retention concepts do not exist independently of each other but interlinked, certain type of memory recall may still be present when certain content of the information is being recalled, for instance, to retrieve an existing evaluation of the object in a survey (Rettig, T., Blom, A., &Höhne, J.,2022). Specifically, by storing

certain aspects of olfactory and gustatory percepts, humans recall their experience on chemosensory mental imagery olfactory sensation, which is well-known as a powerful reminder of past experiences (Lopis, D., Valentin, D., &Manetta, C., 2023; White, T., Thomas-Danguin, T., Olofsson, J., Zucco, G. & Prescott, J.,2020). By and large, human cognitive processes create and transform memory representations of olfactory or gustatory events, subsequently forming olfactory and gustatory mental images. The olfactory sensation and memory are intertwined as olfactory bulb (OB) ascribes the odors to autobiographical memory (Leiker, E., Riley, E., Barb, S., Lazzaro, S., Compère, L., Webb, C., Canovali, G., & Young, K., 2024) whereas the reciprocal development between food memories and word recognition goes beyond the tasting of food: The tongue remembers the taste buds and gustatory pathway; the nose reminisces the aromas and scents or the olfactory memory; and mind registers the sensations experience and that is how the food lingers in the memory (Stone, M., Soulard, J., Migacz, S., & Wolf, E., 2017; Lee, K., 2023).

Secondly, the studies regarding the olfactory and gustatory sensations towards autobiographical memory report a substantial number of studies in support of olfactory sensations as a potent cue for autobiographical memory retention (Haj, M., Gandolphe, M., Gallouj, K., Kapogiannis, D., & Antoine, P., 2018) while some further posit that olfactory cues are more potent than visual cues (de Bruijn, M., & Bender, M., 2017) and others favours the multisensory perception or chemosensory processing to generate autobiographical memory of such tastes in the absence of peripheral inputs (Villinger, K., Wahl, D., Schupp, H., Renner, B., 2021; Carreiras, M., Quiñones, I., Chen, H., Vázquez-Araujo, L., Small, D., & Frost, R., 2024)

Thirdly, place attachment theory describes the phenomenon whereby people develop the bonding that occurs between people and their meaningful environments. Such people–place bonds to physical environments indicate that when people–place bonds become apparent to a certain extent, the intertwining perceptions establish connections with autobiographical memory, evoking positive feelings and engaging their sensesto the physical site (Schweitzer, R., Glab, H., &Brymer, E., 2018; Inalhan, G., Yang, E., & Weber, C., 2021).
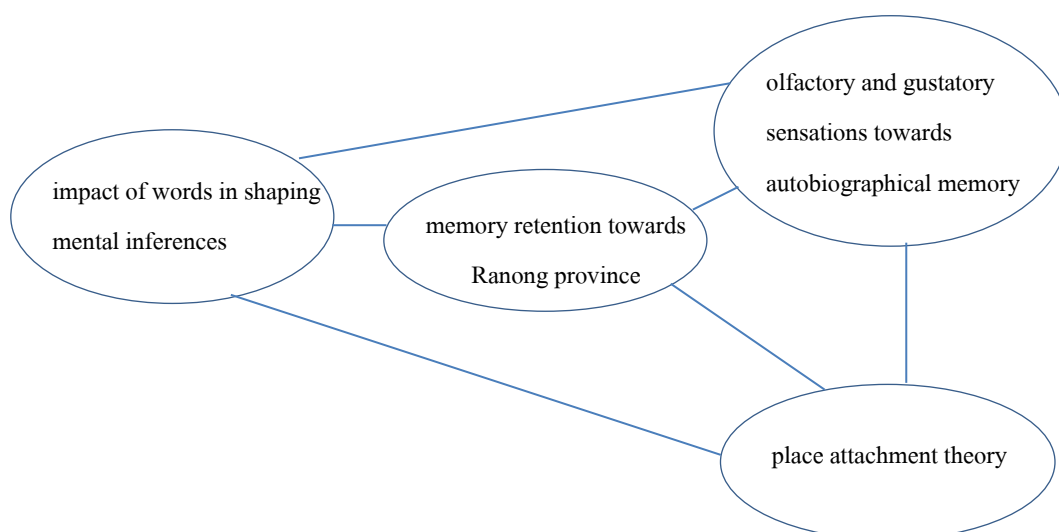
3.2 Research Framework

Figure 1 Research Framework

4. Research Methodology

4.1 Participants

Prior to this study, Ranong natives across age groups (N=31; purposive sampling) participated in a volunteer pilot survey performed to anticipate all the possible answers in regard to the most memorable mementoes related to memory retention of Ranong province. Then, to avoid response bias, the participants in the pilot study were excluded from the final survey population (N=120), and to encourage more honest feedback, any personally identifiable information that could be traced back to any individual were also eliminated from the survey

4.2 Research Design and Data Collection

From the pilot survey, eighteen mementoes were elicited; seven of which entail visual and olfactory sensations whereas eleven of which entail olfactory and gustatory sensations, or chemosenses. Subsequently, after the pilot survey, an anonymous online survey was adopted, using Google Forms, from 11ᵗʰ April 2024 to 12ᵗʰ May 2024. Regardless of age, all participants from purposive sampling (N=120) were divided into three groups, depending on the period of time each of them inhabiting Ranong province: Group 1, or the group of Ranong natives spending all their life in Ranong; Group 2, or the group of non-Ranong natives spending more than two quarters of their life in Ranong (e.g. as spouse; as long-term contract of their career, etc.); and Group 3, or the group of Ranong natives and non-natives occasionally spending their life in Ranong province (e.g. for study purpose, for vacation, for conferences or special events, etc.). The rights to exercise or revoke their voluntary participation were stated clearly in the instruction of the anonymous survey and that the participants could refuse to answer any questions and could withdraw from this research any time. To avoid demographic questions that might forge any traces to the respondents, the survey only collected the information regarding their origin and their inhabiting period, in order to categorize each of them into one of the groups.

All eighteen mementoes collected from the pilot study were administered in the form of multiple-choice selections, on condition that the number of mementoes related to memory retention of Ranong province of the participants was limited to ten. In order to investigate the tripartite of word imageability, its relation to the chemosenses and autobiographical memory retention, a score of zero was assigned to the seven mementoes entailing non-chemosensory sensation, and a score of one, to the eleven mementoes entailing both olfactory and gustatory sensations, or the chemosenses.

4.3 Data Analysis

To delineate the connection between word imageability related to the chemosenses and autobiographical memory retention and that of olfactory alone, an analysis of variance (ANOVA), with a 95% confidence interval (CI), was used to determine whether there are any statistically significant differences of the scores across all groups.

5. Research Findings

The scores of all groups were tabulated in Tables 1 and 2.

Table 1 Descriptive Statistics of the Participants (N=120)

Groups	N	Mean	Std. Dev.	Std. Error	95% CI		Min.	Max.
					Lower B.	Upper B.		
1	25	5.5200	0.96264	0.19253	5.1226	5.9174	4.00	7.00
2	35	6.1143	0.71831	0.12142	5.8675	6.3610	3.00	8.00
3	60	5.6500	1.19071	0.15372	5.3424	5.9576	5.00	8.00
Total	120	5.7583	1.04516	0.09541	5.5694	5.9473	3.00	8.00

Table 2 ANOVA of the Survey Scores

Source	SS	DF	MS	F-stat	P-value
Between Group	6.56	2	3.279	3.108	0.04835
Within Group	123.429	117	1.055		
Total	129.989	119			

Table 1 presents the mean and standard deviation of Group 1, 2 and 3 (M=5.52, SD=0.96; M=6.11, SD=0.71; and M=5.65, SD=1.19, respectively) whereas Table 2 reports the results of ANOVA revealing no statistically significant differences between the group means, $F(2, 117) = 3.108$, p=0.048.

To further explore the difference across the groups, the Fisher's Least significant difference (LSD) Post hoc multiple comparison analysis was carried out (Table 3).

Table 3 Post Hoc Test (Multiple Comparisons)

Dependent Variable: LSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% CI	
					Lower Bound	Upper Bound
1	2	-0.13000	0.24450	0.596	-0.6142	0.3542
	3	-0.59429*	0.26896	0.029	-1.1270	-0.0616
2	1	0.13000	0.24450	0.596	10.3542	0.6142
	3	-0.46429*	0.21846	0.036	-0.8969	-0.0316
3	1	0.59429*	0.26896	0.029	0.0616	1.1270
	2	0.46429*	0.21846	0.036	0.0316	0.8969

*The mean difference is significant at the 0.05 level

Tabulated in Table 3, the results of the Post-hoc LSD multiple comparisons analysis, presented the differences between groups 1 and 2, and between groups 2 and 1 are not significant, although statistically significant differences existed between groups 1 and 3, between groups 2 and 3, between groups 3 and 1, and between 3 and 2.

6. Discussion

Although in the survey, eleven mementoes entailing chemosenses almost ingurgitated the whole list, the findings indicate all participants—with the differences in their origins and their period of time inhabiting Ranong province—reported no statistically significant differences when referring to these mementoes. More interestingly, both Group 1 (Ranong-natives) and Group 2 (non-Ranong natives spending lengthy stay in Ranong did not appear to be fond of their local culinary choices. That being said, the results of the study suggest the connections between both olfactory and gustatory types of mementoes as well as the autobiographical memory retention towards Ranong province while pointing out that the results for the chemosensory mementoes—which were initially considered to potentiate the memory retention of the hedonics of Ranong province among others (as listed by Ranong-natives in the pilot study)—suggest otherwise. In essence, one possible explanation could be that the memory retention was done in the absence of peripheral inputs.

Hence, even though there might have been a substantial number of studies in support of chemosenses to generate autobiographical memory of such tastes even in the absence of peripheral inputs, it can be argued that for gustatory choices to serve as mementoes, the authenticity and indigenousness are required (Stone, M., Soulard, J., Migacz, S., & Wolf, E., 2017; Ghanem, M., 2019; Li, F., 2023), and the familiarity with local food consumption [in this context, among Ranong natives and non-natives with lengthy stay] might have diverged in its appreciation of the local food (Xu, Y., & Zeng, G. 2022). One study also points out that food experiences may result in memory imprints, there has been no evidence to suggest that such connections are universal (Stone, M., Migacz, S., & Sthapit, E., 2022).

7. Suggestions for Further Research

The findings of this study, to a certain extent, agree with the key concept of Geographical Indication (GI) proposed by Department of Intellectual Property (DIP), which seeks to add value to agricultural products, local uniqueness, and traditional knowledge. Based on this concept, all mementoes, or the provincial products proposed by Ranong natives are absent in the list of all GI products residing in a particular geographical area throughout the country (Department of Intellectual Property, 2019). The absence of the authenticity and indigenousness of the provincial mementoes could be resulted from the absence of GI products of the province unveiling their uniqueness and characteristic of the selected products in their geographical area. Further research regarding the relationships between these two, or future research in a more sophisticated scale might be required.

8. Acknowledgement

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Move Analysis of 'Call for Papers' Emails from Potentially Predatory Journals

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ABSTRACT

This study investigates the structure of "call for papers" (CFP) emails from potentially predatory journals. Employing a move analysis framework, the research examines how these emails are crafted to entice researchers into submitting their work. Twenty CFP emails were analyzed, revealing five key moves with constituent steps: 1）Opening, 2）Call to Action, 3）Journal Description, 4）Publication Process, and 5）Closing. The analysis demonstrates that predatory CFP emails mimic the general structure of legitimate CFPs. However, they employ manipulative tactics within each move, such as inflated praise, fabricated credentials, and downplaying the publication process. Recognizing these deceptive strategies can empower researchers to distinguish predatory journals and avoid them and make informed decisions about where to submit their valuable work.

KEYWORDS: move analysis, genre studies, Call for Papers, discourse analysis, predatory journal

1. Introduction

The ever‑evolving landscape of scholarly publishing presents both opportunities and challenges for researchers. While open‑access publishing has provided access to research, it has also created fertile ground for predatory journals. These deceptive publications exploit the desire of academics to disseminate their work, often by mimicking legitimate journals with seemingly prestigious titles and rapid review processes. However, the quality of these publications is often compromised, with questionable peer-review practices and a focus on profit over scholarly integrity.

There has been existing research on predatory journals; interestingly, most of them were written by science or medical sciences scholars (e.g. Tomlinson, 2023; Mercier et al., 2018). Some studies often focused on content analysis, investigating the use of misleading language and deceptive claims of impact factors, while others focused on the overwhelming quantity of emails received. For example, Tomlinson（2023）reported over 1,280 spam emails received during 5 years starting from his first conference attendance. Previous research similarly suggested academic members to be aware of the harmful effects of predatory journals.

Predatory publishing, a term first coined by Jeffrey Beall in 2012, refers to "entities that prioritize self-interest at the expense of scholarship and are characterized by false or misleading information, deviation from best editorial and publication practices, a lack of transparency, and/or the use of aggressive and indiscriminate solicitation practices" (Justin et al., 2024). Identifying predatory journals can be a complex task, particularly for early career researchers or those unfamiliar with specific fields. While various resources like Beall's List (https://beallslist.net/) and Cabell's Predatory Reports (https://cabells.com/) have emerged to warn researchers, predatory journals continuously evolve their tactics. One crucial, yet understudied, element in the predatory journal is the "call for papers" (CFP) email. These emails serve as the initial point of contact, attempting to entice researchers to submit their work. While legitimate journals adhere to ethical guidelines for CFPs, predatory journals often deviate significantly. Swales' (1990) pioneering work on genre analysis provides a framework for discussing the structure and function of various written forms. This framework has been extensively applied to academic writing, including research articles and conference proposals. However, its application to the deceptive genre of predatory journal CFP emails remains unexplored.

As a result, this paper will utilize the theoretical framework of genre analysis, specifically 'move analysis', to examine the structure of CFP emails from potentially predatory journals. As outlined by Swales, move analysis identifies the communicative functions within a specific genre. These moves, often sequential, contribute to the overall goal of the genre. It is expected that a comprehensive understanding of predatory journal CFP email structures can empower researchers, particularly those early in their careers, to make informed decisions about where to submit their work. Hopefully, the findings of this study can be used to develop educational resources and training programs to equip researchers with the tools necessary to identify and avoid predatory journals.

2. Research Objective

(1) To examine the move structure of 'Call for Paper' email from potentially predatory journals.

(2) To identify the constituent steps of 'Call for Paper' emails from predatory journals which make it distinct from the legitimate ones.

3. Literature Review

3.1 Theory, Concept and Related Research

Genre analysis is a branch of applied linguistics that focuses on studying the social function and structural organization of particular types of texts. Genre analysis involves the examination of "moves," which are the functional units that constitute a specific genre. Through the analysis of these moves, researchers can obtain valuable information about the communicative objectives of a particular genre and identify the specific language features linked to those objectives.

The foundational work on move analysis is attributed to John Swales (1990). Swales proposed a framework for analyzing research article introductions, identifying moves like "Establishing the Field,"

"Summarizing Previous Research," and "Introducing Present Research." This framework highlighted the hierarchical organization of genres, with moves further subdivided into steps. Swales' work sparked a surge of research applying move analysis to various genres, including research articles across disciplines (Ötügen et al., 2021), business letters of negotiation (Bhatia, 1993), and student essays (Hyland, 2000).

Following Swales' lead, researchers have developed genre-specific move analysis models. For instance, Narksonthi and Rattanawanitpun (2022) outlined a move structure for movie reviews, including "Giving criticism," "Describing the movie," and "Giving practical information." These genre-specific models demonstrate the versatility of move analysis in uncovering the unique communicative purposes and structures of different text types. Move analysis has also been applied to genres in more contemporary contexts. For instance, studies of online genres, such as blog posts, customer reviews, and social media communication, have explored how new digital genres exhibit hybridized move structures, blending elements of promotional, narrative, and evaluative discourse (Luzón, 2018). Such research underscores how move analysis remains relevant in an age where digital communication increasingly shapes how individuals and organizations communicate.

Beyond genre identification, move analysis also sheds light on the rhetorical strategies employed within a genre. Biber (2007) argues that move analysis, with its focus on communicative purpose, allows researchers to explore how writers use language to achieve specific goals within a genre. For example, the analysis of research article introductions might reveal how authors utilize hedging devices during the "Summarizing Previous Research" move to acknowledge limitations in existing scholarship. This focus on rhetorical strategies allows researchers to delve deeper into the nuanced ways writers shape their texts within a specific genre.

Move analysis has also found applications in teaching writing and second language acquisition. Studies by Johns (1997) and Ahn (2012) demonstrate how genre analysis, coupled with move analysis, can equip learners with the knowledge and skills to produce texts that adhere to the specific conventions of different genres. Similarly, applying move analysis to analyze authentic texts in a target language can help learners develop genre awareness and improve their proficiency in producing genre-appropriate communication.

In conclusion, move analysis has become a cornerstone of genre studies, offering a valuable lens for analyzing the structure, purpose, and rhetorical strategies employed within different text types. From identifying deviations in predatory journal CFP emails to informing writing instruction, move analysis continues to be a powerful tool for researchers and educators alike.

4. Research Methodology

4.1 Text selection

- Source: The data for this study was collected from CFP emails sent to the author's email address. This approach leverages the author's direct experience with predatory journal solicitations and ensures the emails are representative of the current tactics employed.

- Filtering: The author used the words "publish" and "publication" to filter email messages and locate the CFPs. Duplicate emails from the same sender were excluded to avoid redundancy and ensure a diverse range of CFPs were analyzed.

- Sample Size: A total of twenty unique CFP emails were analyzed, providing a sufficient sample size to identify recurring patterns and characteristics within the predatory journal emails.

4.2 Data analysis

- Manual Analysis: All emails were manually compared and categorized to identify the move structures and their constituent steps.

- Data Organization: The extracted information from each email was then input into a Microsoft Excel Spreadsheet. This enabled systematic organization and analysis of the data, facilitating the identification of commonalities and patterns across the predatory CFPs.

- Analysis: Apart from the qualitative analysis, this paper also involved calculating the frequency of specific moves and steps appearing in the emails in order to provide numerical evidence to support the qualitative data.

5. Research Findings

The analysis of twenty emails could identify five major moves and a number of constituting steps. The five moves and their steps are shown below.

Move 1: Opening

- Step 1.1: Greeting
- Step 1.2: Establishing relationship with the recipient

Move 2: Call to Action

Move 3: Journal Description

- Step 3.1: Introducing basic information
- Step 3.2: Providing (fabricated) credibility

Move 4: Publication Process

- Step 4.1: Indicating submission method/guidelines
- Step 4.2: Encouraging submission

Move 5: Closing

- Step 5.1: Closing remark
- Step 5.2: Forwarding request

Move 1: Opening

The first move is 'opening' move which starts the letter and draws attention of the recipient to their journals. This move can be further divided into two steps.

Step 1.1 'Greeting' refers to an opening address which often includes a general greeting and the recipient's title. Predatory emails often resort to using inaccurate titles like "Dr." regardless of the recipient's

actual academic standing. This tactic is a form of flattery intended to inflate the recipient's ego and potentially make them more susceptible to the email's message. Examples are:

- Dear Sir/Madam

- Dear Dr. xxx

- Dear Professor/Researcher

Step 1.2 'Establishing relationship with the recipient' is the prominent step of the CFPs from predatory journals. It often showers the recipient with excessive praise, often mentioning their past contributions to convey familiarity and appreciation. For example,

- With due respect and honor to write this massage after following your contribution towards research and scientific Publication world. It would be a great honor for me to have an author like you since we have been impressed with your great contribution with scientific community.

- We came across your article titled "XXX" that was published in "International Journal of Languages Literature and Linguistics". It was impressive and caught our interest in gaining your contribution in Advances in Social Sciences Research Journal (ASSRJ).

- We are very much grateful to see your contribution in research and academic fields in various journals; you have contributed in your field immensely.

Move 2: Call to Action

The second move in CFPs emails is the 'Call to Action'. It serves as the primary purpose of the email, explicitly urging recipients to submit their articles to the journals. This move is consistently present across all collected CFPs emails. Additionally, it often specifies the target publication or presentation date, emphasizing the urgency of the submission process.

For example,

- We are pleased to announce our Call for Papers for the AWL 2023.

- Call for Papers: XXX journal invites you to contribute your research paper for publication in Volume 9, Issue 6, November 2023.

- We are calling for new submissions for the Vol. 10, No. 4, 2022 issue which will be published in the end of this month.

Move 3: Journal Description

The third move extracted from the CFPs mails is 'Journal Description'. Two steps were used to realize the move. Step 3.1 presents fundamental details about the journal, including its name, overall objectives, and areas of focus. Predatory CFPs often boast an unrealistically broad scope, encompassing a vast array of subject areas, such as

- The scope of the journal also includes studies on food technology development and other articles related to Language, Linguistics, Literature and Culture such as Language and culture Studies, grammar, syntax, phonetics, morphology, semantics, discourse analysis, history of language. Micro Linguistics Macro linguistics Applied linguistics Translation studies Contrastive analysis Education field Language Cognitive Anthropology

Psychology Phonetics Stylistics Philosophy of Language Psycholinguistics Sociolinguistics Ethnolinguistic Phonology Semiotics Epigraphy Paleography Applied field Language teaching Lexicography Applied phonetics Applied sociolinguistics Development of an International Language Development of Special Language Medical Linguistics Graphology Monolinguistic , Literature studies Poetry Prose Essay Drama Novel Philology ,Cultural studies Cross-cultural studies Art Politics of language Religion Customs Humanities Archeology Physiology History studies Tourism will also be considered.

Step 3.2 'Providing fabricated credibility' makes the journal appear more legitimate. This step involves mentioning fabricated elements like a rigorous peer-review process, high impact factors (often irrelevant or misleading), and a prestigious editorial board (potentially consisting of fictitious individuals). The goal is to convince the recipient of the journal's standing and entice them to submit their work.

Examples include:

- Indexing and Abstracting: GooglScholar, Web of Science, WorldCat, Semantic Scholar, CiteSeer, Crossref, Creative Commons, Research Bib academic resource, Research Gate, International Standard Serial Number etc.

- Today, with over 16 years of experience and expertise, 5,900 OA books published, and a community of over 145,000 satisfied scientists globally, we have established relationships with leading research and funding organizations such as NASA, Wellcome Trust, the European Commission, and the Bill and Melinda Gates Foundation. Additionally, we actively work on indexing our authors' works by the renowned databases such as Web of Science and DOAB among others, and Intech Open as a publisher is a member of respected organizations like OASPA, ALPSP, STM, and COPE.

Move 4: Publication Process

This move aims to downplay the actual publication process, potentially obscuring any rigorous steps involved. The publication process of the predatory CFPs often presents a simplified or misleading picture of the process, making submission seem easier and faster than it actually is. Step 4.1 'Indicating submission method/guidelines' involves how researchers can submit their manuscript, often by email. Some CFPs emails also include other submission requirements, such as abstract length, paper formats, etc.

Examples are:

- You can submit your manuscript/paper via email. Email: editor@xxxx.org

- SUBMIT YOUR ARTICLE : xxxx@gmail.com. Kindly submit your article in Word & Pdf file both format with a Article Submission Form

    W ARTICLE SUBMISSION FORM.docx

Step 4.2 'Encouraging submission' further emphasizes the perceived benefits of submitting to the journal. Predatory emails aim to entice researchers by promising quick publication with significantly faster turnaround time compared to legitimate journals. In addition, some CFPs create a sense of urgency to further pressure researchers into submission by using approaching deadlines to highlight the limited time remaining for submission, or offering limited-time submission discounts. Example includes:

- AWL offers a 50% discount for all submissions that take place before 30 September 2023.

- Note: Please mention the Journal name to which manuscript is submitting. Immediate acknowledgement, urgent review and publication within 48 Hrs. after payment.

- Important Dates:

Paper Submission Deadline: Jun 30, 2020

Review Results: Maximum 5 Days from the date of receipt of a manuscript

Move 5: Closing

The final move ends with a closing remark. It includes 2 steps. Step 5.1 'Closing remark' reveals a common pattern used in regular emails such as Regards, Sincerely, and then provides contact information. For example,

- If you have any question regarding the publication of your paper then.

Email: myaipublisher@gmail.com or Call us at +XXX

Awaiting your treasured response!

- I await your favorable response at the earliest to book review slot in upcoming issue of 15th of the coming month.

Regards,

- We Hope to work with you in a long lasting cooperation that you will not regret.

Best Wishes

XXX

Editorial Assistant

XXXX

United Kingdom

Step 5.2 'Forwarding request' encourages the recipient to forward the email to colleagues, potentially expanding the reach of the predatory journal and targeting additional researchers for potential submissions.

- We would like to request you for forward this e-mail to group of your Friends/Students/ Staff /Colleagues / Associates/ Fellow Researchers, who may be benefited out of this.

- We would appreciate it if you could share this information with your colleagues and associates. Thank you.

6. Discussion

This study analyzed the structure of call for papers (CFP) emails from potentially predatory journals, revealing five key moves and their constituent steps. The five major moves and their functions are as follows.

Moves	Functions
Move 1: Opening 1.1 Greeting 1.2 Establishing relationship with the recipient	To grab the reader's attention
Move 2: Call to Action	To explicitly state the purpose of the email
Move 3: Journal Description 3.1 Introducing basic information 3.2 Providing (fabricated) credibility	To provide information about the journal
Move 4: Publication Process 4.1 Indicating submission method/guidelines 4.2 Encouraging submission	To explain the publication process
Move 5: Closing 5.1 Closing remark 5.2 Forwarding request	To end the email with salutation and contact information

The chart below summarizes the percentage of each step from the five moves in the predatory CFPs from the data collected.

Moves	Frequency (n)	Percentage (%)
Move 1: Opening 1.1 Greeting 1.2 Establishing relationship with the recipient	 18 11	 90 55
Move 2: Call to Action	20	100
Move 3: Journal Description 3.1 Introducing basic information 3.2 Providing (fabricated) credibility	 19 14	 95 70
Move 4: Publication Process 4.1 Indicating submission method/guidelines 4.2 Encouraging submission	 18 15	 90 75
Move 5: Closing 5.1 Closing remark 5.2 Forwarding request	 19 4	 95 20

In addition, the bar chart is created to better illustrate the percentage of each step from the five moves.
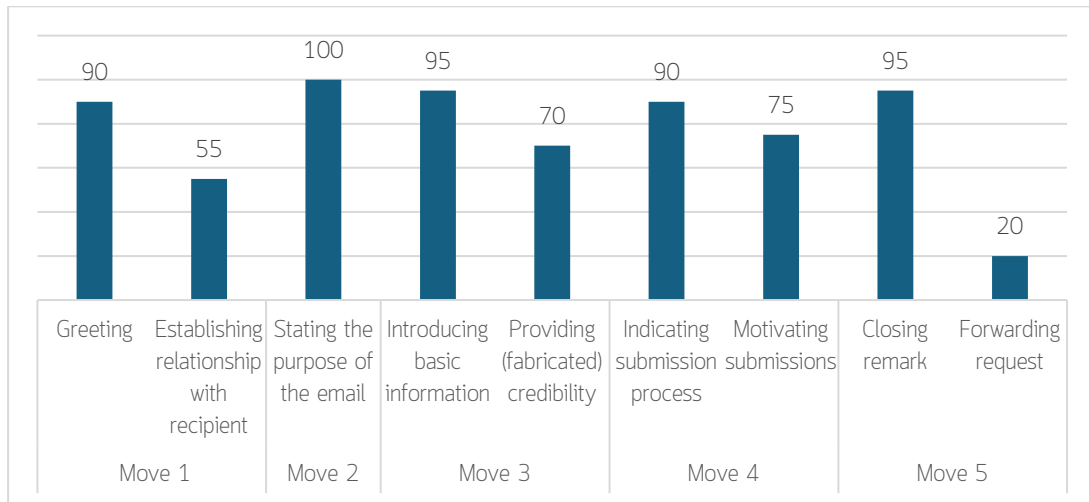
Accordingly, the findings illustrate that Move 2 is the only move that is used across all email invitations as it offers the core message of the CFPs (explicitly inviting participants to submit their manuscripts), while Step 5.2 'Forwarding request' in Move 5 was used the least. At first glance, the structures of the predatory CFPs look just like those of the legitimate ones. Studies from Mohammadi et al. (2013) and Yang (2015) revealed similar patterns of CFP structures from legitimate conferences as shown in the table below.

Mohammadi et al. (2013)	Yang (2015)
Move 1 *Opening move*	Move 1 *Drawing attention*
Move 2 *Salutation move*	1.1 Announcing a novel leitmotif
Move 3 *Informing move*	1.2 Presenting well-established brands
3.1 Information on interested areas of the conference	Move 2 *Identifying the discourse community coverage*
3.2 Information on necessary dates	2.1 Describing the history of the community
3.3 Information on the format of the submitted papers and devoted times for presentations	2.2 Addressing knowledge development
Move 4 *Complementary close and signature*	2.3 Re-visiting current knowledge
	2.4 Filling gaps in existing knowledge
	2.5 Highlighting featured speakers
	2.6 Presenting the committee
	Move 3 *Soliciting contributions*
	3.1 Regulating submissions
	3.2 Scheduling key dates
	3.3 Locating channels for contribution
	3.4 Listing types of contribution

Mohammadi et al. (2013)	Yang (2015)
	Move 4 *Presenting incentives for participation*
	4.1 Inviting potential participants
	4.2 Explaining registration procedures
	4.3 Arranging additional activities
	4.4 Printing the submissions
	4.5 Nominating the beneficiaries
	Move 5 *Clarifying miscellanea*
	5.1 Acknowledging assistance
	5.2 Supplying contextualized notices
	5.3 Suggesting websites/*multimedia*
	Move 6 *Signing off*

From the table, Move 1 from the two papers announces the theme of the conference and the main topics. The other moves in between clarify details of the conferences (i.e. scope, aims, dates, format, etc.) and offer registration/submission guidelines for the participants. Additionally, the final move from both studies ends with closing/signing off. This study similarly shows that the predatory CFPs employ similar structures. However, the differences lie in constituting steps that are employed to realize those moves, as well as the characteristics of language use, which is often boastful and flattery. After comparing the move structures from Mohammadi et al. (2013) and Yang (2015), it was found that the steps below are very specific in the predatory CFPs, making it deviate from the legitimate ones.

- Step 1.2 Establishing a relationship with the recipient: Predatory journals often use inaccurate titles and excessive praise, often without any prior knowledge of their specific research or achievements. This creates a sense of validation and makes authors more receptive to the journal's claims.

- Step 3.2 Providing (fabricated) credibility: Predatory journals boast broad scopes encompassing numerous fields and present fabricated details about rigorous peer review, high-impact factors, and prestigious editorial boards.

- Step 4.2 Encouraging submission: Predatory journals encourage submissions by downplaying the actual publication process, creating the illusion of a faster and easier path to publication.

- Step 5.2 Forwarding request: Predatory journals encourage forwarding the email to further expand their reach.

In conclusion, the overall structure of predatory CFP emails might appear similar to those from legitimate ones, which includes opening, call to action, journal description, publication process, and closing. However, a closer examination from this study reveals key differences in the steps employed to fulfill each move. Predatory journals manipulate the recipient through tactics like inflated titles, fabricated credentials, downplaying the publication process, and encouraging email forwarding to expand their reach. These deceptive strategies aim

to exploit the author's desire for publication, potentially leading to wasted time and effort. Therefore, recognizing these manipulative steps within the seemingly familiar CFP structure can help researchers distinguish predatory journals from legitimate ones, and avoid further submissions to the predatory journals.

7. Suggestion for future research

（1）Expand the data source: This study analyzed CFP emails received by a single author. Future research could gather data from a wider range of researchers across different disciplines to see if the identified moves and steps are consistent across various fields. Additionally, researchers could analyze predatory journal websites and social media posts to see if similar manipulative tactics are employed.

（2）Investigate the language use: This study briefly mentioned the use of boastful and flattering language in predatory CFPs. Future research could conduct a more in-depth analysis of the specific language used in these emails. This could involve techniques like corpus linguistics to identify keywords, phrases, and grammatical structures that are characteristic of predatory CFPs.

（3）Educate researchers: The findings of this study can be used to develop educational resources for researchers to help them identify and avoid predatory journals. These resources could be integrated into research workshops, online tutorials, or informational brochures.

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The Role of Financial Development in FDI-Growth Nexus

: Empirical Evidence in ASEAN Countries

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ABSTRACT

The empirical literature has examined how financial development moderates the impact of FDI on economic growth, yet the results are still ambiguous. Hence, this study investigates the moderating role of inancial development in FDI‑growth nexus in a sample of 10 ASEAN countries by applying LSDVC estimator. The findings reveal that while FDI positively impacts economic growth, this effect is significantly enhanced once countries reach specific thresholds of financial development. Financial indicators such as private credit, money supply, and bank credit are identified as crucial in determining the extent of FDI's influence on growth. The results indicate that countries with better‑developed financial systems are more likely to benefit from FDI, underscoring the importance of financial sector reforms. Policymakers are advised to strengthen financial institutions to at least the threshold levels identified in the study to fully capitalize on the potential of FDI to drive economic growth.

KEYWORDS: Economic growth, FDI, Financial development

1. Introduction

Foreign Direct Investment (FDI) is widely recognized for its role in accelerating economic growth by providing capital, technology, and managerial expertise. However, research has shown that the impact of FDI on economic growth is contingent upon various country‑specific factors, with financial development playing a critical moderating role. Recent studies have increasingly focused on how well‑functioning financial markets amplify the growth-enhancing effects of FDI, particularly in developing and emerging economies.

Theoretically, financial development could enable the efficient allocation of resources by ensuring that the inflow of FDI is channeled into productive investments. A well‑functioning financial system helps allocate capital to sectors and projects that offer the highest returns, maximizing the positive spillover effects of FDI on the local economy. In addition, Countries with better‑developed financial markets can better absorb the technological spillovers from FDI, which leads to higher growth. Iamsiraroj and Ulubaşoğlu (2015), in their global analyses, found that FDI's positive impact on growth becomes more pronounced as financial markets become more developed. Financial development improves capital allocation and provides the infrastructure necessary for local firms to integrate into global value chains, facilitating productivity spillovers from FDI.

However, the empirical evidence remains inconclusive. Many studies found that a higher level of financial development significantly enhances the impact of FDI on economic growth. For instance, Hermes and Lensink（2003）asserted that financial development is a precondition for a country to receive the growth-enhancing effect of FDI. A more developed financial system enables the process of technological diffusion from FDI to the recipient countries. An and others (2023) confirmed that financial development significantly moderates FDI's positive effects on growth, especially once certain financial infrastructure and market development thresholds are met. Azman‐Saini and Law（2010）provided empirical evidence showing that financial development strengthens the positive effects of FDI on economic growth by improving capital allocation and reducing transaction costs, leading to more productive investments.

Meanwhile, many studies documented an insignificant moderating role. An and Yeh (2021), examining the growth effect of foreign direct investment and financial development in emerging and developing Asia countries, found that at the high level of financial development, the positive impact of FDI on economic growth is vanishing. This suggests that financial development does not always play a moderating role in the FDI‐growth relationship. Carkovic and Levine (2005) argue that FDI does not always lead to growth in financially developed economies, and financial development does not consistently amplify FDI's impact on economic growth. Another paper by Shen and others（2010）showed a negative moderating role of financial development on FDI‐growth nexus. They found that financial development proxied by banking liberalization weakens the positive effect of FDI on economic growth in a sample of 80 countries.

Following the discussion above, our study attempts to empirically examine how financial development moderates the impact of FDI on economic growth in the context of ASEAN countries. Our study will contribute to the body of knowledge by providing empirical evidence in ASEAN countries. The result would help to address existing inconclusive empirical findings regarding the moderating role of financial development. Our results will inform policymakers about the impact of FDI and how financial development moderates such an impact. Our research will also investigate the minimum level（threshold）of financial development required to obtain the benefit of FDI.

2. Research Objective

(1) To examine how financial development moderates the impact of FDI on economic growth in the context of ASEAN countries

(2) To examine whether the minimum level (threshold) of financial development exists

3. Literature Review

3.1 Theoretical foundations

Financial development refers to the growth and efficiency of financial institutions and markets that allocate resources efficiently, facilitate investments, and mitigate risks. Theoretical arguments suggest that financial development enhances the ability of an economy to absorb and benefit from FDI inflows by improving

resource allocation, reducing information asymmetries, and lowering transaction costs (Hermes and Lensink, 2003). Well-developed financial systems enable domestic firms to access capital, adopt new technologies, and compete effectively with foreign firms, thereby amplifying the positive externalities associated with FDI (Alfaro and others, 2004).

Endogenous growth theory provides a framework for understanding the role of financial development in moderating the FDI-growth relationship. The theory posits that technological spillovers from FDI, a key driver of long-term growth, are more likely to be absorbed in economies with mature financial systems. In such environments, domestic firms are better able to access credit and funding, allowing them to implement and benefit from new technologies introduced by foreign firms (Durham, 2004).

3.2 Empirical evidence

In empirical literature, the relationship between Foreign Direct Investment (FDI) and economic growth has been widely studied, with many scholars arguing that FDI positively contributes to growth by bringing capital, technology, and expertise to the host country. However, the extent to which these benefits materialize often depends on local conditions, particularly the level of financial development. An and others (2023) found that financial institutions and financial markets enhance the positive impact of FDI on economic growth in emerging and developing Asia. Another study by Nguyen (2022) found that financial development measured by the banking sector and the stock market amplifies the positive effect of FDI on economic growth when threshold values are reached. Lee and Chang (2009) examined the dynamic interrelationships among FDI, economic growth and financial development in a global sample, confirming the positive long-run relationship that financial development and FDI have on economic growth.

While a significant body of literature supports the idea that financial development enhances the positive effects of FDI on growth, there are also studies that present mixed or contradicting results. Osei and Kim (2020) found that the growth effect of FDI becomes negligible and insignificant when financial developments reach a certain level in a sample of 62 middle- and high-income countries. Acquah and Ibrahim (2020) showed an ambiguous impact of FDI on economic growth and financial sector dampens the positive impact of FDI on economic growth in African countries. An and Yeh (2021) found that in the context of emerging and developing Asian countries, the beneficial impact of foreign direct investment (FDI) on economic growth diminishes as financial development reaches higher levels.

4. Research Methodology

4.1 Variables and Sample selection

Before we discuss the model specification, we will describe all variables used in our regression models. In Table 1, our dependent variable is GDP growth, an annual percentage change in output. Our key independent variables are FDI and financial development, which are used to determine their impacts on economic growth. FDI is measured by a ratio of net foreign direct investment inflows to GDP. We use three financial development indicators. The first measure is private credit (PC), denoting gross domestic credit to the private sector as a ratio

of GDP. The second proxy is money supply, measured by the ratio of broad money to GDP. Broad money includes the sum of currency, demand deposits, savings and foreign currency deposits, bank and traveler's checks, and other securities such as certificates of deposit and commercial paper. The last measure is bank credit, denoting the domestic credit to the private sector by banks as a percentage of GDP. These measures capture the size of the financial sector in the host countries. The control variables consist of population growth (POPG), which is the annual population growth rate. Inflation (INF) is measured by the consumer price index. Gross capital formation (CAPITAL), also known as gross domestic investment, is expressed as a ratio relative to GDP. Trade openness (TRADE) is measured by the sum of exports and imports of goods and services divided by GDP. We collected these data from WDI, the World Bank database. All variables are transformed into a natural logarithm except GDP growth and population growth. Our sample consists of 10 ASEAN countries, including Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam. Our data spans from the year 1990 to 2022.

4.2 Model specification

First, we conducted preliminary tests on the impact of FDI on economic growth by regressing FDI (independent variable) with GDP growth. Our regression model is as follows.

$$GDPG_{i,t} = \beta_1 GDPG_{i,t-1} + \beta_2 FDI_{i,t} + \theta_i X_{i,t} + \eta_i + \varepsilon_{i,t} \tag{1}$$

Where $GDPG_{i,t}$ is GDP growth. $GDPG_{i,t-1}$ is the lagged dependent variable. We include the lagged dependent variable in the specification to capture the persistence of the dependent variable. $FDI_{i,t}$ is net FDI inflows. $X_{i,t}$ is a set of control variables. η_i is an unobserved country-specific fixed effect, and $\varepsilon_{i,t}$ is an error term.

To examine the moderating role of financial development, we regress GDPG with FDI, the financial development variable, and the interaction between FDI and financial development. The application of interaction terms is common in the literature to estimate the moderating effect of interested variables. The regression is estimated as follows.

$$GDPG_{i,t} = \beta_1 GDPG_{i,t-1} + \beta_2 FDI_{i,t} + \beta_3 Findev_{i,t} + \beta_4 (Findev_{i,t} * FDI_{i,t}) + \theta_i X_{i,t} + \eta_i + \varepsilon_{i,t} \tag{2}$$

Where $GDP_{i,t}$ is GDP growth. $GDPG_{i,t-1}$ is the lag- dependent variable. $FDI_{i,t}$ is net FDI inflows. $Findev_{i,t}$ is a set of financial development variables (PC, MS and BC). "$Findev_{i,t} * FDI_{i,t}$" is an interaction between FDI and each financial development proxy. $X_{i,t}$ is a set of control variables specific to each pillar. η_i is an unobserved country-specific fixed effect, and $\varepsilon_{i,t}$ is an error term.

It is worth mentioning that the individual significance of $\beta_2, \beta_3, \beta_4$ from equation (1) does not reflect the significance of the moderating impact at all values of financial development. The shortcoming of many empirical studies is that they restrict their analysis to only the coefficient of the interaction term in the regression, exposing their analysis to the problem of overstating or understating results (Kingsley and others, 2017). To remedy this issue, Brambor and others (2006) suggests the calculation of marginal effects at all values of

moderating variables and determine their significances. From the equation (1), a marginal effect (ME) of FDI could be calculated by taking the first derivative with respect to $FDI_{i,t}$ as follows.

$$Marginal\ effect\ of\ FDI\ (ME)_{i,t} = \frac{dGDPG_{i,t}}{dFDI_{i,t}} = \beta_2 + \beta_4 Findev_{i,t} \tag{3}$$

$Marginal\ effect\ of\ FDI\ (ME)_{i,t}$ is basically the magnitude of the impact of $FDI_{i,t}$ on $GDPG_{i,t}$ at a particular value of $Findev_{i,t}$. When $Findev_{i,t}$ is equal to 0, the marginal effect is equal to β_2, indicating that the impact of FDI on $GDPG_{i,t}$ has a magnitude of β_2. When $Findev_{i,t}$ increases by 1, the marginal effect will change by the value of β_4. If β_4 is positive (negative), the marginal effect increases (decreases) when $Findev_{i,t}$ is higher.

Then, we test the statistical significance of a marginal effect. Accordingly, we write the null hypothesis, stating that the marginal effect is not statistically different from zero. The alternative hypothesis otherwise states that the marginal effect is statistically different from zero. Our hypotheses are as follows.

$$H_0 : ME_{i,t} = \beta_2 + \beta_4 Findev_{i,t} = 0$$
$$H_1 : ME_{i,t} = \beta_2 + \beta_4 Findev_{i,t} \neq 0$$

If a marginal effect is significantly different from zero, we reject the null hypothesis. The significance of a marginal effect is determined by its standard error with the following formula.

$$Standard\ error\ (SE) = \sqrt{var(\beta_2) + Findev_{i,t}{}^2 var(\beta_4) + 2\ Findev_{i,t} cov(\beta_2, \beta_4)} \tag{4}$$

The statistically significant marginal effect indicates that it is significantly moderated by its corresponding value of financial development. To see the range of financial development that has a significant moderating impact, we need to calculate all possible values of marginal effects at different values of financial development. To depict the relationship between marginal effects and financial development, we produce a graph plotting values of the marginal effects on the y-axis corresponding to their values of financial development on the x-axis. Then, we plot the confidence intervals, depicted by upper and lower boundary lines surrounding the marginal effects, to ascertain the range of the marginal effects that are statistically significant. When the confidence intervals of marginal effects (the values between upper and lower boundary lines) include a value of zero, we can not reject the null hypothesis that they are statistically different from zero. Thus, those marginal effects are not statistically significant, and their corresponding values of financial development do not have a moderating effect. On the contrary, if the confidence intervals do not include the value zero, those marginal effects are statistically significant, and their corresponding values on the x-axis will show the range of values of financial development that significantly moderates the effect of FDI.

4.3 Estimation methods

Our study will apply LSDVC estimation method. It is a method used in panel data econometrics to address biases in dynamic panel data models, particularly when dealing with short time periods (small T) and fixed effects. The method is an enhancement of the standard Least Squares Dummy Variable (LSDV) approach, which controls for individual-specific fixed effects by including dummy variables for each cross-sectional unit.

In dynamic panel models, the inclusion of lagged dependent variables can introduce a bias known as the Nickell bias, especially when the number of time periods is small. To correct for this, LSDVC uses an initial estimator, such as the Arellano-Bond or Anderson-Hsiao estimator, and then applies bias corrections to improve accuracy.

5. Research Findings

5.1 FDI and Economic Growth

First, we conduct preliminary tests of the impact of FDI on economic growth by LSDVC estimator, presented in Table 3. We found that the coefficients of FDI are positive in most of the regressions, implying that foreign direct investment enhances economic growth in ASEAN countries.

Table 3: The impact of FDI on GDPG

	Dependent variable: GDP growth				
	1	2	3	4	5
Lag GDPG	0.155***	0.075	0.052	0.029	0.033
	(0.00)	(0.15)	(0.32)	(0.45)	(0.40)
FDI	0.574	0.824**	0.914**	0.727*	0.735*
	(0.16)	(0.03)	(0.01)	(0.05)	(0.05)
TRADE		1.528	1.662	1.504	1.452
		(0.24)	(0.21)	(0.29)	(0.31)
POPG			0.786**	0.664*	0.694**
			(0.03)	(0.05)	(0.05)
CAPITAL				0.114**	0.112**
				(0.03)	(0.04)
INF					-0.028
					(0.61)

P-value in parathesis

5.2 The role of financial development

We investigate further whether financial development moderates the relation between foreign investment and economic growth. We take regression 5 from Table 3 and include dependent variables, namely financial indicators and their interactions, to test the moderating impact of financial development. Three financial indicators are applied, namely private credit (PC), money supply (MS), and bank credit (BC), in regression 1, 2, and 3, respectively, displayed in Table 4. The findings show that the coefficient of FDI and the interaction terms (FDI*PC, FDI*MS, FDI*BC) are not significant in all regressions. Meanwhile, financial development indicators are negative and significant. However, neither the coefficients of FDI, financial indicator, nor their interactions reflect the significance of marginal effect at different values of financial development. To this end, we plot the marginal effects of regressions 1, 2, and 3, presented in Figure 1. To determine their significance, their 95%

confidence interval bands are constructed, surrounding marginal effect lines. When the interval bands contain the value 0, the marginal effects are not significant at 5% level, indicating that they are not moderated by their corresponding values of financial development.

From Figure 1 the outstanding finding is the thresholds (shown by the red vertical lines), which are the values of the financial development measures that separate the marginal effects between the significant and the insignificant ones. When the financial development measures are below the thresholds (on the left side of the red vertical lines), the marginal effects are insignificant. However, when these measures are above these values (on the right side of the red vertical lines), they become positive and significant at 5%. This means that when finance is not adequately developed (below the thresholds), FDI does not affect economic growth. However, when it becomes sufficiently developed (above the thresholds), FDI increases economic growth. Thus, the thresholds represent the minimum level of financial development a country needs to attain so that FDI positively impacts economic growth. Then, we examine the marginal effects above the thresholds (on the right side of the red vertical lines) and notice that they increase when their financial development measures escalate. This means that, as finance becomes more developed, the positive effect of FDI on growth is bigger.

Specifically, the values of the thresholds are at ln PC of 2.9 (regression 1), ln MS of 2.7 (regression 2), and ln BC of 2.8 (regression 3), which could be translated as the ratio of private credit to GDP of 18, the ratio of money supply to GDP of 14 and the ratio of bank credit to GDP of 16. Let's take Regression 1 for interpretation. At the threshold, the marginal effect is around 0.82, implying that a 1% increase in FDI contributes to a 0.82 percentage point rise in output growth. When this financial indicator PC increases to the highest value at ln PC of 5.19 (the ratio of private credit to GDP of 180), the effect rises to 1.53 percentage points, implying that a 1% increase in FDI is associated with a 1.53 percentage points rise in growth.

For regression 2, at the threshold, the marginal effect is around 0.85, implying that a 1% increase in FDI contributes to a 0.85 percentage point rise in output growth. When this financial indicator MS increases to the highest value at ln MS of 5.00 (the ratio of money supply to GDP of 148), the effect rises to 1.56 percentage points, implying that a 1% increase in FDI is associated with a 1.56 percentage points rise in growth.

For regression 3, at the threshold, the marginal effect is around 0.87, implying that a 1% increase in FDI contributes to a 0.87 percentage point rise in output growth. When this financial indicator BC increases to the highest value at ln BC of 5.19 (the ratio of bank credit to GDP of 180), the effect rises to 1.61 percentage points, implying that a 1% increase in FDI is associated with a 1.61 percentage points rise in growth.

Table 4: Financial development and FDI – Growth nexus

GDPG: dependent variable	Financial development indicators		
	Private credit	Money supply	Bank credit
	Reg 1	Reg 2	Reg 3
Lag GDPG	0.030	0.025	0.031
FDI	-0.056	-0.39	0.039
PC	-3.077***		
FDI*PC	0.316		
MS		-4.161***	
FDI*MS		0.341	
BC			-3.079***
FDI*BC			0.301
TRADE	4.792***	5.652***	4.828***
POPG	0.054	-0.188	0.051
CAPITAL	0.153***	0.167***	0.153***
INF	-0.047	-0.064	-0.052

Figure 1: Marginal effects of FDI
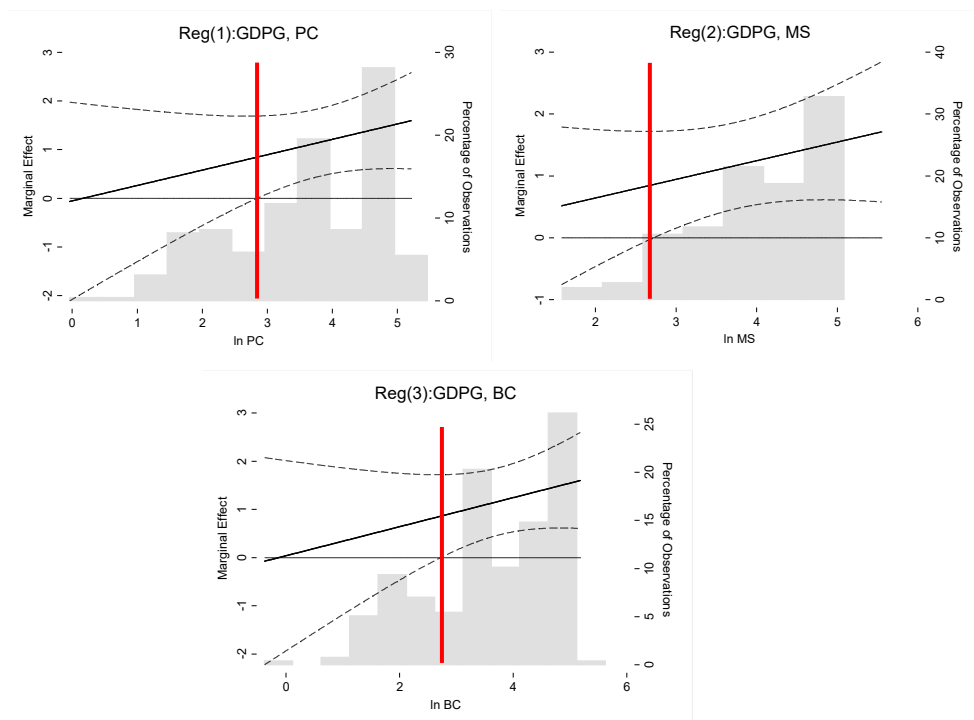
6. Discussion

Financial development plays the crucial role in moderating the impact of FDI on economic growth in ASEAN countries. When the financial development is not well‑developed, FDI does not have a positive impact on economic growth. After financial development has been strengthened to reach the threshold level, FDI begins to have a positive impact on economic growth. The positive impact of FDI becomes bigger as financial development is higher. Our study is line with previous literature such as Nguyen (2022) and Hermes and Lensink (2003) who demonstrated that financial development enhances FDI's growth effects, but only after reaching a certain threshold. When financial markets are underdeveloped, FDI's contribution to growth can be limited. However, once financial development passes a particular level, it boosts the absorptive capacity of the economy, allowing for more efficient capital allocation, technology transfer, and spillovers from FDI.

7. Suggestion

We suggest that policymakers in ASEAN countries need to prioritize strengthening their financial systems to meet or exceed the identified thresholds to fully harness the benefits of FDI for economic growth. Without adequate financial development, the potential of FDI to drive growth remains untapped. The policymakers should strengthen financial development to at least reach the threshold (the ratio of private credit ratio to GDP of 18 or the ratio of money supply to GDP of 16 or the ratio of bank credit to GDP of 16) or past that level.

8. Acknowledgement

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A Study On Business Model Innovation of Online Video Platforms

from The Perspective of Value Co-creation

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ABSTRACT

Network video platforms have abundant data and resource allocation authority, linking content production and consumption ends and influencing value co‑creation. Business model innovation is significant. This paper collates relevant theories, collects data via questionnaires, uses SPSS26.0 for quantitative analysis, conducts reliability and validity tests. Research shows value co-creation impacts network video platform business model innovation; user co-creation behaviors drive model renewal. Network embedding as a moderating variable promotes co‑creation and business model innovation. The study provides theoretical support and empirical evidence for understanding network video platform business model innovation mechanisms and offers inspirations for related research and practice.

KEYWORDS: User Participation; Value Co-creation; Network Embedding; Business Model Innovation

1. Introduction

In the knowledge economy era, data, knowledge, users are important resources. Network video platforms have abundant data resources and allocation authority, linking production and consumption ends, influencing value co‑creation. Business model innovation is significant. CNNIC data shows network video user utilization rate is rising yearly. Network video platforms' innovative content expands overseas. Rich content attracts more users to participate, enhancing enterprise new product development performance and online community belonging. (Xie Xuemei & Wang Lijun; 2019). The more intense users' demands for product information and personal emotional needs are, the more inclined they are to actively engage in value co-creation activities. Network videos lead the new media trend with intelligence and socialization, and the network video industry is growing rapidly. The business model innovation of network video platforms involves joint participation and value creation by users and the platform and among users. The concept of value co‑creation emphasizes users' active role and contribution. Therefore, studying the interaction and cooperation between users and the platform and among users is crucial for understanding the effect and impact of business model innovation.

2. Research Objective

1. Reveal user engagement methods and extent on online video platforms, analyze user participation and commitment for business model innovation foundation and understand users' role in value co-creation.

2. Explore business model innovation construction and implementation on online video platforms, analyze impact based on value co-creation, S-O-R and resource-based theories.

3. Analyze relationships among user engagement, value co- creation, network embeddedness and business model innovation on online video platforms, construct research model and framework.

4. Investigate business model innovation factors from user-platform and user-user co-participation and value creation, quantitatively analyze impact on online video platforms, provide research directions.

3. Literature Review

3.1 Theory, Concept and Related Research

3.1.1 Theory

Based on the value co-creation theory of service-dominant logic, Vargo and Lusch proposed the famous "service-dominant logic". The value co-created under the service-dominant logic is not "exchange value", but "use value" (value-in-use) realized by consumers in the consumption process. Based on the value co-creation theory, the platform enables external innovators to jointly create value with platform leaders and other participants. The SOR (Stimulus-Organism-Response) theory was put forward by psychologist Woodworth in 1926. The user participation-value co-creation-business model innovation model framework based on the S-O-R (Stimulus-Organism-Response) theory aims to analyze the dynamic interaction process between users and business models. Through the value co-creation process of user participation, enterprises can better understand and meet user needs, and then achieve innovation in business models. In 1984, Wernerfelt proposed the "resource-based theory of the firm". Barney, J. (1991) believes that VRIN resources (Valuable, Rare, Imperfectly imitable, Non-substitutability) give enterprises a competitive advantage. The resource-based theory emphasizes the key elements for enterprises to gain an advantage in market competition. Enterprises need to effectively integrate and utilize various resources to create maximum value.

Business model innovation is a process of reconstructing the enterprise operation system. In this process, enterprises will readjust their existing resources (Massa, L., Tucci, C. L., & Afuah, A, 2017). Through technological disruption, platform sharing, and ecosystem construction (Vaska, S., Massaro, M., Bagarotto, E. M., & Dal Mas, F., 2021), the evolutionary and alternative reconstructions of the digital platform's ecological embedding capabilities are realized (Wang Bingcheng, Sun Yuxin, Zhang Shiqiang & Zeng Lijun, 2024), completing the business model innovation of enterprises. The business model innovation of network video platforms refers to the process of redefining and optimizing the platform's profit model and value chain by means of digital technology, content innovation, and user experience design to meet user needs, increase user stickiness, expand revenue sources, and maintain competitive advantages.

User participation refers to the process in which users participate in the product innovation process

and provide knowledge or other scarce resources for enterprises according to their own needs, including efforts in psychological, physical, and emotional aspects. User participation is of great value for the upgrading of enterprise capabilities. It is a process of guiding users to provide effective information and participate in the product development and capability upgrading and transformation of enterprises. In the early stage of platform entrepreneurship, user enthusiasm can enable the opening of innovative service functions and effectively enhance the strength of the platform. The prerequisite for enterprises to master successful innovation in the external market (West and Bogers 2014) is to regard customers as the source of knowledge and co-developers of products (Cui, A. S., & Wu, F. 2016; De Jong, J. P., & von Hippel, E. 2009). User participation promotes value co-creation and enhances enterprise innovation, thereby increasing the market share for enterprise development.

The term "value co-creation" was first proposed in the book "The Future of Competition" co-authored by Prahalad and Ramaswamy. The value co-creation of cross-border integration has, to some extent, eliminated the traditional boundaries of the online video industry. The traditional value creation theory holds that consumers are merely consumers of value (Vargo, S. L., & Lusch, R. F. 2004). However, Prahalad and Ramaswamy (2000) revealed the essence of jointly creating consumer experience value and value co-creation. Value co-creation runs through the entire consumption experience process, and consumers are the core and decisive factors in jointly creating experience value with enterprises. For the dynamic structure of digital platforms with consumers and complementors on the periphery, digital platform owners use governance mechanisms to promote value co-creation with ecological participants. Conducting e-commerce activities through the value co-creation network can effectively promote business model innovation, achieve multi-dimensional and three-dimensional value co-creation, and promote high-quality development of the industry. The value co-creation process of realizing collaborative interaction through resource interaction forms a virtuous cycle relationship with the business model innovation of platform-based enterprises.

3.2 Research Framework
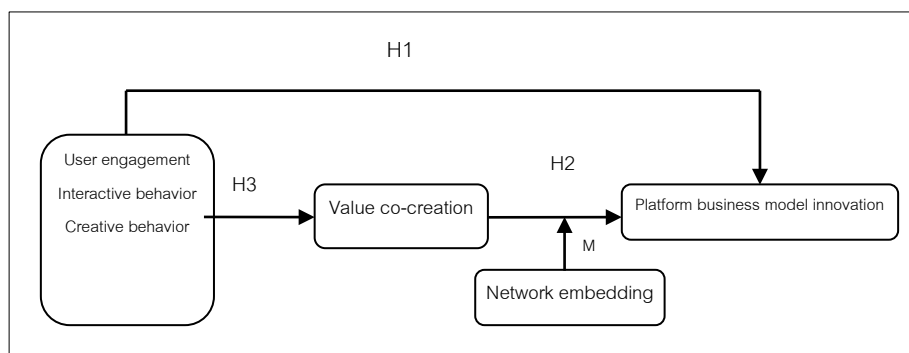
Figure 1 Research Framework

3.3 Research Hypotheses

Hypothetical	Hypothetical content
H1	User participation has a positive impact on the innovation of business models in online video platforms.
H1a	The interactive behavior of users has a positive impact on the innovation of business models in online video platforms.
H1b	The creative behavior of users has a positive impact on the innovation of business models in online video platforms.
H2	Value co-creation has a positive impact on the innovation of business models in online video platforms.
H3	User participation has a positive impact on value co-creation.
H3a	The interactive behavior of users has a positive impact on value co-creation.
H3b	The creative behavior of users has a positive impact on value co-creation.

4. Research Methodology

4.1 Research Design

This paper mainly adopts literature research method, questionnaire survey method and empirical analysis method for research.

4.2 Population and Sample

In this questionnaire survey, more than 400 questionnaires were sent out, and 387 were recovered. After excluding incomplete questionnaires, 356 valid questionnaires were finally obtained. The recovery rate is 96.75%, and the survey validity is 89%.

4.3 Research Instrument

This paper uses spss26.0 and AMOS software tools for data processing.

4.4 Data Collection

Table 4-1 KMO and Bartlett's Test

KMO Sampling Adequacy Measure		0.844
Bartlett's Test of Sphericity	Last Read Chi-Square	2547.146
	Degrees of Freedom	120
	Significance	0.000

Table 4-2 Structural validity examination

Fit indices	CMIN/DF	RMSEA	GFI	NFI	CFI	IFI	TLI
Standard Values	＜3 or 5	＜0.08 or 0.1	＞0.9	＞0.9	＞0.9	＞0.9	＞0.9
Default model	1.222	0.025	0.962	0.956	0.992	0.992	0.989

Table 4-3 Correlation

	Interaction Behavior	Creative Behavior	Value Co-creation	Business Model Innovation	Network Embedding
Interaction Behavior	1	.277**	.362**	.290**	.183**
Creative Behavior	.277**	1	.284**	.264**	.127*
Value Co-creation	.362**	.284**	1	.375**	.289**
Business Model Innovation	.290**	.264**	.375**	1	.484**
Network Embedding	.183**	.127*	.289**	.484**	1

** At a significance level of 0.01 (two-tailed), the correlation is significant.

* At a significance level of 0.05 (two-tailed), the correlation is significant.

Table 4-4 Mediation Effect Analysis of Value Co-creation

Variable	Model 1		Model 2		Model 3	
	Business Model Innovation		Value Co-creation		Business Model Innovation	
	β	t	β	t	β	t
Interaction Behavior	0.290***	5.708	0.362***	7.309	0.178**	3.412
Value Co-creation					0.311***	5.975
R^2	0.084		0.131		0.168	
F	32.580***		53.422***		35.736***	

Note: ***： P＜0.001； **： P＜0.01； *： P＜0.05.

Table 4-5 Mediation Effect Test of Value Co-creation in Bootstrap

Path	Effect Value	SE	Bootstrap 95% Interval		Effect Proportion
			Lower	Upper	
Total effect	0.308	0.061	0.187	0.428	
Direct effect	0.188	0.060	0.071	0.308	61.04%
Indirect effect(s)	0.120	0.028	0.069	0.178	38.96%

Table 4-6 Moderation Effect Analysis of Network Embeddedness

Variable	Model 1		Model 2	
	Business Model Innovation		**Business Model Innovation**	
	β	t	**β**	t
Value Co-creation	0.257***	5.507	0.246***	5.278
Network Embeddedness	0.409***	8.767	0.426***	9.076
Value Co-creation × Network Embeddedness			0.105*	2.343
R²	0.295		0.305	
F	73.702***		51.591***	

Note: ***：P＜0.001；**：P＜0.01；*：P＜0.05。

4.5 Data Analysis

From the above table 4‑1, it can be seen that the KMO measure value is 0.844, which is greater than 0.8, indicating that the scale data is very suitable for factor analysis. The approximate chi-square value of Bartlett's sphericity test is 2547.146, with 120 degrees of freedom, and the p‑value is 0.000, less than 0.01, passing the significance test at a significance level of 1%. Therefore, it can be concluded that the scale data is very suitable for factor analysis. See Table 4-5 for detailed results of factor analysis.

Based on Table 4‑2, it can be observed that the CMIN/DF is 1.222, RMSEA is 0.025, GFI is 0.962, NFI is 0.956, CFI is 0.992, IFI is 0.992， TLI is 0.989, indicating a high level of fit between the model and the data, good structural validity, and compliance with the standard values.

According to the correlation coefficient results in Table 4‑3, at a two‑tailed significance level, all variable correlations are significant. The correlation coefficient between interaction behavior and creative behavior is 0.277, with value co‑creation 0.362, business model innovation 0.290, and network embedding 0.183. There are significant positive correlations between interaction behavior, creative behavior, value co‑creation and business model innovation. Also, significant positive correlations exist between interaction behavior and creative behavior, and interaction behavior and value co‑creation.

As shown in Table 4‑4, in the model with business model innovation as the dependent variable, interaction behavior significantly positively influences it (β=0.290, P<0.001). In the model with value co-creation as the dependent variable, interaction behavior significantly positively influences it (β=0.362, P<0.001). In Model 3, after adding value co‑creation as the mediator variable, R² increases. Interaction behavior still significantly influences business model innovation (β=0.178, P<0.01), and value co‑creation also significantly positively influences business model innovation (β=0.311, P<0.001). The results suggest that value co‑creation partially mediates between interaction behavior and business model innovation.

As per Table 4‑5, using Bootstrap with a sample size of 5000 yields mediation effect results. The Bootstrap sampling 95% interval for the mediation effect is (0.069, 0.178), with no 0 included in the upper and lower limits, indicating a significant mediation pathway and an effect proportion of 38.96%. The Bootstrap

sampling 95% interval for the direct effect is $(0.071, 0.308)$, with no 0 included, suggesting a significant direct effect pathway and an effect proportion of 61.04%. The Bootstrap sampling 95% interval for the total effect is $(0.187, 0.428)$, with no 0 included, indicating a significant total effect pathway. Thus, value co-creation partially mediates between interaction behavior and business model innovation.

As shown in Table 4-6, to verify if network embeddedness moderates the relationship between value co-creation and business model innovation. In Model 1, with value co-creation and network embeddedness as independent variables and business model innovation as the dependent variable, it's found that both value co-creation (β=0.257, P<0.001) and network embeddedness (β=0.409, P<0.001) significantly positively influence business model innovation. In Model 2, based on Model 1, the interaction term value co-creation × network embeddedness is included. It's found that value co-creation (β=0.246, P<0.001), network embeddedness (β=0.426, P<0.001), and the interaction term value co-creation × network embeddedness (β=0.105, P<0.05) all significantly positively influence business model innovation. Thus, network embeddedness positively moderates the relationship between value co-creation and business model innovation.

5. Research Findings

This paper concludes that in online video platforms, user participation has a significant impact on business model innovation. Users' interactive and creative behaviors drive the diversification of content supply models, enhance user experience, accelerate interaction between the platform and users, and promote the transformation of business models from transactional to service-oriented. Meanwhile, value co-creation serves as an intermediary between user participation and business model innovation. User participation provides an important foundation and impetus for business model innovation by promoting value co-creation. Moreover, network embeddedness plays a regulatory role between value co-creation and business model innovation, helping the platform make better use of external resources, promote the value co-creation process, and thus optimize the business model and enhance competitiveness. Managing and guiding user participation is crucial for the sustainable development of online video platforms, enabling close interaction with users and promoting innovation and progress of the platform.

6. Discussion

In the business model innovation of online video platforms, user participation in value co-creation activities, including information sharing and data behavior sharing, is widely emphasized. User value co-creation is crucial for platform innovation and drives platform development and value chain evolution. In B2B, efficient innovation improves transaction efficiency and promotes enterprise participation. In B2C, it enhances user purchase intention and platform profit. Novel business model innovation focuses on new content and expanding business boundaries.

User participation in online video platforms involves interactive and creative behaviors. Different models have different user roles. Value co-creation theories based on consumer experience and service logic reveal its

importance for business model innovation, reflected in diversifying content supply, enhancing user experience, and promoting model transformation. Platforms should value user participation for sustainable development.

Network embedding plays a regulatory role between value co-creation and business model innovation. It affects enterprise-external stakeholder relationships and impacts the relationship between the two. In online video platforms, it regulates this relationship by facilitating external resource utilization and promoting value co-creation and business model innovation, enhancing competitiveness and achieving sustainable development. Managing network embedding is crucial.

In online video platforms, user participation as an independent variable is significant. It includes behaviors like watching, commenting, sharing, and creating content, promoting interaction and affecting value co-creation. It indirectly influences business model innovation through value co-creation, stimulating co-creation activities, promoting value exchange and cooperation. Understanding user needs through participation helps optimize content and service, providing a foundation for business model innovation. Managing and guiding user participation is essential for platform development.

7. Suggestion

1) Current Study Recommendations

(1) Differentiate and explore various forms of user engagement on online video platforms to understand their diversity and uniqueness.

(2) Examine cross-platform differences in user engagement to identify strengths and weaknesses.

(3) Analyze the relationship between user engagement behaviors and value co-creation.

(4) Investigate the moderating role of network embedding in user engagement, value co-creation, and business model innovation.

(5) Consider user engagement, value co-creation, and network embedding comprehensively for business model innovation.

2) Future Research Recommendations

(1) For user engagement: Focus on emerging engagement methods, cross-cultural comparisons, and long-term tracking.

(2) For value co-creation: Analyze the relationship between user engagement behaviors and platform value.

(3) For network embedding: Explore its moderating role and use social network analysis.

(4) For business model innovation: Focus on different platforms' innovation and paths, and the impact of user engagement, value co-creation, and network embedding.

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A Study of Early Childhood Teacher Competencies Using the Southeast Asia Teachers Competency Framework and Priority Needs Index for International School Teachers in Yangon, Myanmar

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ABSTRACT

This study conducted a needs analysis utilizing the Southeast Asia Teachers Competency Framework in the context of early childhood teachers in international schools in Yangon. The study's objectives were as follows: 1. To determine the current levels of teacher competencies according to the SEA-TCF in the context of early childhood education in Yangon, Myanmar; 2. To determine the desired levels of teacher competencies according to the SEA-TCF in the context of early childhood education in Yangon, Myanmar; and 3. To find the priority needs for the development of teacher competencies according to the SEA-TCF in the context of early childhood education in Yangon, Myanmar. One hundred and ninety-five early years teachers from six international schools participated in the study. Both current and desired means of teacher competencies were determined. Overall levels of current competencies were moderately high, and desired competencies were high. Paired samples t-tests were conducted on the means to determine their significant differences. The competency "Know and Understand What I Teach" emerged as the top priority for development, with the highest Priority Needs Index (PNI) value of 0.28. This indicates that it requires the most attention for improvement. The competency "Help My Students Learn" had a PNI value of 0.23, placing it second in priority. "Engage the Community" ranked third, with a PNI value of 0.21. Lastly, the competency "Become a Better Teacher Every Day" was identified as having the lowest PNI value of 0.16, ranking fourth and last in priority.

KEYWORDS: Teaching Competencies, Early Childhood Education

1. Introduction

Ideally, the journey of education for every individual begins with early childhood education, as it plays a pivotal role in laying the foundation for lifelong learning and development. Early childhood education (ECE) is important for the holistic development of young minds and benefits society. Studies have substantiated the importance of ECE and have indicated that children who participate in education early or have opportunities to go to school at an early age do better on assessments for math and reading and have better development overall (Bakken et al., 2017; Daelmans et al., 2017).

Nonetheless, many of these studies have been done in developed countries, and there needs to be a greater quality of ECE among countries from low-resource environments. In many Asian countries, although ECE is improving, the lack of government regulations for operating and registering schools, lack of curriculum guidelines, and unclear requirements for professional qualifications for teachers hampers the quality of ECE provided. According to Gupta (2014), in resource-limited countries, the quality of education may experience problems related to the lack of guidelines for the regulation of education providers, curriculum requirements, and teacher qualifications, thereby resulting in an educational environment that may be unregulated and unstandardized. Much of the ECE in Asia is offered by programs that private, non-government providers manage with no systematic framework to regulate these programs. This environment contributes to a high variance in the quality of teacher competencies. Competencies are the abilities that teachers acquire through training and experience. They are related to what and how teachers must do to engage students in the act of learning.

The problems related to ECE in Myanmar have been exacerbated by the political unrest that the country has been experiencing, resulting in widespread disruption within Myanmar's education system. Shortages and displacement of teachers have affected schools. Consequently, people with minimum educational background or experience started entering the education field to work as teachers. Among jobs preschool teacher positions are easy to apply for as the minimum requirement is an undergraduate degree. The schools faced challenges in recruiting qualified teachers for the required positions due to the need for more teachers (Thang, 2022).

Thus, this study looks at the current levels of ECE teacher competencies through the lens of the Southeast Asia Teacher Competency Framework to determine which competencies must be prioritized and developed. This study hopes to fill a gap in the research related to ECE in Myanmar and provide insight into the competencies needed to establish better quality teaching in the ECE context.

2. Research Objective

The research objectives for this study include:

1) To determine the current levels of teacher competencies according to the SEA-TCF in the context of early childhood education in Yangon, Myanmar.

2) To determine the desired levels of teacher competencies according to the SEA-TCF in the context of early childhood education in Yangon, Myanmar.

3) To find the priority needs development of teacher competencies according to the SEA-TCF in the context of early childhood education in Yangon, Myanmar.

3. Literature Review

This research focuses on investigating and prioritizing the competencies of early childhood teachers at schools in Yangon, Myanmar. The framework that underpins this study is the Southeast Asia Teachers Competency Framework. The main theory and discussion on teacher competencies and early childhood education in the context of Myanmar follow.

3.1 Southeast Asia Teachers Competency Framework (SEA-TCF)

The SEA-TCF was created by eleven Ministries of Education from Southeast Asia countries in July 2018 (SEAMEO-INNOTECH, 2018). It helps teachers evaluate their competencies to understand their needs for successful performance in students' learning processes. School leaders can use it to guide their schools' professional development plans. As per the SEA-TCF, teacher competency defines a combination of skills, knowledge, behavior, and attributes that enable effective or better education. Education today and tomorrow can be different as the world changes rapidly and demands for education increase. Therefore, teachers rely on a mix of skills to handle their challenging roles and deal with the changing education context. While the SEA-TCF is designed to provide a comprehensive set of standards to guide teachers in the Southeast Asian Region, the framework can draw from several theories to provide a comprehensive standard.

The SEA-TCF was used in this study to provide the framework for the expected or desired competencies that ECE teachers should have. It was chosen because it was developed by experts in the region, including Myanmar education experts, and is appropriate for ECE teachers in this context. The instrument developed for the SEA-TCF was used to determine the levels of current and desired competencies.

The four competencies in the SEA-TCF include *Knowing and Understanding What I Teach*, *Helping My Students Learn*, *Engaging the Community*, and *Becoming a better teacher every day*. Each of the main competencies is comprised of sub-competencies.

Know and Understand What I Teach: This competency includes three sub-competencies: 1) expanding knowledge of the subject matter, 2) understanding education trends, policies, and curricula, and 3) staying updated about local, national, regional, and global developments. There are also six enabling competencies with 18 success descriptors outlining tasks such as understanding subject content, utilizing research-based knowledge, and staying updated on trends and policies to enhance teaching and implement the curriculum.

Help My Students Learn: This competency compromises three sub-competencies: 1) Understanding the needs and strengths of students by carefully checking students' backgrounds, listening and observing them, utilizing the most effective teaching and learning approaches, and acknowledging and valuing their strengths; 2) Selecting suitable teaching and learning strategies to craft clear and understandable lessons and establishing a safe, healthy, and secure environment where all students can have equal learning opportunities; 3) Designing assessment tools to track the progression of each student for offering appropriate support and guidance, and using the results for self-reflection to enhance instruction.

Engage the Community: This competency involves three sub-competencies that demonstrate that teachers establish a network with parents and caregivers to foster a welcoming environment and maintain the partnership, involve the community in school activities to support student learning and promote respect for diversity and inclusion by embracing different cultures and differences within the classroom.

Become a Better Teacher Every Day: This competency encompasses three sub-competencies that explain firstly, teachers need to understand themselves and others to identify strengths and areas for improvement, be aware of one's emotions and well-being, and foster positive relationships with others. Secondly, practicing

kindness and compassion towards students and colleagues, maintaining a passion for teaching, and supporting students in achieving their learning objectives. Thirdly, engage in continuous professional development for personal growth and inspiration, share good practices, and provide peer mentoring to colleagues.

3.2. Teacher Competencies

"Competency" refers to a teacher's ability to carry out tasks mainly focused on teaching (Ololube, 2006, as cited in Estudillo, 2021). Nessipbayeva (2012) said that competency is more than just knowing things and having skills; it is about dealing with complex situations using mental and social resources, like skills and attitudes, in a specific setting. According to the Southeast Asia Teachers Competency Framework (SEA-TCF, 2018), competencies are a mix of skills, knowledge, behavior, and traits that lead to effective job performance. When teachers have the right skills, knowledge, and good relationships with students, students become happy learners, achieving a lot academically, emotionally, and physically, and there is a link between them.

Teaching is complicated, so a teacher uses various skills to handle the ever-changing education environment. Teachers need to use various methods, strategies, and techniques in instruction, classroom management, communication, problem-solving, and assessment to meet the complex demands of teaching. Teachers working with different age groups have specific competencies. Zarmri et al. (2019) mentioned that teacher competence is the standard for mastering educational competencies to meet current needs. Teaching competencies are the skills and abilities teachers need to support student learning and development effectively. One of the most important competencies is communication skills. Teachers must communicate clearly with students, parents, and colleagues, including explaining concepts in simple terms, listening actively, and providing constructive feedback that helps students improve. Classroom management is another key competency, as managing a classroom effectively is crucial for creating a positive learning environment. This involves establishing clear rules and handling disruptions calmly and fairly.

Subject knowledge is essential for teachers, as they must deeply understand the topics they teach and stay updated with the latest developments in their field. Instructional planning is also important, as teachers must design engaging lessons catering to different learning styles. This involves setting clear objectives, using various teaching methods, and adapting lessons. Assessment skills are crucial, as teachers must assess students' progress through tests, quizzes, and other methods, interpreting results to identify strengths and areas for improvement.

Cultural competency is vital in today's diverse classrooms. Teachers should understand and respect diverse backgrounds and perspectives, creating an inclusive environment where all students feel valued and respected. With the increasing use of technology in education, teachers should be comfortable using digital tools and resources to enhance learning. Emotional intelligence is another important competency, as teachers should be empathetic and aware of students' emotional needs, which helps build strong relationships and support social and emotional development.

Critical thinking and problem-solving are also essential competencies. Teachers should encourage students to think critically and solve problems by modeling these skills, asking thought-provoking questions, and guiding students through problem-solving. Finally, professional development is important, as teachers should be

committed to lifelong learning by seeking opportunities to improve their skills and stay informed about new teaching methods and educational research. Teachers can create a supportive and effective learning environment that helps all students succeed by developing these competencies.

Competence means a high level of professional performance, and in education, there is a direct link between a teacher's competence and student performance. All jobs require certain competencies. For example, even after getting a medical license, doctors need hands-on practice to sharpen their skills and apply their theoretical knowledge in real-life situations. Similarly, quality education involves effective teaching, organized lessons, and most importantly, competent teachers with high-quality skills for their students.

Peklaj (2015) explained how teacher competencies connect to student achievements using a model. To help students achieve, teachers focus on three processes: First, the (meta) cognitive processes, where students solve problems, actively recall what they learned, and form opinions by analyzing different aspects. They also take charge of their learning by planning, monitoring, evaluating, and correcting learning tasks. The second process, affective-motivational, happens when students set goals, form attitudes toward teachers, subjects, and peers, and develop educational interests and values. The final process, social, involves students building relationships within the school, including with teachers and peers.

3.3. Early Childhood Education in Myanmar

Early childhood care and development (ECCD) is a top priority in Myanmar. It is essential to recognize the importance of a child's early years in shaping their potential and enabling them to become productive citizens. Research has shown that high-quality preschool participation is critical for children's lifelong well-being, education, and development (Nasiopoulou, 2020). In Myanmar, increasing investments in child development from the government and non-governmental organizations is necessary to promote social and economic equity, enhance human capacity, and improve national competitiveness. Researchers agree that investing in early childhood education as a long-term strategy yields positive outcomes and is cost-effective.

In Myanmar, all preschools, including those operated by local, foreign, or non-governmental organizations, must register according to the Early Childhood Care and Development Law, enacted by the Union Hluttaw on February 6, 2014. These licenses are required to establish a licensed school and provide ECCD services, targeting children from birth to eight years old. These services can be conducted or sponsored by the Department of Social Welfare (DSW) of the Ministry of Social Welfare, Relief and Resettlement (MoSWRR), other organizations, or the private sector. The government is committed to strengthening social protection, which includes early childhood care and development, health, education, and social welfare, as integral parts of the country's expanded national economic development.

The Ministry of Social Welfare, Relief, and Resettlement led the development of a multisectoral Policy for Early Childhood Care and Development (ECCD) in collaboration with several ministries and organizations, including the Ministry of Education (MoE), Ministry of Health (MoH), and UNICEF. The ECCD policy aims to ensure that children in Myanmar, aged birth to eight years, receive comprehensive ECCD services to reach their

full developmental potential. These services aim to assist parents, caregivers, and service providers in holistically nurturing children.

Schools often hire teachers who need experience or a teaching background due to high demand and ease of getting a job. This is common in Myanmar's early childhood education sector, where working with young children is an easier way to earn money. Ball (2023) noted a need for more training and education opportunities in ECCD, leading to a shortage of qualified staff with the necessary skills and teaching competencies.

The Ministry of Education (MOE) reports challenges in preschools, such as ensuring high-quality services, involving parents in child development, and improving teacher training. The ECCD policy noted that most early primary schools in Myanmar use traditional methods, and teachers need new skills for a child-centered approach. The MOE highlighted challenges in improving education quality, infrastructure, and management in Teacher Education Institutions (TEIs), Education Colleges (EC), the University of Education (UOE), and the University for the Development of National Races (UDNR). A national continuous professional development (CPD) program to upgrade teachers' skills is crucial. By enhancing teacher skills, student learning outcomes in Myanmar's schools are expected to improve and meet educational goals.

3.4 Conceptual Framework of the Study
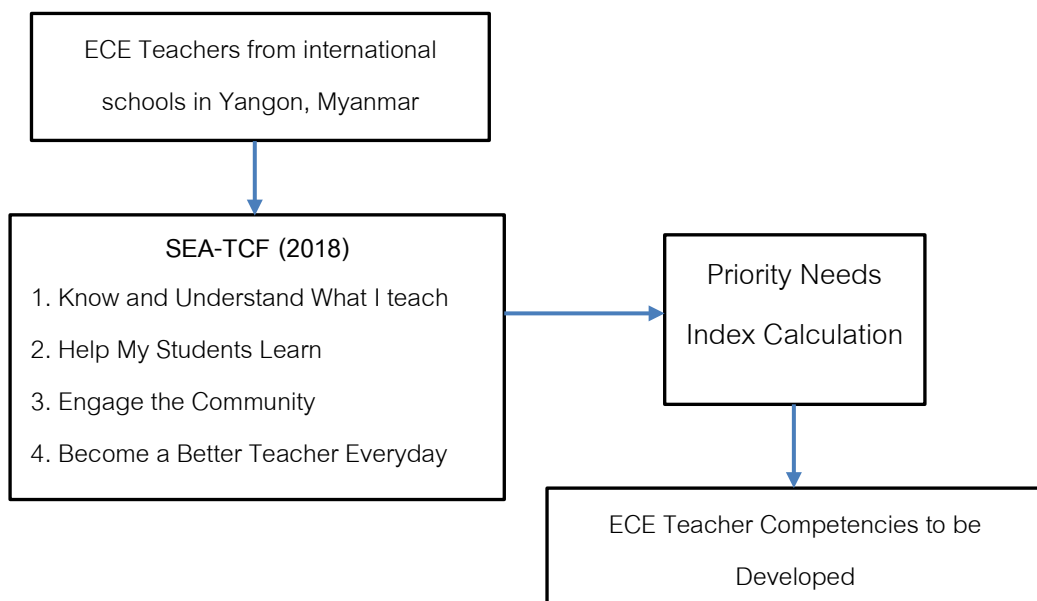
Figure 1: Conceptual Framework

4. Research Methodology

4.1 Research Design

The methodology used in this study was a needs assessment research design. The researcher adapted an existing tool to evaluate the teaching competency needs of ECE teachers in the target group. The Modified Priority Index (PNI$_{modified}$) method was used to identify these needs. The PNI calculation is based on a method developed by Wongwanich et al. (2014). This method involved identifying the current and expected levels of competencies

and calculating the differences (means and standard deviations) for each main component, sub-component, and individual question item. Competencies with the largest statistical differences in means were prioritized.

4.2 Population and Sample

This study focused on early childhood teachers from international schools in Yangon, Myanmar. One hundred ninety-five early childhood teachers participated in this study in the 2023-2024 academic year. The researcher used a non-random, purposive sampling technique, which resulted in total population sampling. Table 1 shows the number of teachers by school and the sample size.

Table 1: Population and Sample of Teachers at the Schools Included in the Study

	School	μ	σ
1	International School A	21	21
2	International School B	30	30
3	International School C	26	26
4	International School D	28	28
5	International School E	50	50
6	International School F	40	40
	Total	**195**	**195**

4.3 Research Instrument

The research instrument consisted of two parts. Part I gathered demographic information such as gender, age, education, and years of experience. Part II included thirty-one questions from the SEA-TCF (2018) in four areas: *Know and Understand What I Teach*, *Help my Students Learn*, *Engage the Community*, and *Become a Better Teacher Every Day*. The SEA-TCF has been used in other studies of teacher competencies and has been tested for both validity and reliability. Although frequent use of an instrument in many studies does not guarantee its validity, it can suggest potential validity through peer-reviewed research and evaluation by experts. The following research has used the SEA-TCF: Thongphukdee and Ratana-o-larn (2021); Mhunpiew et al. (2021); Amihan et al. (2023); and Saenghong et al. (2024). For the current study, the overall Cronbach's alpha score was 0.98. The four primary competencies—"Help My Students Learn," "Knowing and Understanding What to Teach," "Engage the Community," and "Become a Better Teacher Every Day"—had corresponding Cronbach's alpha values of 0.98, 0.96, 0.93, and 0.94.

4.4 Data Collection

The schools were contacted, and permission was granted to collect data. The data collection process took place over three weeks, from June to July 2024, and the research instrument was distributed to participants in person. Participation in the survey was voluntary, and to maintain research ethics, every effort was made to ensure the anonymity of schools and respondents and the confidentiality of data.

4.5 Data Analysis

The Priority Needs Index (PNI$_{modified}$) method was used where the current and expected levels were identified, and the difference (means and standard deviation) were calculated for each main component, sub-component, and individual question item. Based on the participants' perspectives, the PNI illustrates the importance of discrepancies in prioritizing the needs for appropriate development. The PNI$_{-modified}$ formula is as follows:

$$PNI_{modified} = \frac{I - D}{D}$$

The competencies that had means with the highest statistical differences were prioritized.

The "I" (Importance) refers to the desired or expected state of the teacher competencies being evaluated in the survey. The "D" (Degree) refers to the current state or level of those competencies. A low PNI modified score or mean value level indicates that the current state is weak or deficient in that particular competency area. This signals a need for improvement and more attention to enhance that competency. In other words, a low PNI modified score demonstrates that improvement is required in that particular area of teacher competencies.

5. Research Findings

5.1 Demographic Findings

The research involved 195 ECE teachers, 181 females (92.8%) and 14 males (7.2%). The participants were divided into four age groups: 75 teachers (38.5%) aged 18 to 25 years, 90 teachers (46.2%) aged 26 to 35 years, 27 teachers (13.8%) aged 36 to 45 years, and three teachers (1.5%) aged 46 to 55 years. Of the total number of teachers, 22 (11.3%) have completed high school. The majority, 149 teachers (76.4%), hold a Bachelor's degree. In addition, 15 teachers, or 7.7% of the total, have earned a Master's degree. The remaining nine teachers, accounting for 4.6%, have diplomas or certificates classified as 'Others.' The data highlights that a Bachelor's degree is the most common level of educational attainment among these teachers. There were no teachers in this group with a Doctorate. According to the data, 27 teachers, representing 13.8% of the total, have less than six months of experience. The largest group, 71 teachers (36.4%), have between seven months and two years of experience. A significant portion, 45 teachers or 23.1%, have three to five years of experience. Additionally, 32 teachers, accounting for 16.4%, have six to ten years of experience. The remaining 20 teachers, or 10.3%, have over ten years of experience. These results indicate that most teachers, 71 individuals or 36.4%, have between seven months and two years of experience.

5.2 Teaching Competency Results

The data in Table 2 indicate that the teachers' highest current competency was "Become A Better Teacher Every day," with a mean score of 3.17, while the lowest current competency was "Know and Understand What I Teach," with a mean score of 2.75. Consequently, the mean score for teachers' current competencies as a whole was 2.97, translating to a Moderate-High rating.

Table 2: *Summary of Current/Degree Levels of Competencies (n=195)*

No	Competency	N	Minimum	Maximum	Mean	σ
1	Know and Understand What I teach	195	1.00	4.00	2.75	.74735
2	Help My Students Learn	195	1.00	4.00	3.01	.70243
3	Engage the Community	195	1.00	4.00	2.94	.67023
4	Become A Better Teacher Everyday	195	1.44	4.00	3.17	.59357
	Average	**195**	**1.42**	**4.00**	**2.97**	**.61008**

The data presented in Table 3 shows that the highest desired competency among teachers was "Help My Students Learn," with a mean score of 3.70. Meanwhile, the lowest current competency was "Know and Understand What I Teach," with a mean score of 3.51. As a result, the overall mean score for teachers' desired competencies was 3.61, which corresponds to a high rating.

Table 3: *Summary of Desired/Important Levels of Competencies (n=195)*

No	Competency	N	Minimum	Maximum	Mean	σ
1	Know and Understand What I teach	195	1.00	4.00	3.51	.55805
2	Help My Students Learn	195	1.22	4.00	3.70	.42437
3	Engage the Community	195	1.86	4.00	3.57	.46109
4	Become A Better Teacher Everyday	195	1.78	4.00	3.67	.45054
	Average	**195**	**1.73**	**4.00**	**3.61**	**.40514**

A paired sample t-test was conducted to verify that the means obtained for the current and desired levels of teacher competencies were statistically different, thereby justifying the need for the PNI calculations. This statistical method compares the means of two related groups. The t-test analysis of teacher competency levels revealed significant differences between the current and desired levels, as indicated by the results in Table 4. Therefore, the justification for doing the priority needs analysis was confirmed.

Table 4: *The Comparison of Current and Desired Levels of ECE Teachers' Competencies by Paired Sample Test*

Paired Samples Test

Paired Differences

	Mean	Std. Deviation	Std. Error Mean	95 % Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 Current and Desired level of Know and Understand What I teach	-.76239	.87537	.06269	-.88603	-.63876	-12.162	194	.000
Pair 2 Current and Desired levels of Help My Students Learn	-.69608	.77965	.05583	-.80620	-.58597	-12.468	194	.000
Pair 3 Current and Desired levels of Engage the Community	-.63590	.72222	.05172	-.73790	-.53389	-12.295	194	.000
Pair 4 Current and Desired levels of Become a Better Teacher Everyday	-.50028	.60358	.04322	-.58553	-.41504	-11.574	194	.000

*p value < 0.05

Following the paired samples t-test results, the PNI was calculated for each of the competencies and individual items. Table 5 presents the current and desired levels of teacher competencies for ECE teachers and the Priority Needs Index (PNI). Participants rated the current level as Moderate-High, with an overall mean score of 2.97, and the desired level as High, with an overall mean score of 3.61.

Using the modified Priority Needs Index (PNI), the data analysis ranked teacher competencies in order of priority. The highest priority was "Know and Understand What I Teach," with a PNI modified value of 0.2763. "Help My Students Learn" ranked second with a PNI modified value of 0.2292, followed by "Engage the Community" in third place with a PNI modified value of 0.2142. The lowest priority was "Become a Better Teacher Every Day," with a PNI modified value of 0.1577.

Table 5: *Ranking of ECE Teacher Competencies in Order of Importance*

Competency	Importance (I)	Degree of Success (D)	PNI= (I-D)/D	Rank
Know and Understand What I teach	3.51	2.75	0.2763	1
Help My Students Learn	3.70	3.01	0.2292	2
Engage the Community	3.57	2.94	0.2142	3
Become A Better Teacher Everyday	3.67	3.17	0.1577	4
Overall	**3.61**	**2.97**		

*PNI modified = (I – D) / D. In this formula, (I) represents importance (the desired state), and D represents the degree of success (the current state). The PNI value indicates the significance of the gap; a higher value denotes greater priority for improvement.

6. Discussion

The demographic profile of the 195 ECE teacher participants highlighted several findings. Notably, there was a predominance of female teachers, making up 181 participants. However, the participants' age, educational background, and work experience did influence their teaching competencies. As the study observed, from 2021 to the present (2024), due to the political situations in Myanmar, which make the education system unstable, the shortage of teachers and growing demand in the school market resulted in the hiring of individuals from other career fields who are jobless with at least a Bachelor's degree, even if they lack formal teaching experience. This trend was evident in the demographic data, which indicated that the largest group of participants was 26-35 years old and supposed to have work experience of at least over three years and above if they graduated at 21. The majority (149 teachers) had a Bachelor's degree as their highest level of education.

Additionally, the work experience of the participants was predominantly on the lower side, with 71 teachers having between 7 months to 2 years of experience, and 27 teachers with less than six months of experience. These demographic findings suggest that the overall teaching competencies among the participants were moderate to high. This can be attributed to the recent influx of individuals entering the ECE teaching profession, many of whom have the minimum educational qualifications but need more extensive classroom experience.

The current study in Myanmar produced findings consistent with three previous studies on teacher competency levels. The earlier studies by Mhunpiew and Asavisanu (2023) and Abanador and Laganao (2020) used the SEA-TCF \ questionnaire to assess teacher competency levels. Across these studies, the competency "Become a Better Teacher Every Day" consistently ranked first and received the highest score among the four competencies assessed. Teachers from these studies possessed several key abilities, such as self-awareness and understanding of others. For instance, they can assess their strengths and areas for growth, manage their emotions effectively during conflicts, and address mental and physical health challenges. They also foster strong relationships within and outside the school, ensuring positive interactions with colleagues and others involved in their work.

Additionally, teachers demonstrate human goodness in their personal and professional lives by showing kindness and compassion and setting high standards as role models for students and colleagues. They avoid favoritism, build students' confidence by creating opportunities, and help uncover students' talents and skills. Furthermore, teachers are committed to ongoing professional development, sharing best practices at local and international events, mentoring new teachers, and publishing research findings in various journals and conferences. The current study in Myanmar also found this competency to be the highest scoring. In two of the previous studies, conducted by Mhunpiew and Asavisanu (2023) in Thailand and Abanador and Laganao (2020) in the Philippines, the teacher competency levels mirrored the current study's findings, ranking "Become a Better Teacher Every Day" first, followed by "Help My Students Learn," "Engage the Community," and "Know and Understand What I Teach" in that order. Teachers from Myanmar, Thailand, and the Philippines agree that "Becoming a Better Teacher Every Day" is the most crucial competency for a competent teacher. To achieve this, teachers must identify areas for growth and improvement, maintain self-awareness of their physical and mental health, create a positive environment, and build strong relationships with parents, colleagues, and students. They should practice kindness by listening to others, serving as role models at school, encouraging students and supporting their strengths to boost confidence, committing to lifelong learning and personal and professional development, and sharing their knowledge with the school community and international gatherings.

Based on the PNI (Priority Needs Index) analysis, the research findings indicate that Yangon teachers have room for improvement in the competency area of "Knowing and Understanding What to Teach." This competency ranks lowest among the four because Myanmar teachers needed help incorporating research findings into their practice. They needed to be more familiar with research, and much of the training and professional development programs they received did not emphasize the value of research-based knowledge. This disconnects between theory and practice has led to a disconnection between teachers' understanding of educational policies, trends, and curricular developments and their ability to translate these insights into their instructional approaches meaningfully. Most training focused on creating lesson plans, conducting classes, managing schedules, and handling interactions with parents and students. As a result, teachers were unable to connect educational policies and trends to their teaching practices and needed more insight to update or implement curricula based on new developments. Instead, they followed the methods prescribed by their schools, unaware that curricula can be adaptable and flexible according to current trends and policies. To address this competency gap, a comprehensive approach is needed. This includes providing targeted professional development to help teachers engage with educational research and changing teacher training programs to incorporate research into classroom practice better. By implementing these efforts, Myanmar can improve the teaching profession and enhance students' education quality.

7. Recommendations

This section suggests recommendations to enhance the competencies of early childhood education (ECE) teachers. Although the self-assessed competencies are already considered high, there are always

opportunities for further improvement. These recommendations are intended for teachers and school administrators in the field of ECE.

Teachers can use several strategies to improve the content they teach to support professional growth and enhance teaching quality. First, it is important to participate in continuous professional development. Attending workshops, seminars, and conferences helps teachers stay up-to-date with the latest research and advancements in their subject areas, allowing them to bring new knowledge and techniques into their classrooms. Additionally, using various resources, such as books, online articles, videos, and interactive tools, can make lessons more engaging and cater to different learning styles.

Collaboration with colleagues is another effective way to improve content delivery. Teachers can gain new ideas and perspectives by sharing insights and teaching strategies. Collaborative planning sessions and peer observations are especially helpful for this. Seeking feedback from students is also essential, as it helps teachers understand which parts of the content students find challenging or engaging, allowing them to adjust their approach for better effectiveness and relevance.

Aligning lessons with national curriculum standards ensures that teaching materials meet educational requirements. Integrating technology into lessons can also make content delivery more interactive and engaging. Using real-world examples helps students see the relevance and importance of their learning. Teachers can use case studies, current events, and practical examples to make abstract concepts more tangible. Pursuing advanced education, like taking advanced courses or earning additional certifications, can increase teachers' content knowledge and introduce new teaching methods. Reflecting on and revising teaching practices based on student outcomes and feedback leads to continuous improvement. Finally, joining professional networks, such as associations or online forums, gives teachers access to resources, discussions, and collaborations with experts in the field.

School administrators can help teachers become more competent by providing support, resources, and opportunities for professional growth. One important way is to offer professional development through regular workshops and training sessions focusing on new teaching methods, curriculum updates, or technology integration. Administrators can also fund teachers to attend external conferences and seminars. Creating a collaborative environment is crucial, so administrators should set up professional learning communities where teachers can share best practices, discuss challenges, and develop new strategies together. Implementing mentorship programs that pair new teachers with experienced mentors can provide guidance and support, helping them navigate challenges and improve their skills.

Encouraging reflective practices is also important. Administrators can provide time and resources for teachers to engage in self-assessment, such as peer observations. Regular feedback from administrators can help teachers identify areas for improvement. Facilitating technology integration through training and access to the latest tools can enhance teaching and learning.

Recognizing and rewarding teachers who demonstrate competence and dedication can motivate others. Administrators can create recognition programs that celebrate achievements and provide incentives for growth. Promoting work-life balance is essential for teachers' well-being, so administrators should offer mental health

resources and encourage a healthy work environment. Lastly, providing up-to-date teaching materials and educational technology so teachers have what they need for effective instruction.

This study was conducted in Yangon, and expanding the research to other cities across Myanmar would be valuable to assess the competency levels of teachers in different regions. By analyzing and comparing the results from future studies, governments, schools, and educational institutions can better understand teachers' development needs and provide professional development programs to support them nationwide. This would significantly impact the overall education sector in Myanmar.

Since Myanmar, Thailand, and the Philippines have used the SEA-TCF to assess teacher competency levels, researchers in other Southeast Asian countries are encouraged to conduct similar studies to evaluate their teachers' competencies. Comparing the results across different countries will help refine and improve the framework to meet teachers' needs throughout Southeast Asia.

This study was conducted specifically for local teachers at six international schools and did not include foreign ECE teachers from those six schools. In Addition, the findings of this study are limited to the local teachers at the six specific international schools examined. The results may represent only some ECE international school teachers in Yangon and could differ from those at other international schools in the city. In other words, the perspectives and experiences of ECE international school teachers at other international schools in Yangon could potentially be different.

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Effects of Using A Role-play Activity on English Speaking Ability of Students at Rajamangala University of Technology Lanna Lampang

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ABSTRACT

The objectives of this study were to compare English speaking ability of students before and after learning with a role-play activity, and to study the satisfaction of the students with a role-play activity. The sample comprised 20 students enrolled in English for Communication in the summer course of the 2023 academic year at Rajamangala University of Technology Lanna Lampang. The total duration of the study was 21 hours, including 15 hours of instruction, 3 hours for a pre-test, and 3 hours for a post-test. The research instruments consisted of: 1) five lesson plans using a role-play activity, 2) an English speaking ability test, 3) an English speaking ability assessment, and 4) the satisfaction questionnaire regarding students' perceptions of the lessons by using a role-play activity. The data analysis employed statistical methods such as mean, standard deviation, and a dependent samples t-test. The findings indicated: 1) a statistically significant improvement ($p < 0.05$) in the English speaking ability of students after participating in using a role-play activity; 2) the satisfaction regarding students' perceptions of the lessons by using a role-play activity has a mean score of 4.55 with a standard deviation of 0.19, indicating highly satisfied of satisfaction.

Keywords: A Role-play Activity, Student's Speaking Ability, Students' Satisfaction

1. Introduction

The English Language is a globally influential means of communication that has evolved over centuries, originating in England but now spoken and understood by millions worldwide, which serves as a bridge between people of different cultures, enabling them to exchange ideas, conduct business, and engage in various forms of social interaction (Crystal, 2003). English has become the global language due to its universal qualities, facilitating communication and relationships worldwide amid rapid technological advancements. It plays a vital role in international business, science, education, travel, and tourism, serving as a common language across various sectors. English's dominance in today's globalized world underscores its importance as a global means of communication (Rao, 2019).

Thailand has faced persistent challenges in English language teaching and learning, with many Thais struggling to use English effectively. Thai students often lack opportunities to practice English, leading to low confidence and proficiency in speaking. Cultural tendencies to avoid making mistakes further exacerbate these issues. Research shows that Thai students have very low communicative English proficiency despite extensive study, and Thailand is consistently ranked at a very low level on the English Proficiency Index (Paesupat, 1998; The Thailand Research Fund, 2012). Brown (2001) identified major obstacles to successful second language acquisition, especially in speaking skills, such as uncertainty about what to say, fear of making mistakes, and fear of losing face. These barriers are often due to traditional English teaching methods that emphasize grammar over speaking practice and lack engaging, conversational materials. As a result, many learners struggle with speaking English effectively.

English language education typically comprises four core skills: listening, speaking, reading, and writing. Among these, speaking is particularly vital in second‑language settings, as it is often used for daily communication. Speaking is perhaps the most essential human skill, typically practiced without much reflection on the underlying processes (Hayrire, 2004). It involves the oral production of words or sentences, facilitating effective communication between people. However, students often face difficulties in developing their speaking skills. Speaking is communicating ideas and feelings in an ordinary voice. It requires being able to use words to express yourself, and knowing how to use language in a way that reflects who you are (Nurdevi, 2013). The writer believes that speaking uses the word and build the sound to deliver our ideas, feelings, thoughts, and will aloud in an ordinary voice. Besides, success in communication is often dependent as much on the audience as on the speaker. Moreover, speaking is an effective skill in the verbal mode. It can be more complicated than it seems at begin with, and it involves more than just pronouncing words correctly (Godoy,2012).

Moreover, several factors impact students' speaking skills, including interest, materials, media, and teaching techniques (Fadilah, 2016). Flowerdew and others (2005) identify seven challenges in speaking, such as speed control, limited vocabulary, and difficulty in recognizing cues and transitions, which can hinder students' speaking abilities. Addressing these challenges is crucial for improving speaking skills. The teacher's choice of method greatly influences students' interest and practice, especially in contexts where classroom practice is the main opportunity for speaking English, as in Indonesia (Rabbani and others, 2016). To enhance speaking skills, teachers have introduced innovative methods like role-play.

To address these issues, innovative teaching methods such as roleplay have been introduced to enhance speaking skills. Roleplay offers students the opportunity to practice speaking in various social contexts, allowing them to create dialogues based on different themes and assume diverse perspectives (Fadilah, 2016). This method supports speaking development by encouraging creativity, helping students overcome the challenges posed by a lack of daily English conversations (Nunan, 2020). Additionally, role play helps reduce the apprehension and lack of confidence that many students feel (Fifa, 2020; Nunan, 2020). Through roleplay, students engage in meaningful activities that promote confidence, expand vocabulary, and facilitate the practical use of English (Adib, Munawaroh, & Darussalam, 2022).

Roleplay is a widely‑used communicative technique in English classrooms that fosters fluency, encourages peer learning, and increases classroom interaction (Ladousse, 1987). It also aids in social, emotional, physical, and cognitive development, making it an effective method for teaching English as a second language (Anis, 2020). By providing opportunities for creative language use and real‑life conversation simulations, roleplay has been shown to significantly improve students' speaking skills (CJ, L, 2018; Hattings, 1993, cited in Lee & Park, 2017).

Based on the problems in speaking skill above; the researcher is interested to use a role-play activity to develop students speaking ability. Based on the researchers' observation during the teaching experiences in high vocational certificate students at Rajamangala University of Technology Lanna Lampang, there are some problems in teaching‑learning English speaking skill. The problems were that the students were shy or lack confidence and ability to speak in English. When teachers ask them to answer the questions and present their works in front of the class, they are still shy and afraid to do so. As the result, when the researcher asks the students why they keep quiet, most of them say that they do not know how to speak and are afraid to make mistakes. They lack self‑esteem to try to speak English as they are afraid of making mistakes. That makes them unable to express their ideas in English. The classroom activities do not give many opportunities to students to show their capacity in speaking skills also. Therefore, using a role-play activity could be one of the most effective teaching methodologies to cope such problem. The outcomes of this study will be presented in a dependent study titled "Effects of A Using Role-play Activity on English Speaking Ability of Students at Rajamangala University of Technology Lanna Lampang."

2. Research Objective

(1) To compare English speaking ability of students before and after learning with a role-play activity

(2) To study the satisfaction of the students at Rajamangala University of Technology Lanna Lampang after learning with a roleplay activity

3. Literature Review

English Speaking Ability

According to Harmer (2000), learners should know "language features" and the ability to process them in communication. If the speaker dominates these language features, will help learners to acquire successful communication goal. Speaking does not cover just knowing the linguistic feature; linguistic feature of the message expanding oral communication requires more than memorized vocabulary and grammatical comprehension.

Derakhshan (2015) states one of the obstacles of learning speaking is contradiction between class materials and courses, so that most of the teachers do not facilitate situations for real practice in speaking. Besides, the teacher should take into account learners' interest and needs. Learners should take part in oral activities to exchange spontaneously their thought in second language speaking.

Mackey (2007) defines speaking as oral expression that involves not only the use of right patterns of rhythm and intonation but also that of right words order to convey the right meaning. Manser (2000), speak is talk to somebody about something, use your voice to say something; be able to use a language; make a speech to an audience; say or state something.

From the definitions above, it can be concluded that speaking is the most important skill of language which is about expressing ideas, opinions, or feelings to others by using words or sounds of articulation in order to inform, to persuade, and to entertain.

Roleplay

A role-play activity, as described in the literature, is an effective method for enhancing language skills by simulating real-life scenarios where learners can practice spontaneous communication. Harmer (2015) emphasizes the importance of role-play in fostering communicative competence, highlighting its ability to create an immersive environment where learners can practice language in a way that reflects authentic social interactions. According to Harmer, such activities promote fluency by encouraging learners to use language creatively, rather than merely recalling memorized phrases or structures. This aligns with the principles of communicative language teaching, which prioritize interaction and meaningful use of language.

Similarly, Lee and Park (2021) found that role-play activities significantly enhance students' confidence and motivation in language learning. Their study showed that students engaged in role-play exhibited higher levels of enthusiasm and willingness to communicate, likely because role-play reduces the pressure of real-life communication by allowing learners to act out specific roles. Lee and Park argue that role-play also helps students develop pragmatic skills, as they learn to adjust their language to suit different social contexts, which is essential for effective communication. Overall, role-play is a valuable tool in language instruction, providing a balance between structure and freedom that enables learners to actively engage in and internalize new language concepts.

Related Studies

Islam and Islam's (2012) research contribute to the understanding of role play as an effective pedagogical tool for enhancing English language skills, particularly in developing speaking abilities and increasing student motivation. Their findings align with a broader body of literature that emphasizes the benefits of interactive and engaging teaching strategies in language education. The implications of their study underscore the importance of incorporating role play in language curricula, particularly in contexts where real-world communication skills are essential.

Harmer's (1991) work has significantly influenced language teaching methodologies, particularly in promoting communicative and interactive approaches to language learning. His insights into the importance of interaction, task-based learning, role play, and motivation continue to be supported by contemporary research in language education. For educators, incorporating these principles can enhance the effectiveness of teaching practices and improve students' speaking skills.

Joyce & Weil (2001), as cited in Kunaruk (2015), who describe role-play as a learning activity that simulates real-life situations. Such activities provide examples for students to understand real-life roles and enable

them to respond emotionally and behaviorally. This role-playing is also a critical factor in effectively developing speaking skills.

Rossukon Thoaubon (2019), who studied the effects of using role-play activities in teaching to improve students' English-speaking skills in a communication-focused curriculum. The research showed a significant improvement in students' English-speaking abilities after learning through role-play activities, with statistically significant results at the .05 level. The learners' satisfaction with the role-play-based teaching approach for developing English-speaking skills was also at a high level.

3.2 Research Framework
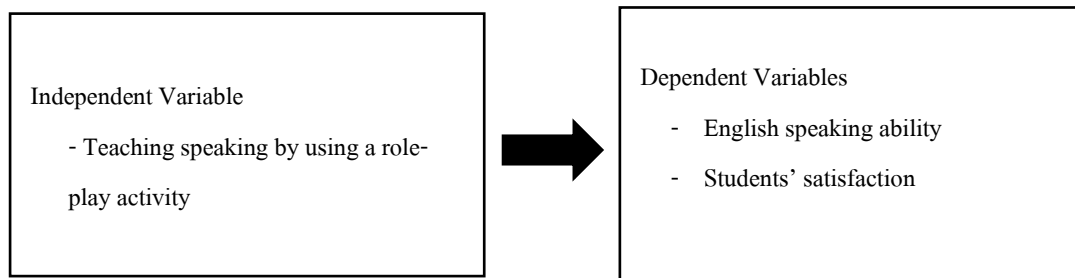
Figure 1 Research Framework

3.3 Research Hypotheses

English speaking ability of students after learning with a role-play activity is higher than before learning with a role-play activity.

4. Research Methodology

4.1 Research Design

This research is a quasi-experimental study using the one group pretest-posttest design.

4.2 Sample Group

There are twenty students in high vocational school level who enrolled in English for communication in the summer course of the 2023 academic year at Rajamangala University of Technology Lanna Lampang by cluster sampling.

4.3 Research Instrument

The instruments utilized in this research consist of

1) five lesson plans

2) An English speaking ability test divided into 2 sections; individual interview and situation-based conversation role-play

3) An English speaking ability assessment

4) The satisfaction questionnaire regarding students' perceptions of the lessons by using a role-play activity is divided into four aspects: 1) content, 2) role-play activities, 3) learners, and 4) teaching materials/lessons with a total of 15 items using a five-level Likert scale format.

4.4 Data Collection

The procedures for experiment data were collected from a sample group as follows:

1) The English speaking ability test using a role-play activity was conducted as a pre-test. The test consists of two parts: an individual interview with 10 questions and a situation-based conversation. Students drew lots from 5 situations and chose only one. Each pair was given 3-5 minutes for their selected situation. The English speaking ability evaluation criteria, based on a role-play activity, were used to assess each student individually. The pre-test scores were recorded for comparison with the post-test scores.

2) The experiment was conducted over 5 weeks, with 3 hours per week, totaling 15 hours. The teaching process for each lesson was divided into three stages:

2.1) Preparation Stage:

The teacher reviews vocabulary and grammar, introduces the lesson, and states the objectives. A sample dialogue is presented that connects the content and context of the role-play activity, which includes individual, pair, group, and whole-class activities.

2.2) Practice Stage:

The teacher presents a dialogue related to the lesson content, reads aloud, and demonstrates role-play scenarios. The teacher creates roles in the given situation, and the students then perform the role-play.

2.3) Production Stage:

Students pair up to create dialogues based on the given situation and perform the role-play. The teacher provides feedback and suggestions regarding the activity and the performers. The teacher also asks students for their opinions on any problems or challenges faced during the activity, as well as their own suggestions for improvement.

3) After the students completed all 5 lessons, the teacher conducted a post-test using the same method as the pre-test. Students drew lots from 5 situations and chose only one to perform a role-play based on the situation they received. The English speaking ability evaluation criteria were used to assess each student individually.

4) The students completed the satisfaction questionnaire regarding students' perceptions of the lessons by using roleplay activities is divided into four aspects: 1) content, 2) role-play activities, 3) learners, and 4) teaching materials/lessons with a total of 15 items

5) The scores from the English speaking ability test and the satisfaction survey were analyzed using statistical methods.

6) The researcher reported research's results and conclusions.

4.5 Data Analysis

1) Comparison of English speaking ability using dependent T-test

The English speaking ability of students, which incorporated using roleplay activities, was compared using dependent t-test statistics. This test evaluates whether there is a significant difference in the students' ability levels pre- and post-test. The dependent t-test is appropriate here because it compares the means

of the same group of students at two different times (before and after the intervention), taking into account the paired nature of the data.

   2. Analysis of the satisfaction regarding students' perceptions of the lessons by using roleplay activities

   To analyze the satisfaction regarding students' perceptions of the lessons by using roleplay activities to develop English speaking ability, a satisfaction survey was conducted. The satisfaction questionnaire regarding students' perceptions of the lessons by using a role-play activity is divided into four aspects: 1) content, 2) role-play activities, 3) learners, and 4) teaching materials/lessons with a total of 15 items, rated on a 5-point Likert scale, where respondents indicated their level of satisfied with each statement.

5. Research Findings

   1) The result of data analysis for comparing students' English speaking ability before and after learning through a role-play activity

Table 1 A comparative analysis of English speaking ability scores before and after learning by using a role-play activity of 20 students, totally 2 sections.

English speaking ability	$\overline{X}$	SD	$\sum D$	$\sum D^2$	t	P
Pretest	18.7	2.20				
			265	3,753	16.61	.000
Posttest	32.0	4.50				

  *Significant at the 0.05 level (p<0.05)

   Based on the table 1, the students' pre-test and post-test scores averaged 18.7 and 32.0, respectively. A comparison of the students' English-speaking ability before and after the course revealed that the post-test scores were significantly higher than the pre-test scores at the .05 level of statistical significance.

   2) The result of data analysis for studying the satisfaction regarding students' perceptions of the lessons by using a role-play activity

Table 2 The results of the satisfaction questionnaire regarding students' perceptions of the lessons by using a role-play activity

Statements	Mean	S.D.	Level
1. Content Aspect			
1) The lesson content is interesting.	4.53	0.51	Highly Satisfied
2) The difficulty level of the content is appropriate for the students' level.	4.60	0.50	Highly Satisfied
3) The lesson content is relevant to situations students encounter in daily life and work.	4.50	0.57	Satisfied
Average scores of content aspect	**4.54**	**0.28**	**Highly Satisfied**
2. Activity Aspect			Satisfied
4) The activities are well-organized, progressing from easy to difficult.	4.47	0.51	Satisfied
5) The activities effectively enhance students' understanding.	4.53	0.51	Highly Satisfied
6) The activities help improve students' English-speaking skills.	4.60	0.50	Highly Satisfied
7) The activities allow students to apply their knowledge in real situations.	4.43	0.57	Satisfied
Average scores of activity aspect	**4.51**	**0.26**	**Highly Satisfied**
3. Learner Aspect			
8) Role play increases students' interest in learning.	4.53	0.57	Highly Satisfied
9) Role play enhances students' motivation to learn.	4.63	0.49	Highly Satisfied
10) Role play boosts students' confidence in using English.	4.60	0.56	Highly Satisfied
11) Role play improves students' attitudes towards learning English.	4.50	0.57	Satisfied
Average scores of learner aspect	**4.57**	**0.28**	**Highly Satisfied**
4. Teaching Materials/Lesson Aspect			
12) The teaching materials are appropriate for the students' level.	4.57	0.50	Highly Satisfied
13) The teaching materials help enhance students' speaking skills.	4.57	0.50	Highly Satisfied
14) The teaching materials stimulate students' interest in the content.	4.53	0.51	Highly Satisfied
15) The teaching materials make the lesson easier to understand.	4.63	0.50	Highly Satisfied
Average scores of teaching materials / lesson aspect	**4.58**	**0.20**	**Highly Satisfied**
Total average scores	**4.55**	**0.19**	**Highly Satisfied**

From Table 2, it is found that the satisfaction regarding students' perceptions of the lessons by using roleplay activities has a mean score of 4.55 with a standard deviation of 0.19, indicating highly satisfied of

satisfaction. When considering the satisfaction levels by aspect, it was found that students' satisfaction was at the highest level in all aspects.

6. Discussion

1. The findings from Research Question 1 indicated that students' English speaking ability significantly improved after engaging in a role‑play activity, demonstrating a meaningful difference at a significance level of .05. This improvement can be attributed to 3 factors as follow:

1.1 Challenging Teaching Methods: The role‑play activities were well‑suited to the students' proficiency levels, enhancing their vocabulary, pronunciation, and sentence structures. These foundational skills fostered confidence and understanding of language use, as emphasized by Harmer (1991), who advocated for teachers to introduce unfamiliar language concepts. Harmer (2008) further noted that effective speaking involves not only knowledge of the language but also the ability to produce it, considering elements like tone and body language.

1.2 Motivational Activities: The designed speaking activities motivated students to use English more naturally. Techniques such as drilling, structured training, and prompting questions facilitated active participation and correction of language errors, aligning with Richards and Rogers (1986), who described Situational Language Teaching as a method for developing speaking skills through practice and repetition.

1.3 Increased Confidence and Motivation: Role-play activities enhanced students' confidence and motivation to learn, resulting in higher post‑test scores compared to pre‑tests. This finding supports Islam and Islam (2012), who indicated that role‑play promotes fluency and fosters a positive attitude toward speaking. Additionally, Joyce & Weil (2001), as cited in Kunaruk (2015), highlighted that role‑play simulates real‑life situations, helping students understand their roles and respond appropriately, which is crucial for developing effective speaking skills.

2. The findings from Research Question 2 indicated a high level of student satisfaction with lessons incorporating role-play activities, evidenced by a mean score of 4.55 (SD = 0.19). The results can be detailed in the following areas:

2.1 Satisfaction with Teaching Materials: Students rated their satisfaction with teaching materials at 4.58 (SD = 0.20). The use of authentic materials and real‑life scenarios in role‑play activities enhanced understanding and engagement. This aligns with Ladousse (1987), who noted that role‑play encourages participation among shy learners, while role-related dress-ups further increase interest.

2.2 Satisfaction with Learner Development: Students expressed high satisfaction (mean score of 4.57, SD = 0.28) with their English‑speaking skills, noting that practice built their confidence and proficiency. This supports the views of Eckard and Mary Kearny (1981) and Littlewood (1995), who described role-play as a natural means of expression in simulated situations, enhancing language competence through guided practice.

2.3 Satisfaction with Content Relevance: Students rated their content satisfaction at 4.54 (SD = 0.28), appreciating the relevance and appropriateness of the material to their lives. The structured content,

designed to complement role-play activities, allowed students to logically apply their learning, which aligns with Richards and Rodgers (1986) who emphasized the importance of varied practice in language learning.

2.4 Satisfaction with Role-Play Activities: Students reported high satisfaction (mean score of 4.54, SD = 0.28) with role-play activities, noting improvements in understanding and motivation. The activities allowed for creative expression and active participation, aligning with Brown (2001), who highlighted the importance of engaging activities tailored to student interests. The three-step teaching method—Preparation, Demonstration, and Practice—further supported students' gradual skill development, consistent with Mason (2006) and Ments (1989), who emphasized the effectiveness and enjoyment of role-play in language learning. Rossukon Thoaubon (2019) also found that role-play significantly improved students' English-speaking abilities, indicating high satisfaction with this teaching approach.

7. Suggestion

1) The role-play situation which can be adapted to develop grammar accuracy in students' writing skill.

2) Appropriate teaching model or giving situations without conversation which can be useful for students who are poor at English and who need to create it by themselves

8) Acknowledgement

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Research on factors affecting research user satisfaction of archives websites taking provincial archives websites in the Yangtze River Delta region of China as an example

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ABSTRACT

As the Internet service platform of archives, archive websites provide archival information and services to the public, and even in the context of the rapid development of microblogging, WeChat and other emerging social platforms, archive websites are still favored by users because of their authority. Archives websites play a crucial role in strengthening communication between archival institutions and users, understanding users' needs, and promoting innovation in archival information services. Focusing on research users, this study aims to explore the key factors affecting their satisfaction and provide a reference for developing archive websites in China. By analyzing the websites of provincial comprehensive archives in the Yangtze River Delta region, this study identifies the factors affecting the satisfaction of research users and constructs corresponding models and hypotheses. Through questionnaire surveys and statistical analysis methods, this study verifies the influence of factors such as perceived usefulness, ease of use, enjoy the perception, information quality, system quality, quality of service on user satisfaction and makes suggestions for improvement accordingly.

Keywords: Archives website; Research user; User satisfaction

1. Introduction

The development of Internet technology has activated traditional disciplines and changed the way users search and utilize archival information. In the era of Web 2.0, Chinese provincial and municipal archives have adapted to the Internet trend by optimizing their websites and sharing resources. With its economic vitality, openness and innovation, the Yangtze River Delta region has entered a new phase of archival work with the regional integration strategy. Archives worldwide provide services to the public through web portals, and Chinese provincial archives have been building websites to meet user needs since 1996. Despite China's enormous population of Internet users, the number of visits to and user satisfaction with the websites of provincial comprehensive archives in the Yangtze River Delta region still needs to be higher. With limited resources, archives should enhance their service functions to meet user needs. Research users prefer the information services

provided by archive websites. However, the factors affecting the convenience and satisfaction of online access need to be explored in depth. The core value of archive websites is reflected in improving user satisfaction.

2. Research objectives

First, by understanding the archive utilization psychology of research users, this paper studies the factors that influence obtaining the satisfaction of research users of China's provincial comprehensive archives' websites, improving the online service level of archives, and enhancing service quality.

Second, based on the factors affecting user satisfaction, we propose a research-based user satisfaction improvement strategy for Chinese provincial archives' websites to help archives optimize the structure of archival digital resources.

3. Literature review

3.1 Theory, Concepts and Related Research

3.1.1 Theory

1) Technology Acceptance Theory

The Technology Acceptance Model (TAM) was proposed by Davis in 1989 to explain and predict users' attitudes toward using emerging technologies. The model emphasizes users' intention to use, attitude to use, perception of usefulness, and ease of use. The TAM has been widely validated and applies to several domains. The TAM theory mainly consists of eternal variables, attitude to technology (AT), perceived usefulness (PU), and perceived ease of use (PEOU), as shown in Figure 3.1.
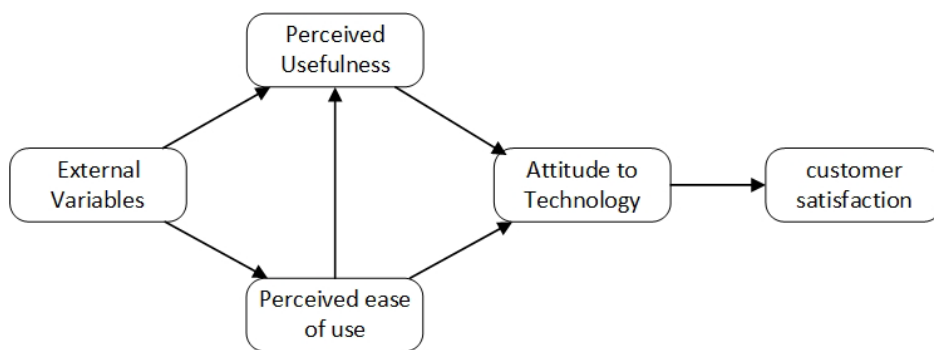
Figure 3.1 Technology Acceptance Model (TAM)

According to the TAM model, external factors shape users' cognitive beliefs by influencing usefulness and ease of use perceptions, such as motivation, system characteristics, and environment. Ease-of-use perceptions similarly influence usefulness perceptions, affecting users' perceptions and attitudes towards information systems, which determine their intention to use them. Davis points out that research in different

disciplines needs to consider the impact of specific external variables on usefulness and ease-of-use perceptions. These system-related external variables affect users' perceptions of effectiveness and ease of use.

2) Information Systems Success Theory

Delone and Mclean in 2003 developed a model for assessing the success and effectiveness of information systems implementations through six measured variables（system, information, service quality, usage, intention to use, user satisfaction, and net benefits）（Melgis et al., 2024）. Seddon argued that the model categorizes numerous factors into six main categories and establishes a theoretical framework for the interaction of these factors, providing a foundation for the study of information systems success. The model has stimulated interdisciplinary research, with scholars conducting empirical studies in their respective fields and validating the model through structural equation modeling, introducing the variable of "user involvement". This is shown in
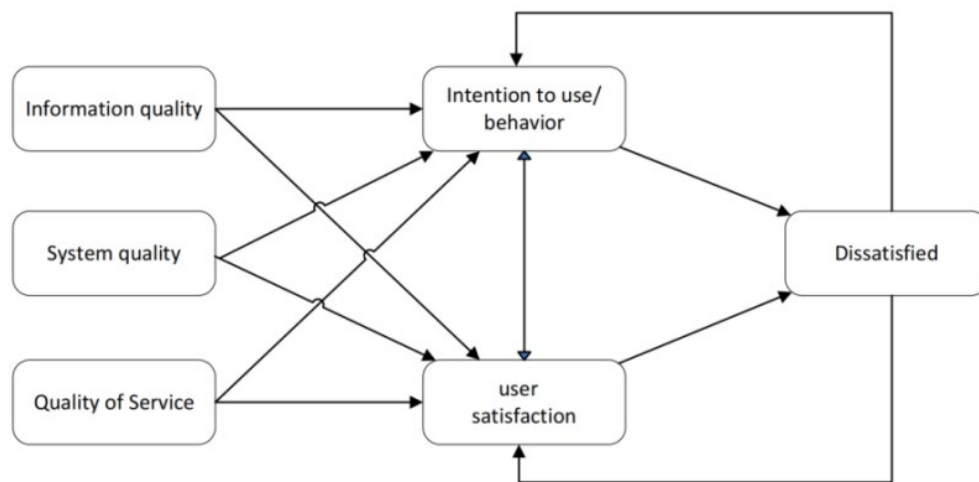
Figure 3.2 Information Systems Success Model

3) Enjoyment of Perception

Enjoyment perception refers to the pleasurable feelings that users experience when using an information system, and it plays an important role in promoting the acceptance and continued use of information systems（Liu & Wei, 2020）. In this study, we refer to the positive feelings generated by users of provincial archives' web platforms during the process of using them as "enjoy the perception". In this study, we argue that perceived enjoyment reflects how well a website is used, focusing on the immersion that users feel when using an archive's website.

3.1.2 Related concepts

1) Comprehensive Archives Website

Websites provide services such as information writing, publishing and access to information, while archive websites focus on publishing archival information and services. Chinese archives websites are diverse, including central and local websites and websites of different construction entities. Archival websites are platforms for archives departments to publish information and provide services on the Internet, covering archives

overview, business work and collection resources. This study focuses on the websites of provincial-level comprehensive archives in China's Yangtze River Delta region.

2) Research users

Scholars such as Jiang Guan (2020) pointed out that research users are groups of people who utilize archival materials for purposes such as academic research, compilation of history and educational propaganda. Research users in this study specifically refer to those users who utilize archival digital resources for research, including university teachers, students and researchers. These users have specialized knowledge and information processing skills, and their needs are clear and distinctive. They usually need a large amount and wide range of information and invest a long time in finding and utilizing archival resources, so these users are relatively stable and easy to research and interview.

3.1.3 Status of research

1) Archives web site research

Martin K.E. (2007) studied the development process of the North Carolina government website archive and explored how to select web archive content and help users select archives. Xie Sufang (2010) et al. established an evaluation system for college archive websites based on the information construction theory and determined the evaluation index weights through hierarchical analysis. Ma Renjie (2013) et al. applied user marketing thinking to the construction of archive websites, emphasized the emotional value of users, and proposed a practical application led by user relations. Bian Zhaoling (2015) and others constructed an evaluation system for the websites of Chinese provincial comprehensive archives and evaluated their information dissemination effects. Wang Ruan (2018) guided by service quality theory, constructed a model of service quality influencing factors for archive websites and proposed optimization paths and countermeasures. Wang Jing (2022) et al. conducted a comparative analysis of the geographical differences in the construction of archive websites in China, and concluded that China's current provincial archive websites are still in a state of underdevelopment and imbalance, and there is more space for construction and development. He Xing (2022) and others based on China's first historical archive portal research, China's comprehensive archive website sustainable development strategy for the relevant analysis, that the archive website is not only to provide archive users with archive retrieval, information consulting and other one-stop online and offline services, it should focus on multiple perspectives, multi-functional development, to meet the needs of diversified users, and to highlight the richness of comprehensive archive collection resources, this superiority and as an independent archive website. It is believed that the website of the archives should not only provide archive users with one-stop services on-line and off-line, but also focus on the development of multi-perspective and multi-functional services to meet the needs of diversified users, so as to show the richness of the comprehensive archives and their cultural characteristics as independent cultural institutions.

2) Concepts and Research on User Satisfaction

User satisfaction has been the focus of attention in the consumer market since 1965, when it was proposed by Cardozo, an American scholar. Satisfaction is derived by comparing users' expectations before

and after using a product, and it is the key to the study of the effect of product use. User satisfaction is an important indicator of the success of an information system and is closely related to user behavior and attitudes. In 1988, Fornell combined structural equations and mental paths to create the satisfaction model, which became the basis for the satisfaction index model in various countries. Sweden, the United States and Europe then developed their own satisfaction models, such as the Swedish Customer Satisfaction Model (SCSB), which later developed into the American Customer Satisfaction Model (ACSI), and the European Customer Satisfaction Model (ECSI). These models consider that customer satisfaction is influenced by factors such as perceived quality, brand image, customer expectations and perceived value, etc. Since 2001, China's Ministry of Information Industry has been conducting research on customer satisfaction of telecom operators and has included satisfaction in key performance indicators (KPI).

3) Information organization user satisfaction study

Based on the information construction theory, Xie Sufang (2010) and other scholars established a mathematical model for the evaluation index system of university archive websites through hierarchical analysis. Luo Baoyong (2011) and other scholars studied Harvard University archive website, emphasized the influence of interactivity, personalized service, search tools and digital resources integration on user satisfaction, and suggested that Chinese university archive websites should focus on content reconstruction and technological innovation. Based on the technology acceptance model, Zhu Dogang (2012) studied the attitudes and behavioral intentions of Wuhan university students towards the use of mobile libraries, and found that perceived usefulness and ease of use had a significant effect on attitudes and behavioral intentions. Meng Meng (2017) and other scholars verified the influencing factors of user satisfaction in digital libraries through questionnaire survey based on LibQual+ model. Yin Lichun (2019) and other scholars investigated the factors affecting user satisfaction using a plain Bayesian classifier and cluster analysis. Jiang Guan (2020) and other scholars constructed a model of factors influencing user satisfaction of in-library reading services in the National Archives of China through qualitative research methods. Cui Xu (2021) et al. through the construction and validation of the "expectation-satisfaction index" evaluation system, take the user as the center, carry out in-depth expansion, improve the added value of archival services, and enhance the effect of interactive information service optimization strategy of China's provincial archival website interactive information service. In the field of archival science, more qualitative research methods have been adopted, and relatively few quantitative studies on user satisfaction have been conducted, which, to a certain extent, affects the scientificity and credibility of the research.

3.2 Research Framework

3.2.1 Construction of the theoretical model

This study analyzes the factors influencing research-based user satisfaction of archive websites and their relationships in the context of theoretical foundations and technology acceptance theory. It is shown that information quality, system quality, service quality, perception of usefulness, perception of ease of use and perception of enjoyment directly or indirectly affect user satisfaction. This study constructed a model to describe the interaction between these factors and user satisfaction, as shown in Figure 3.3.
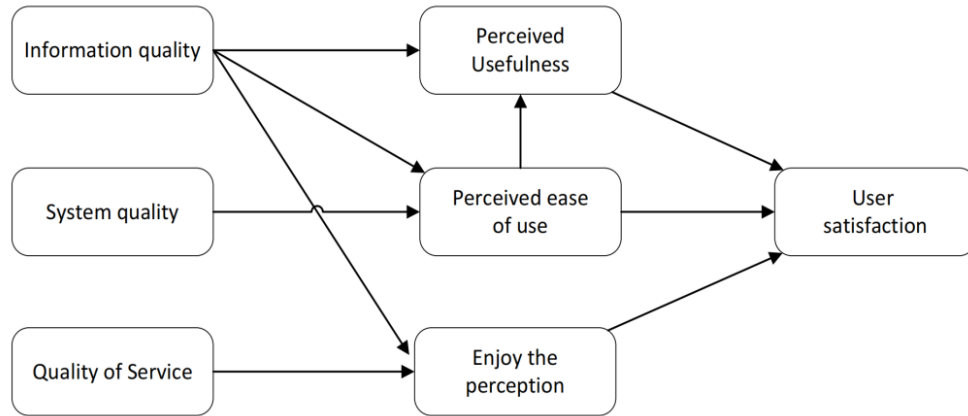
Figure 3.3 Model of Factors Influencing Research User Satisfaction on Archives Web Sites

3.3 Research hypotheses

1) Relationship between perceived usefulness, perceived ease of use, enjoy the perception, and user satisfaction

In information systems research, the TAM model states that usefulness perception and ease of use perception significantly influence user satisfaction. This study follows this framework and introduces enjoyment perception while considering the influence of other factors on satisfaction, such as heart flow experience. Accordingly, the following hypotheses are proposed:

H1: Perceived usefulness positively influences user satisfaction for research users of the archives website

H2: Perceived ease of use positively influences user satisfaction for research users of the archives website

H3: Enjoy the perception positively influences user satisfaction for research users of the archives website

2) Relationship between information quality, perceived ease of use, and perceived usefulness

The TAM model emphasizes users' perceptions of usefulness and ease of use of technology, and usefulness is concerned with how the technology helps users learn, work, and live, especially the quality of information. High‑quality information, such as complete, rich, accurate, and timely archive Web site content, enhances usefulness perceptions. Based on this, this study proposes relevant hypotheses:

H4: Information quality positively influences perceived usefulness for research users of the archives website

H5: Perceived ease of use positively influences perceived usefulness for research users of archives website

3) Relationship between information quality, system quality, and perceived ease of use

The quality of the system of an archive's website affects user perception, and ease of use reflects the user's acceptance and proficiency of a new system. When studying user willingness, it is essential to consider the

intrinsic psychological factors of users, such as pleasure and perceived ease. At the same time, concise content and well-developed system navigation can enhance user experience and perceived ease of use. Based on this, this study proposes two hypotheses:

H6: Information quality positively influences perceived ease of use for research users of archives website

H7: System quality positively influences perceived ease of use for research users of archives website

4) Relationship between information quality, quality of service, and enjoy the perception.

Users of China's provincial archives mainly obtain information through traditional websites, and the lack of interaction and sense of ambiance affects the motivation of website users. Psychology indicates that satisfying needs and providing high-quality resources can enhance users' concentration and pleasure. A fast interaction and good experience on archive websites will promote users' mind-flow experience and satisfaction. Based on this, the following two hypotheses are proposed:

H8: Information quality positively influences the perception of research users of archives website

H9: Quality of service positively influences the perception of research users of the archives website

4. Research methodology

In this study, the questionnaire was designed using a 5-point Likert scale, and the questionnaire questions were optimized by combining the literature analysis and authoritative scales. The final questionnaire was distributed online to research users in the Yangtze River Delta region who had used the websites of provincial archives to collect data, while at the same time, the valid questionnaire data were subjected to reliability and exploratory factor analysis using advanced statistical software; validation factor analysis was used to test the relationship of the variables and the fitness of the model.

4.1 Study design

This study collected data through questionnaires and quantitatively analyzed using statistical software to verify the theoretical models and hypotheses. The questionnaire survey was divided into two stages: pre-survey and formal survey and the formal questionnaire was issued after the pre-survey was passed. The pre-survey assessed the validity of the questionnaire and optimized the questionnaire design. The formal questionnaire contained a cover letter, personal information, 24 test items and an open-ended question to collect respondents' experience and satisfaction influencing factors.

4.2 Data collection

The questionnaires were distributed to archive-related WeChat groups and QQ groups in the Yangtze River Delta region through the online platform Question star. In this study, 80 pre-survey questionnaires were distributed, and 75 valid questionnaires were collected. After pre-survey screening, statistical analysis showed

that the questionnaire design is reasonable and suitable for large‑scale research. Formal questionnaire 400, together with the pre‑survey total of 480 questionnaires issued, 417 valid questionnaires recovered, the recovery rate of 86.875%, the sample size of the reliability of the strong, can be used for data analysis.

4.3 Data analysis

4.3.1 Descriptive analysis of variables

Descriptive analysis uses statistical indicators such as means and standard deviations to summarize a data set's central tendency and dispersion to understand the variables' characteristics and help get a clear picture of the overall data pattern.

Table 4.1 summarizes the research users' ratings of the various indicators of the archive website. The mean score for information quality was 3.28, with a standard deviation of 1.055, indicating that users generally recognized the quality of information, but opinions varied. The mean ratings for system quality, quality of service, perceived usefulness, perceived ease of use, enjoy the perception, and user satisfaction ranged from 3.27 to 3.34, with a standard deviation of 1.068 to 1.139, reflecting those users positively evaluated various aspects of the website.

Table 4.1 Descriptive analysis of variables

Variable	N	Min	Max	Mean	Standard
Information quality	417	1	5	3.28	1.055
System quality	417	1	5	3.27	1.068
Quality of service	417	1	5	3.33	1.092
Perceived usefulness	417	1	5	3.30	1.072
Perceived ease of use	417	1	5	3.34	1.118
Enjoy the perception	417	1	5	3.29	1.139
User satisfaction	417	1	5	3.29	1.119

4.3.2 Reliability and validity analysis

The formal research and the pre‑survey used the same analytical methods, and advanced statistical software was used to analyze the inter‑item correlations and conduct reliability tests. The results show that the total scale reliability is 0.929, and the alpha coefficients of each variable are over 0.8, indicating that the questionnaire design is reasonable, and the data are stable and reliable; the KMO value of each variable is over 0.6, and the P value of the Bartlett's Spherical Test is less than 0.01, indicating that the questionnaire has good structural validity and is suitable for further analysis. As shown in Tables 4.2 and 4.3 below.

Table 4.2 Cronbach reliability analysis

Dimension	Number of terms	Cronbach's α
Information quality	4	.843
System quality	4	.836
Quality of service	3	.815
Perceived usefulness	4	.864
Perceived ease of use	3	.822
Enjoy the perception	3	.832
User satisfaction	3	.809
Overall scale	24	.929

Table 4.3 KMO values and Bartlett analysis

Variable	KMO	The sphericity test of the Bartlett		
		Chi-square	Degree of freedom	p
Perceived usefulness	.826	753.259	6	0.000
Information quality	.819	650.354	6	0.000
System quality	.812	631.281	6	0.000
Perceived ease of use	.717	447.287	3	0.000
Quality of service	.717	425.329	3	0.000
User satisfaction	.715	409.075	3	0.000
Enjoy the perception	.714	484.839	3	0.000
Overall scale	.923	4968.200	276	0.000

4.3.3 Validation factor analysis

Validated factor analysis（CFA）is used to examine the consistency of the theoretical model with the data, to test the fit of the hypothesized model to the data, and to validate the validity of the measurement instrument and the theoretical assumptions through the fit metrics. The higher the factor loading value, the better the validity. In this study, the questionnaire data were analyzed by CFA through statistical software to produce relevant data, as shown in Figure 4.1. According to the data in Table 4.4, the CMIN/DF value is 1.080, RMSEA is 0.014, GFI is 0.952, NFI is 0.951, and CFI is 0.996, which indicates that the model fit is high, and the validity of the research results is good.
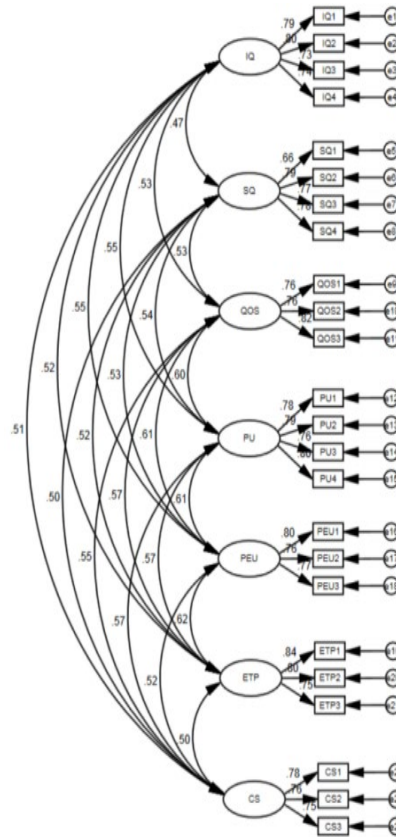
Figure 4.1 Validated factor analysis (CFA) plot of factors influencing research-based

user satisfaction on archive websites

Table 4.4 Construct Validity Test

Fits Index	Adaptation Standards	Model Value
CMIN/DF	<3	1.080
RMSEA	<0.08	0.014
GFI	>0.9	0.952
NFI	>0.9	0.951
CFI	>0.9	0.996

4.3.4 SEM analysis

Combined with the theoretical satisfaction model, the questionnaire data was analyzed using advanced statistical software to produce the following SEM model path detection results.

Table 4.5 SEM model path detection results

Influence path	Standard pat	S.E.	C.R.	P
Perceived usefulness→User satisfaction	0.325	0.074	4.419	***
Perceived ease of use→User satisfaction	0.202	0.070	2.725	0.006
Enjoy the perception→User satisfaction	0.240	0.053	4.117	***
Information quality→Perceived usefulness	0.363	0.064	5.579	***
Perceived ease of use→Perceived usefulness	0.409	0.062	6.156	***
Information quality→Perceived ease of use	0.411	0.065	6.640	***
System quality→Perceived ease of use	0.368	0.080	5.820	***
Information quality→Enjoy the perception	0.329	0.073	4.919	***
Quality of service→Enjoy the perception	0.400	0.080	5.773	***

***$P<0.001$

The data analysis in Table 4.5 shows that all the impact paths are significant, and all the hypothesized paths of the model are valid. The results are shown in Table 4.6 and Figure 4.3 below.

Table 4.6 Results of research hypothesis testing

Number	Hypothesis	Whether to
H1	Perceived usefulness positively influences user satisfaction for research users of the archives website.	Accepted
H2	Perceived ease of use positively influences user satisfaction for research users of the archives website	Accepted
H3	Enjoy the perception positively influences user satisfaction for research users of the archives website	Accepted
H4	Information quality positively influences perceived usefulness for research users of the archives website	Accepted
H5	Perceived ease of use positively Influences perceived usefulness for research users of archives website	Accepted
H6	Information quality positively influences perceived ease of use for research users of archives website	Accepted
H7	System quality positively influences perceived ease of use for research users of archives website	Accepted
H8	Information quality positively influences the perception of research users of the archives website	Accepted
H9	Quality of service positively influences the perception of research users of the archives website	Accepted
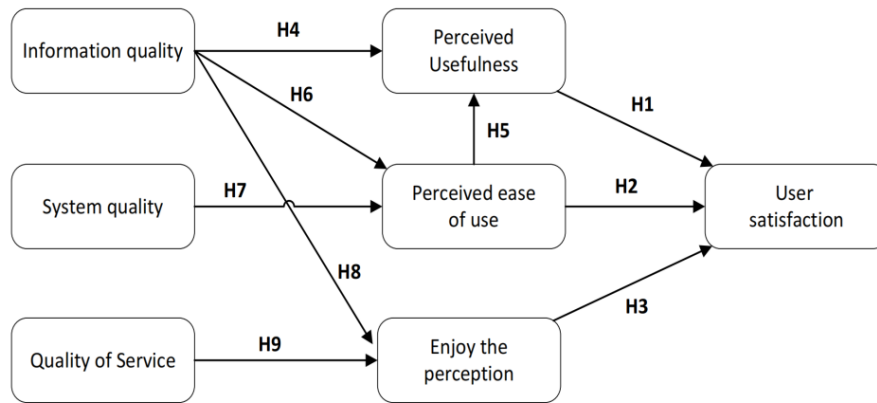
Figure 4.2 Research Model of Factors Influencing User Satisfaction in Archive Website Research

5. Findings

Data analysis revealed that perception of usefulness, ease of use and enjoyment directly influenced research users' satisfaction with the archive's website. Users perceived that the information and services on the website were helpful to their research, and the user-friendly interface and ease of operation also increased satisfaction. Also, enjoyable experience increases users' positive evaluation of the archive's website. Information quality, system quality, and service quality indirectly affect user satisfaction, and high-quality content, efficiently functioning systems, and good service are also vital in increasing user satisfaction.

6. Discussion

This study is mainly based on the current situation of the websites of provincial comprehensive archives in the Yangtze River Delta region of China, the existing research results of various disciplines, classical theories, and other modelling, and it is completed using quantitative research methods. Because there are fewer practical references for this study, the questionnaire design and the extraction of influencing factors, the study may need to be more comprehensive and in-depth due to the influence of various practical problems, preneed tonal, more subjective reasons, and macro factors. Some factors affecting user satisfaction have yet to be discovered and are involved in the aspects that need further research and exploration.

7. Recommendations

This paper aims to analyze the factors affecting user satisfaction of archive websites to improve website utilization and user experience and provide insights for developing archive websites in China. Suggestions include the following aspects:

1) Raise the importance of the archive's website, constantly update its content, link it to the physical archive, and increase its financial investment.

2) Enrich collection resources, optimize search experience, integrate archival resources, and improve service quality.

3) Enhance website features, provide personalized services, and optimize digitization efficiency.

4) Branding, protecting user privacy, and improving content accuracy and relevance.

5) Lower user expectations, reorient communication and reduce information asymmetry.

6) Utilize the educational value of the website and set up user education modules to enhance users' ability to utilize the archives.

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Room 4:

Science, Technology, Engineering

DEMATEL Method for Safety Management in an Expressway Construction Project in China

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ABSTRACT

Safety management in a construction project, especially a major construction project such as expressway construction, is very complex. Many factors must be treated and maintained at the standard level. Furthermore, the safety factors in construction projects are not independent. They may influence and affect each other. Thus, we must use an appropriate risk assessment tool to solve this complicated problem. This article proposed the Decision-making trial and evaluation laboratory (DEMATEL) technique to identify and categorize risk factors in an expressway construction site. There were 143 respondents in the study who contributed their opinions to quantify thirteen factors corresponding to the DEMATEL procedure. The result shows that the most influential and prominent factors are F11 (Poor safety management), F13 (Poor construction site management), F6 (Poor project scheduling), and F5 (Poor site conditions). Other dependent factors, such as F1 (Employee behavior) and F8 (Inappropriate equipment and tools), are raised to the standard by improving these factors. The DEMATEL not only groups the factors with their prominence and influence characteristics but also recommends a way to improve safety management reasonably.

KEYWORDS: Safety management, construction industry, multi-criteria decision making, DEMATEL

1. Introduction

Expressways have developed rapidly to be one of the significant infrastructure construction projects in China. The country's total mileage of expressways reached 161,000 km in 2020, representing an annual increase of 7.62% (Chen and others, 2022). The latest data released by the Ministry of Transport shows that China's expressways currently cover about 98% of cities with an urban population of more than 200,000, and the national expressway mileage has reached 131,000 kilometers, ranking first in the world (Yi, 2017). By the end of 2022, the total length of China's expressway network reached 177,000 km.

Expressway construction sites is a type of construction industry which infamous for the highest accidents rate compared to any other construction sites (Orji and others, 2016). This phenomenon arises because the construction business predominantly comprises a greater proportion of a significant number of workers engaged on a seasonal or temporary basis (Seker and others, 2017). Therefore, understanding the causes of

accidents and how these factors contribute to the likelihood of risks leading to accidents is crucial for accident and injury prevention (Manu and others, 2012).

The literature on occupational risk assessment reveals that accidents are caused from a wide range of factors such as unsafe tools, conditions related with the work site, the industry specific problems, unsafe methods related with the work, human factors and management issues (Parsamehr and others, 2023). Physical hazards on construction sites occur because of continuing exposure to mechanical process or work activity. As a result, physical hazards can cause various types of injuries, from minor and requiring first aid only, to disabling and/or fatal (Babalola and others, 2023).

Physical risks in the construction industry are not to be taken lightly. They encompass several scenarios, including working at elevated levels, the potential for objects to fall, and exposure to electricity. Accidents involving high-elevation falls are considered the most common cause of injury or death on construction sites (Pinto and others, 2011). Slips and trips resulting in falls are considered the most common workplace risks and account for one-third of all severe injuries. Incidents involving machinery impact, as well as fires and explosions resulting from the combustion of combustible substances, are additional prevalent occupational hazards encountered on construction sites. OSHA (Occupational Safety and Health Administration) and have reported that falls and accidents caused by falling objects are the leading causes of both injuries and fatalities in the construction business in the United States (Duryan and others, 2020).

Regarding profession type, construction site workers may face significant hazards such as falling from machinery and machines overturning when traveling on slopes. Furthermore, electrical equipment such as cables, circuit breaker panels, and cords pose a significant hazard to personnel in regions exposed to electricity. The primary causes of physical injuries on construction sites are typically attributed to technical or human faults (Zhu and others, 2021). Truck drivers, plant operators, and electricians are the heightened risk of experiencing fatal accidents.

Accidents in the construction business are identified by several Occupational Risk Assessment (ORA) methodologies. This study proposes a more efficient and feasible method to streamline the risk assessment procedure for an expressway construction project. The DEMATEL approach is not just a tool but a beacon of hope. It is frequently employed to derive a cause-effect diagram of interconnected elements. This method is more effective than traditional procedures because it reveals the connections between criteria, ranks the criteria based on the type of links, and exposes the severity of their impacts on each criterion.

The DEMATEL approach is not just a method but a potential game-changer. It is a multi-criteria decision-making method, offers a unique perspective in the field of risk assessment literature. It allows for evaluating cause-and-effect relationships among risk factors and provides an analytical measure of the degree of relation or strength of influence (Yazdi and others, 2020). This innovative approach could revolutionize the way we understand and manage risk in the construction industry.

Accordingly, this study is interested to apply a multi-criteria decision making (MCDM), named Decision Making Trial and Evaluation Laboratory (DEMATEL) method, to assess the risk factors in an expressway construction project in China.

2. Research Objective

(1) To propose a practical safety risk assessment tool, DEMATEL, in construction industry with the case of an expressway construction project.

(2) To identify risk factors for a case study and be a sample for other construction sites.

3. Literature Review

3.1 Safety management in construction industry

Construction sites are very hazardous areas where fatal and non-fatal accidents persistently occur (Pinto and others, 2011). There are many sources in construction projects, such as poor working conditions, temporary employment, and substandard work environment. Additionally, the most complex aspect of safety management in the construction industry is that the operations depend on contractors, sub-contractors, and suppliers. This circumstance has been proven to increase the risk of accidents (Seker and others, 2017).

Safety management affects not only safety, accidents, and injuries but also economics, costs, and business—the idea that the resource safety issue should not deteriorate. Nevertheless, in practice, safety issue safety issue may be ignored for economic reasons. Zhou and others (2015) noted that construction safety has become a focal point due to the rising workers' compensation insurance premiums resulting from a significant surge in medical costs and recovery care for work-related accidents. Research conducted in several sectors indicates that the construction business has an above-average incidence of injuries and associated expenses.

Alkiassy and others (2020) stated that despite technological breakthroughs for occupational health and safety management systems, the construction industry still requires work health and safety improvements. The current literature mainly emphasizes safety management techniques to mitigate the effects of unforeseen events and implement effective and user-friendly risk management strategies across various organizational and project levels. For instance, via AHP-based analysis, we may examine safety risks associated with near-miss incidents. It incorporates exploratory factor analysis and structural equation modeling to study the many components contributing to safety risks. Additionally, we can integrate risk management processes inside a model-based environment. Previous research has examined fuzzy qualitative risk management models to mitigate occupational safety risks. These models have been used to analyze and simulate single and combined safety risks at the situational level. Additionally, a real-time safety risk evaluation model has been developed to enhance decision-making quality in the construction of buildings and structures.

Keng and Razak (2014)'s study in line with the report of Cheng and others (2004). The study findings indicated that the construction site normally has well-organized and effective safety practices. The practices include safety policy implementation, education and training programs, site safety inspections, safety audits,

safety meetings, site safety organization, provision of personal protective equipment, emergency support and safety monitoring devices, fall protection systems, and safety promotion activities. However, other issues arose in relation to safety practices, including workers' lack of knowledge regarding work procedures, insufficient financial resources allocated to safety management, workers' lack of awareness, and communication difficulties between supervisors and workers due to language barriers.

3.2 Safety risk assessment

Risk assessment is a methodical procedure that finds, assesses, and manages potential hazards and dangers in a given scenario or location. It is a technique used for decision‑making that assists in identifying the steps that should be taken to eliminate or manage risks. It also helps prioritize these measures based on their probability and impact. Specifically, a safety risk assessment is a methodical procedure that detects and controls potential dangers in a workplace with the aim of safeguarding the well-being and security of both employees and visitors. The process entails a comprehensive assessment of the complete work environment, encompassing procedures and equipment, to identify potential dangers and implement appropriate solutions (Sanni‑Anibire and others, 2020).

Several risk assessment methods are available for different types of industries and processes. Most of them have common stages, which can be divided into three steps: Step 1: Potential hazards identification; Step 2: Risk assessment performing; Step 3: Significant risk ordering.

3.3 DEMATEL method

Decision-making trial and evaluation laboratory (DEMATEL) method was founded in Geneva Research Center of the Battelle Memorial Institute. It can solve intricate and challenging problems in the real world. The DEMATEL approach is based on graph theory and matrix operations. By examining the logical connections and direct cause‑and‑effect relationships among a system's constituents, we can classify these elements into two groups: the affected group and the causal group. This approach's clear advantage is its ability to incorporate the thoughts of multiple specialists in a certain industry and analyze complex relationships between different aspects using a visualization structure model (Mohandes and others, 2022).

The DEMATEL technique can effortlessly transform the interrelations among the identified factors into a perceptible structural model of the system being studied. This procedure can be executed by breaking down the factors into cause‑and‑effect categories. DEMATEL is a method that is both appropriate and significantly beneficial for analyzing the interdependent relationships between the factors in a complex system, as evidenced by this feature (Si and others, 2018). In this regard, the identified factors can be ranked, and the resulting priorities can be further utilized for long‑term strategic decision‑making and corresponding improvement plans. In other words, DEMATEL cannot resolve any decision‑making issues; it can only assess the interdependence of cause-and-effect factors. Figure 1 illustrates the procedures of the DEMATEL method in its original form.

A group direct-influence matrix generating	Step 1
A normalized direct-influence matrix implementing	Step 2
An influence relation map producing	Step 3
A causal diagram drawing	Step 4
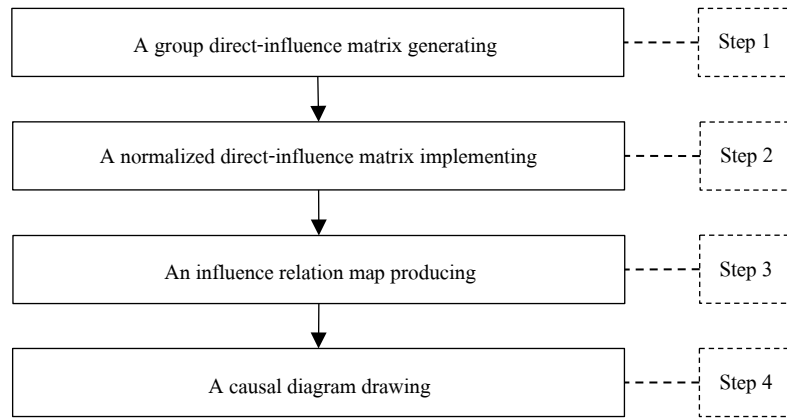
Figure 1 DEMATEL procedure

4. Research Methodology

4.1 Research Design

This research procedure primarily follows the DEMATEL procedure. It starts from research instrument design which purpose to identify key factor in safety risk of expressway construction.

4.2 Population and Sample

The sample company is a state-owned expressway construction company. It is a confidential issue; thus, the company's details cannot be uncovered. The study area is limited to a construction project of this company, which is ongoing expressway construction. The expected respondents are the construction site employees, divided into three levels: operation, middle-management, and top-management staff. The operation staff includes laborers, equipment operators, and foremen who work physically on construction sites. The middle-management staff includes engineers, design officers, planning officers, and supervisors. The top management includes managers, directors, and deputy directors. There are a total of 143 expected respondents: one hundred expected respondents are in the first level; thirty-two expected respondents are in the second level; and eleven expected respondents are in the third level. Please note that the proportion of respondents occurred randomly.

4.3 Research Instrument

A questionnaire was designed using key factor from the opinion of Safety engineering department and literature such as Orji and others (2016), Raheem and Issa (2016), Boadu and others (2020), Zhu and others (2021), and Mohandes and others (2022). Table 1 shows the key factors of accidents and potential occupational hazard on expressway construction safety management.

Table 1: Key factors on expressway construction

Code	Key factors of accidents	Potential
F1	Employee behavior	Inadequate placement and posture during work, failure to utilize provided personal protection equipment, accidents resulting from falling from elevated surfaces, and ocular injuries caused by foreign objects entering the eye during activities such as welding, cutting, and grinding.
F2	Employees' education, skills, experience	The potential risks include surpassing the operator's lifting capability, insufficient familiarity with operating vehicles such as bulldozers, diggers, and excavators, lack of competence in welding and cutting operations, cave-ins during or after excavation, transportation accidents, and exposure to fumes, gases, fire, and explosions.
F3	Poor communication channel in construction site	Confusion may arise due to the physical separation of workers, excessive background noise, or inadequate communication between safety officers and employees. This can lead to mishaps involving heavy equipment or exposure to electricity.
F4	Poor health condition of employees	Risky conduct resulting from exhaustion, incidents of falling from vehicles such as bulldozers, diggers, and excavators, transportation mishaps on the premises, instances of losing balance when working on scaffolding, and other related occurrences.
F5	Poor site conditions	Working in a congested environment with inadequate warning signage, at elevated heights, and being exposed to potential hazards such as tripping over cables, falling into holes, being crushed, jammed, or pinched by things, or becoming entangled between mechanical parts.
F6	Poor project scheduling	Common causes of workplace accidents include irregular work schedules resulting in extended work hours, poor coordination between jobs and personnel, improper use of equipment, power tools and machinery mishaps, and cave-ins during or after excavation.
F7	Inappropriate materials	The failure to achieve the specified material needs and the incomplete disposal of surplus and unsuitable materials, such as brush, grass, weeds, and rubble, can result in hazards such as tripping and exposure to gasses, fumes, smoke, and fire.
F8	Inappropriate equipment and tools	Equipment and tool deficiencies include inadequate personal protective equipment and improper equipment utilization for jobs, such as accidents caused by carrying or lifting heavy objects or being crushed, jammed, or pinched by objects.
F9	Safety practices	Failing to prioritize safety as a fundamental aspect of the project, neglecting to pre-qualify contractors based on safety criteria, and neglecting to provide workers with training on the proper use of safety equipment, safety protocols, and any task-specific safety risks and precautions, resulting in incidents such as falls, tripping on bricks on scaffolds, and collisions with scaffolds.
F10	Construction operations	Some examples of occupational hazards include manual handling, exposure to hazardous products, working on scaffolding, ground working, being struck by formwork on a crane, and building/structure collapse.
F11	Poor safety management	The absence of personal protective equipment, regular safety meetings, and safety training has resulted in incidents such as fall accidents, being struck by a lorry platform while attaching it, and being struck by a scaffold, among others.
F12	Poor safety awareness of employees	The construction workers lack awareness of job-related safety and health issues. They also need to be more conscious of the importance of wearing personal protection equipment. Additionally, there is a lack of enforcement of safety laws, resulting in workers being exposed to hazards such as electricity and caught between machinery parts.
F13	Poor construction site management	The issues identified include inadequate provision of personal protective equipment (PPE) and safety gear by management, insufficient education in terms of safety training and orientation, incidents involving falls from heights and falling objects, accidents caused by being crushed by plasterboard during removal from trolleys, and exposure to high levels of vibration.

4.5 Data Analysis

1) A group direct-influence matrix generating

Suppose that there are n factors, $F = \{F_1, F_2, F_3, \ldots, F_n\}$, in a complex system. There are l decision-makers examine the relationship between all factors. They are asked to specify how much factor F_i has a direct influence on F_j by using a five-point Likert scale, i.e., very high (VH) influence (4), high (H) influence (3), moderate (M) influence (2), low (L) influence (1), and no (N) influence (0). Accordingly, suppose that $Z_k = \left[z_{ij}^k\right]_{n \times n}$ as an individual influence matrix, is prepared by kth decision-maker, where the factor's degree to F_i influences F_j. Then, after combining all the l decision-makers data, the group direct-influence matrix can be formulated as Eq. (1).

$$Z_{ij} = \frac{1}{l} \sum_{k=1}^{l} z_{ij}^k, \quad \forall i, j = 1, 2, \ldots, n \tag{1}$$

2) A normalized direct-influence matrix implementing

To receive a normalized matrix, Eq. (2) is used to calculate $X = \left[x_{ij}\right]_{n \times n}$. It is named the normalized direct-influence matrix.

$$X = \frac{1}{\max \sum_{j=1}^{n} a_{ij}} \times Z, \quad 1 \leq i \leq n \tag{2}$$

where all the elements of matrix X are in $[0, 1]$, and $0 \leq \sum_{j=1}^{n} x_{ij} \leq 1$.

Next, the total direct-influence matrix ($T = \left[t_{ij}\right]_{n \times n}$) is calculated using Eq. (3).

$$T = X + X^2 + X^3 + \cdots + X^h \tag{3}$$

Please note that the direct effect of F_i on F_j is t_{ij}. The total direct-influence matrix now reflexes the relationship between factors. Eq. (4) determines the total direct-influence matrix as Eq. (2.3) when $h \to \infty$.

$$T = X(I - X)^{-1} \tag{4}$$

where I is an identity matrix and can be involved with Markov chain theory as: X^h is the power of matrix X, and converges solutions to the inversion of matrix ($\lim_{h \to \infty} X^h = [0]_{n \times n}$). The total direct-influence matrix is $\sum_{h=1}^{\infty} X^h$; thus, we have:

$$\sum_{h=1}^{\infty} X^h = X(I + X^1 + X^2 + \cdots + X^{h-1})$$
$$= X \times (I - X)^{-1} \times (I - X) \times (I + X^1 + X^2 + \ldots + X^{h-1})$$
$$= X \times (I - X)^{-1} \times (I - X^h)$$
$$T = X \times (I - X)^{-1}$$

3) An influence relation map producing

The influential relation map is graphical information showing the effects of the factors. It can be drawn by first calculating C and R. Equations (5) and (6) are the C and R calculation, respectively. They are the summation of T's columns and rows, respectively.

$$R_i = \sum_{i=j}^{n} t_{ij}, \quad \forall i \in \{1, 2, \ldots, n\} \tag{5}$$

$$C_j = \sum_{i=1}^{n} t_{ij}, \quad \forall j \in \{1, 2, \ldots, n\} \tag{6}$$

where R_i is the sum of row ith which can be called the degree of influential impact, C_j is the sum of column jth and which can be called indirect influence received by factor j from all other factors.

It is important to note that in this context, j is equal to i, where i and j are both elements of the set $\{1,2,\ldots,n\}$. The term $(R + C)$ is referred to as 'Prominence' and represents a horizontal axis vector that indicates the relative importance assigned to each factor. Likewise, $(R - C)$ known as 'Relation' is then determined for the vertical axis which indicates the net effect.

    4) The causal diagram drawing

The diagram with the horizontal axis $(R + C)$ and the vertical axis $(R - C)$ is drawn. The horizontal axis 'Prominence' means the importance degree of the factor, whereas the vertical axis 'Relation' means the extent of the influence. If the $(R - C)$ axis is positive, the factor is in the cause group. On the other hand, if the $(R - C)$ axis is negative, the factor is in the effect group. Causal diagrams can convert complex relationships of factors into a simple structural model, providing awareness for problem solve.

5. Research Findings

5.1 Demographic data

There were 100% return rate, 143 respondents. There were 25.17% women and 74.83% men. In terms of education level, 20.28% of respondents had a high school/vocational degree, 68.53% had a bachelor, 8.39% had a master, and 2.80% had a doctoral degree. In terms of experience, 20.28% of the respondents have experience in the business less than five years, 60.84% have experience between five and ten years, and 18.88% have experience more than ten years.

5.2 Importance and effects of factors

1) A group direct-influence matrix generating

The direct-influence matrix is calculated using Eq. (1) and (2), as shown in Table 2.

Table 2: Direct-influence matrix of 143 respondents

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
F1	0	1.14	2.07	2.67	2.11	2.61	1.15	1.23	3.78	2.98	2.34	2.98	1.42
F2	3.95	0	2.05	2.86	2.18	1.02	1.15	1.98	2.93	2.07	3.62	3.55	2.69
F3	2.63	1.18	0	1.38	1.95	2.95	1.97	2.09	2.99	2.74	3.01	2.79	3.17
F4	2.17	1.08	1.11	0	1.42	2.79	1.05	1.17	2.35	2.01	3.03	2.94	2.77
F5	3.21	1.18	2.18	2.36	0	2.35	3.01	3.44	3.59	3.25	1.45	3.06	1.88
F6	3.62	1.55	1.23	1.83	1.60	0	2.98	3.11	3.33	2.94	3.01	3.25	1.18
F7	1.11	0.98	0.55	0.27	0.44	3.05	0	1.60	2.22	1.76	2.83	1.99	1.23
F8	3.42	0.21	1.06	1.42	1.23	3.17	0.54	0	2.97	2.91	3.27	1.20	1.42
F9	2.15	0.48	1.49	2.53	2.77	1.99	0.73	3.11	0	1.24	0.97	0.75	0.29
F10	0.55	0.96	0.11	2.45	2.60	2.74	0.55	2.75	2.13	0	1.23	1.05	1.23
F11	3.77	2.39	3.11	3.56	3.61	1.20	0.98	3.46	3.09	2.45	0	3.15	1.11
F12	3.85	1.93	0.98	1.57	2.01	1.47	2.93	3.19	3.11	2.88	3.75	0	1.02
F13	3.79	2.19	2.74	2.18	3.72	3.22	3.19	3.28	3.56	3.01	3.12	3.33	0

2) A normalized direct-influence matrix implementing

The normalized direct-influence matrix is determined using Eq.（2）. Then, the total direct-influence matrix is calculated using Eq. (3) and (4), as shown in Table 3.

Table 3 : The total direct-influence matrix of 143 respondents

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	R
F1	0.4439	0.2412	0.3131	0.4267	0.4134	0.4559	0.3002	0.4505	0.5839	0.4885	0.4714	0.4700	0.2894	5.3481
F2	0.6370	0.2418	0.3596	0.4916	0.4755	0.4726	0.3432	0.5371	0.6407	0.5309	0.5773	0.5535	0.3686	6.2295
F3	0.5741	0.2669	0.2810	0.4275	0.4488	0.5089	0.3553	0.5212	0.6161	0.5283	0.5371	0.5089	0.3659	5.9401
F4	0.4893	0.2314	0.2751	0.3288	0.3768	0.4395	0.2855	0.4272	0.5197	0.4410	0.4720	0.4516	0.3139	5.0517
F5	0.5961	0.2673	0.3474	0.4601	0.3923	0.5038	0.3877	0.5650	0.6423	0.5508	0.5027	0.5211	0.3350	6.0716
F6	0.5903	0.2709	0.3115	0.4333	0.4284	0.4136	0.3733	0.5386	0.6151	0.5245	0.5293	0.5111	0.3027	5.8427
F7	0.3500	0.1767	0.1954	0.2545	0.2617	0.3547	0.1854	0.3404	0.3999	0.3353	0.3681	0.3286	0.2071	3.7580
F8	0.4883	0.1880	0.2543	0.3500	0.3460	0.4248	0.2462	0.3596	0.5029	0.4374	0.4447	0.3713	0.2553	4.6686
F9	0.3806	0.1588	0.2235	0.3206	0.3265	0.3322	0.2099	0.3816	0.3376	0.3255	0.3167	0.2963	0.1875	3.7975
F10	0.3384	0.1749	0.1840	0.3204	0.3248	0.3528	0.2070	0.3760	0.4022	0.2867	0.3252	0.3057	0.2132	3.8113
F11	0.6465	0.3169	0.3957	0.5221	0.5241	0.4943	0.3466	0.5921	0.6623	0.5572	0.4855	0.5542	0.3354	6.4328
F12	0.5838	0.2758	0.2992	0.4180	0.4310	0.4478	0.3620	0.5286	0.5954	0.5110	0.5368	0.4051	0.2917	5.6861
F13	0.7316	0.3521	0.4328	0.5469	0.5935	0.6240	0.4637	0.6685	0.7663	0.6496	0.6545	0.6324	0.3431	7.4590
C	6.8499	3.1627	3.8725	5.3006	5.3428	5.8249	4.0660	6.2864	7.2844	6.1666	6.2214	5.9098	3.8090	

3) An influence relation map producing

The map requires the prominence and relation indices which can calculated using Eq. (5) and (6). Table 3 illustrates the $R+C$, $R-C$, and their identification. Table 4 shows the 'Prominence', 'Relation', and their identification.

Table 4 :The total direct-influence matrix of 143 respondents

	R	C	$R+C$	$R-C$	Identify
F1	5.3481	6.8499	12.20	-1.50	Effect
F2	6.2295	3.1627	9.39	3.07	Cause
F3	5.9401	3.8725	9.81	2.07	Cause
F4	5.0517	5.3006	10.35	-0.25	Effect
F5	6.0716	5.3428	11.41	0.73	Cause
F6	5.8427	5.8249	11.67	0.02	Cause
F7	3.7580	4.0660	7.82	-0.31	Effect
F8	4.6686	6.2864	10.95	-1.62	Effect
F9	3.7975	7.2844	11.08	-3.49	Effect
F10	3.8113	6.1666	9.98	-2.36	Effect
F11	6.4328	6.2214	12.65	0.21	Cause
F12	5.6861	5.9098	11.60	-0.22	Effect
F13	7.4590	3.8090	11.27	3.65	Cause

4) The causal diagram drawing

The diagram is divided into four quadrants. The first quadrant identifies essential or complex factors. The second quadrant spots the modest important factors and influential factors. The third quadrant identifies the less significance and influent factors. The fourth quadrant points out the good prominence but low correlation. Figure 2 is the causal diagram.
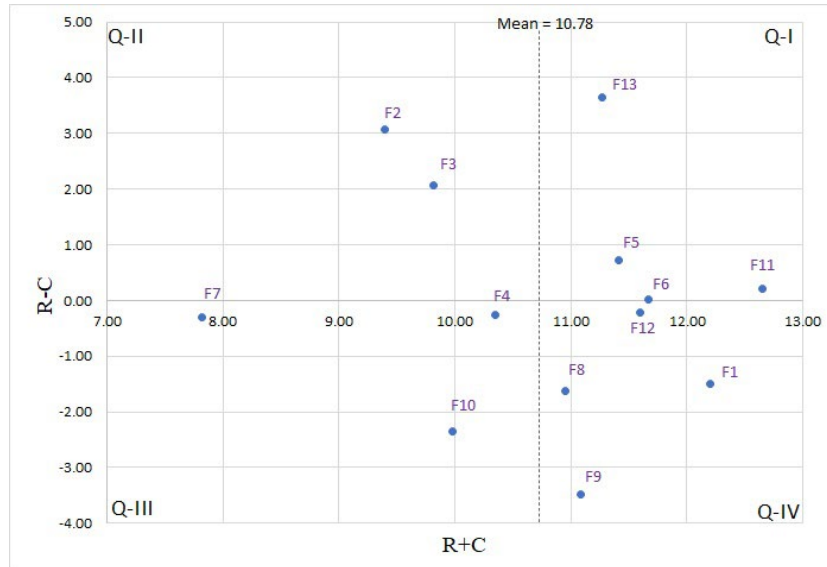
Figure 2 The importance and relationships of the factors

6. Conclusion

Based on the findings of this study, factors in quadrants 1 and 2, F2, F3, F5, F6, F11, and F13 are the cause factor that influent other factors, see Table 4 and Fig. 2. The most prominent and strong relation factors are F11 (Poor safety management), F13 (Poor construction site management), F6 (Poor project scheduling), and F5 (Poor site conditions). The management level must focus on these factors by allocating reasonable resources to theses to achieve standard practice of a safety construction management. Additionally, F2 (Employees' education, skills, experience) and F3 (Poor communication channel in construction site) have a strong correlation with safety construction site in the modest level. Factors in quadrant 4, F1 (Employee behavior), F8 (Inappropriate equipment and tools), F9 (Safety practices) and F12 (Poor safety awareness of employees), are influenced by the factors in the first quadrant. It means by improving the first quadrant factors, the fourth quadrant factors can be improved. On the other hand, there is no opportunity to improve factors in quadrant 4 without improving factors in quadrant 1.

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Occupational Hazard Assessment in Construction Projects: A Case Study

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ABSTRACT

Occupational hazard assessment is the substantial first step in safety management. It is essential in complicated work systems, especially in the construction industry. This article exemplifies the use case of multi-criteria decision-making tools. Tools such as the analytic network process, analytic hierarchy process, and fuzzy failure mode and effects analysis are packed systematically. The case study shows that decision-making yields different results from conventional failure mode and effects analysis. It overcomes drawbacks of the conventional tool, such as the interdependence among factors, the relative importance of factors being overlooked, and the difficulty of estimating values. Furthermore, this article illustrates that the construction functions, hazard factors, and causes are analyzed reasonably.

KEYWORDS: Safety management, construction industry, multi-criteria decision making, failure mode and effects analysis, fuzzy theory.

1. Introduction

The construction industry has experienced significant growth relative to the global population in recent years. Therefore, there is a requirement for additional shelters, workspaces, infrastructures, and amenities, which leads to the expansion of the construction business as a significant sector in every economy (Osei-Asibey et al., 2021). In 2016, the construction industry contributed over 11% to the global Gross Domestic Product (GDP). By 2020, this sector is projected to make up 13.2% of the world's GDP (Choi et al., 2019). Nevertheless, despite the recent advancements in construction safety, the risk of accidents remains much higher than in most other industries. The high incidence of injuries in construction work can be linked to the specific characteristics of this field, which require the use of heavy machinery and working under challenging conditions.

Construction projects inevitably involve inherent risks characterized by high degrees of unpredictability. Therefore, it is prudent to prioritize safety and risk management in building projects (Peñaloza et al., 2020). Considerable endeavors have been dedicated to developing safety systems to avert accidents and enhance safety performance.

The most efficient method for enhancing safety performance is to prevent accidents and minimize uncertainty prior to their occurrence. Therefore, evaluating safety-related hazards is the basis for establishing safety management. Consequently, risk assessment is regarded as a crucial element of safety management systems (Provan et al., 2020).

Various approaches have been employed to evaluate the hazards related to workplace safety. Among them, Failure Mode and Effects Analysis (FMEA) is well recognized as a prevalent method (Falcone et al., 2013). In this context, fuzzy logic can be integrated with the FMEA method to address the limitations of the conventional FMEA approach. The Fuzzy FMEA approach not only overcomes these limitations but also yields superior outcomes when dealing with ambiguous concepts and imprecise data (Pinto et al., 2011). This practical advantage instills confidence in its effectiveness. In addition, the conventional FMEA method is not sufficiently flexible in incorporating expert opinions. Therefore, a Fuzzy Expert System (FES) can be implemented to obtain the necessary flexibility (Alizadeh et al., 2022).

The uncertainty surrounding occupational accidents can be attributed to two factors: random variations caused by environmental, natural, or temporal changes (statistical uncertainty) and uncertainty arising from relative information (such as expert opinions) or the dispersion of data (non-statistical uncertainty) (Raheem and Issa, 2016). However, due to the limited availability of prior information for analysis and the absence of feedback from the workshop in the early stages of the project, it is necessary to consider the subjective probability condition.

The rest of this article is organized as follows. Section 2 declares the objective of the study. Section 3 reviews the relevant background theory such as safety management system, occupational hazard assessment, and failure mode and effects analysis. The construction industry is the main context of the literature examine. Section 4 explains the research procedure and its study framework. The result and conclusion are drawn in sections 5 and 6, respectively.

2. Research Objective

This study aims to implement occupational hazard assessment based on multi-criteria decision-making. It uses decision techniques such as failure mode and effects analysis, the analytic network process, the analytic hierarchy process, and fuzzy rule-based techniques. The practical framework is depicted systematically.

3. Literature Review

3.1 Safety Engineering and Management

Safety engineering is the systematic design and implementation of measures to mitigate the risk of accidents in workplaces. Engineering Safety Concepts offers comprehensive methodologies and strategies to minimize accidents by employing a risk management procedure to identify and eliminate dangers through design. Incidents are capable of occurring and indeed do occur. Workplaces and industries that utilize equipment, chemicals, and other potentially dangerous elements are prone to incidents that can result in injuries or even

fatalities if a thorough engineering safety approach is not implemented. Due to its multidisciplinary nature, safety engineering attracts many professionals who actively contribute to accident prevention and safety engineering.

A Safety Management System (SMS) is a set of organized processes implemented throughout an organization to facilitate informed decision-making based on risk assessment in daily business operations. Safety Management Systems enable enterprises to provide products or services with the utmost level of safety and ensure the maintenance of safe operations. SMS can also fulfill official obligations, such as those outlined in Title 14 of the U.S. Code of Federal Regulations (CFR), which are enforced by the Federal Aviation Administration (FAA). The International Civil Aviation Organization (ICAO) states that the fundamental components of a safety management system are hazard identification, occurrence reporting, risk management, performance measurement, and quality assurance.
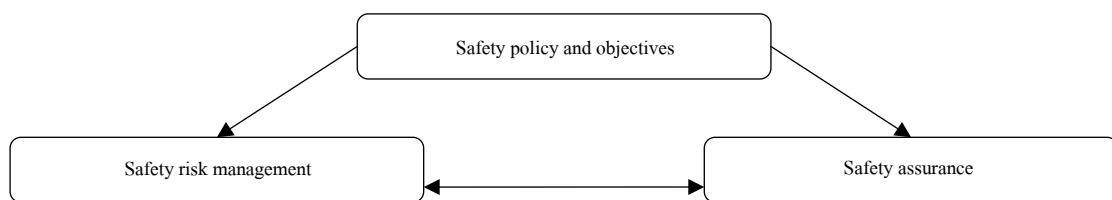
Figure 1 Safety management system

Source: Manawis (2024)

A safety management system primarily offers a methodical way to oversee and mitigate safety hazards in operational activities. Additionally, it seeks to enhance safety by leveraging current procedures, showcasing corporate responsibility, and strengthening the overarching safety culture. Efficient safety management is essential for operating and expanding the business, particularly in high-risk sectors such as aviation, energy, maritime, and construction, where health and safety are paramount. Although first intimidating, developing safety management systems is crucial for promoting and maintaining workplace safety. By using an appropriate technical solution, such as a digital platform, we may optimize and simplify this procedure.

3.2 Occupational Hazard Assessment in the Construction Industry

The ever-changing nature of the construction sector necessitates the implementation of more effective approaches to project management. Most construction organizations currently face challenges related to uncertainty, complexity, low performance, and inefficiency in their building projects. Hence, it is crucial to identify effective remedies for regions that want enhancement. Additionally, it is essential to implement techniques that demonstrate a novel approach to enhancing performance and encouraging best practices on building sites (Demirkesen and Zhang, 2021).

The construction sector is inherently perilous, with a high incidence of both fatal and non-fatal occupational injuries, primarily due to its distinctive characteristics. The situation is marked by constant fluctuations, utilization of diverse resources, unfavorable working conditions, lack of stable employment, and challenging settings (such as noise, vibration, dust, cargo handling, and direct exposure to weather). Moreover, it

necessitates the synchronization of various interrelated contractors, sub‑contractors, and operations, which might lead to heightened susceptibility to accidents.

Occupational injuries and illnesses have a significant influence on both safety and health, as well as the economy, due to the substantial expenditures associated with work‑related injuries. The issue of construction safety has been prominent due to the rising premiums for workers' compensation insurance, which may be attributed to a significant increase in the costs of medical treatment and recovery for work‑related injuries. Research across several sectors indicates that the construction business exhibits an above‑average incidence of injuries and associated expenses.

An ORA process involves collecting information that enhances understanding of a specific hazardous scenario. This information is typically characterized by uncertainties, ranging from ambiguous or indistinct characteristics (such as inaccurate borders) to excessive data or even contradictory information (resulting from several sources). Therefore, ambiguous data hinders a comprehensive understanding of the facts and does not aid in making informed decisions. Probabilities play a crucial role in traditional ORA methodologies. However, there is often a lack of clarity and understanding regarding their interpretation and use, which can undermine the effectiveness of the study.

3.3 Failure Mode and Effects Analysis (FMEA)

3.3.1 FMEA fundamentals

Failure Mode and Effects Analysis (FMEA) is a systematic approach to identify and analyses all potential failure modes within a system. It involves investigating the root causes of these failure modes, assessing their impact, and developing plans to address the identified problems (Mohammadi and Tabakolan, 2013). Risk Priority Numbers (RPNs) are utilized in conventional Failure Mode and Effects Analysis (FMEA) to determine the risk priority of discovered failure modes. The range of the Risk Priority Number (RPN) spans from 1 to 1,000 and can be determined by multiplying the scores of risk variables, including incidence (O), severity (S), and detection (D).

$$RPN = O \times S \times D \tag{1}$$

where O is the failure probability, S is the failure severity, and D is the power of detection.

Multiple studies have endorsed the utilization of the Failure Mode and Effects Analysis (FMEA) technique for risk management purposes. The typical Failure Mode and Effects Analysis (FMEA) does have certain limitations. Quantifying the likelihood of failure events in FMEA might be arduous or potentially unattainable in certain instances (Yang and Wang, 2015). Simultaneously, a substantial portion of the information in the Failure Mode and Effects Analysis (FMEA) is communicated through the utilization of terms like 'likely' and 'Very high.' Various combinations of O, S, and D can yield identical results in RPN analysis, although the associated risk implications can vary significantly between various scenarios. Take, for instance, two separate instances, one with the values O = 3, S = 5, D = 3, and the other with the values O = 9, S = 5, and D = 1, respectively. While the combined RPN value of both occurrences will equal sixty, the risk implications of both events may differ. Liu et al. (2012) conducted extensive research and created a comprehensive compilation of all

the problems found in FMEA. They highlight the omission of considering the relative importance of O, S, and D and instead assume that all three components hold equal value.

3.3.2 Conventional FMEA

Detection refers to the ability to identify a potential risk event with sufficient time to make necessary preparations and take appropriate action to mitigate the risk. The values of these three elements can vary from "1" to "10." Components of the system with a high-Risk Priority Number (RPN) are considered to be more critical than those with lower values. Research has shown that the traditional Failure Mode and Effects Analysis (FMEA) is a highly effective approach for reducing the likelihood of errors and failures inside a system. Conversely, the conventional Reverse Polish Notation (RPN) method has faced significant criticism in scholarly publications due to many factors. In the classic FMEA, the severity, occurrence, and detection are measured on a scale. An interested reader is referred to Sharma and Srivastava (2018).

4. Research Methodology

4.1 Research Design

Step 1: Network diagram building.

The network diagram is based on the analytic network process concept which an element in a cluster can affects to another element in the same or different clusters. Figures 2 shows the network of causes-and-effect of this study. Please note that the acronyms are pre-determined dominant hazard factors and causes (G1 and G2), Construction functions (CF), Hazard factors (HF), and Hazard causes (HC).
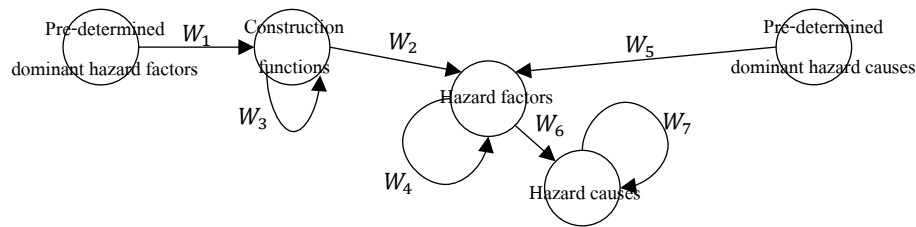
Figure 2 Analytic network diagram

Step 2: Super-matrix generating.

The super-matrix is constructed as follow.

$$
\begin{array}{c|ccccc}
 & \text{G1} & \text{G2} & \text{CF} & \text{HF} & \text{HC} \\
\hline
\text{G1} & 0 & 0 & 0 & 0 & 0 \\
\text{G2} & 0 & 0 & 0 & 0 & 0 \\
\text{CF} & W_1 & 0 & W_2 & W_3 & 0 \\
\text{HF} & 0 & W_5 & 0 & W_4 & W_6 \\
\text{HC} & 0 & 0 & 0 & 0 & W_7
\end{array}
\qquad (2)
$$

where W_1 is the relative important construction functions with respect to pre-determined dominant hazard factors, W_2 is the inner dependent construction factors, W_3 is the outer dependent construction factors and hazard causes, W_4 is the inner dependent hazard factors, W_5 is the relative important hazard factors with respect to pre-determined dominant hazard causes, W_6 is the outer dependent hazard factors and hazard causes, and W_7 is the inner dependent hazard causes.

Step 3: Elements' weight calculation

This step uses fuzzy pairwise comparison based on the analytic hierarchy process method. The linguistic variables are translated into triangular fuzzy numbers (TFNs). The numbers and their definitions are illustrated in Table 1. Please note that the seven-level scale is used in the AHP instead of the ten-level scale. The seven-level comparison scale includes absolutely unimportant (1/9,1/7,1/3), strongly unimportant (1/7,1/5,1/3), weakly unimportant (1/5,1/3,1), equally important (1,1,1), weakly important (1,3,5), strongly important (3,5,7), and absolutely important (5,7,9).

Suppose that one column of a submatrix contained m elements. Accordingly, the pairwise comparison matrix for m elements can be represented by $E = [\tilde{e}_{ij}]_{m \times m}$, which $\tilde{e}_{ij} = 1/\tilde{e}_{ji}$. Then, each column is derived by using Eq. (3).

$$\widetilde{w}_i = \frac{\left(\prod_{j=1}^m \tilde{e}_{ij}\right)^{1/m}}{\sum_{i=1}^m \left(\prod_{j=1}^m \tilde{e}_{ij}\right)^{1/m}}, \quad \forall i,j \in \{1,2,..,m\} \tag{3}$$

where $\widetilde{w}_i$ is the fuzzy weight of the element i in a column of a submatrix, and $\widetilde{w}_i = (w_i^a, w_i^b, w_i^c)$, $\forall i \in \{1,2,...,m\}$. Please note that w_i^a, w_i^b, and w_i^b are the smallest, most, and largest likely values, respectively. The pairwise comparison matrix E is, then, tested the consistency by performing critical value calculation by using Eq. (4) to (6)

$$\lambda_{max} = \frac{1}{m}\left(\sum_{i=1}^m \left(\frac{\sum_{j=1}^m e_{ij}^k w_i^k}{w_i^k}\right)\right), \quad \forall i,j \in \{1,2,...,m\} \tag{4}$$

$$CI = \frac{\lambda_{max} - m}{m - 1} \tag{5}$$

$$CR = \frac{CI}{RI} \tag{6}$$

λ_{max} is the largest eigenvalue of the matrix E, CI is the consistency index, and RI is the random index which can be found in Winston (2004). If the CR is lower than 0.1, the matrix E is consistency and acceptable.

Step 4: Relative importance of hazard factors and causes.

The limit matrix is calculated by determining $\lim_{n \to \infty} E^n$. However, in this study, the hazard-factor interdependent weight can be obtained by $W_{HF}^I = W_4 \times W_2$. The construction-function interdependent weight can be obtained by $W_{CF}^I = W_3 \times W_1$. The hazard-factor weigh, lastly, can be calculated as $W_{HF} = W_{HF}^I \times W_{CF}^I$. Next, the hazard-cause weight is calculated by $W_{HC} = (W_7 \times W_6) \times (W_4 \times W_5)$. Please note that since the values in the matrix are crisp values, we used the TFNs operations in these steps.

Step 5: Fuzzy ordering

The W_{HF} and W_{HC} are denoted by TFNs. The fuzzy ordering formula is used.

$$R(\tilde{A}) = \sqrt{\frac{\frac{(b-a)^3}{4} + \frac{(b-a)a^2}{2} + \frac{2(b-a)^2 a}{3} + \frac{(c-b)^3}{12} + \frac{(c-b)b^2}{2} + \frac{(c-b)^2 b}{3}}{3(c-a)}} \tag{7}$$

where $R(\tilde{A})$ is the area of a TFN $\tilde{A} = (a,b,c)$. For any two $\tilde{A}_i$ and $\tilde{A}_j$, 1) if $R(\tilde{A}_i) < R(\tilde{A}_j)$, then $\tilde{A}_i < \tilde{A}_j$, 2) if $R(\tilde{A}_i) = R(\tilde{A}_j)$, then $\tilde{A}_i = \tilde{A}_j$, and 3) if $R(\tilde{A}_i) > R(\tilde{A}_j)$, then $\tilde{A}_i > \tilde{A}_j$.

Step 6: Fuzzy risk priority number calculation

There are three sub-steps to calculate the fuzzy-RPNs: 1) fuzzy-rule base construction, 2) fuzzy inference, and 3) defuzzification. The first sub-step depends on the expert to construct the rule based on his experience. Figure 3 shows the general rule base. The linguistic variables and their definitions are shown in Tables 1 and 2. The second sub-step uses Eq. (8) and (9) to discover the risk level of $\tilde{A}$.

Rule i: If Occurrence is $\tilde{A}_{i1}$
             and Severity is $\tilde{A}_{i2}$
             and Not detection $\tilde{A}_{i3}$
             then Ris priority number is $\tilde{C}_i$.

Figure 3 Rule-base method for FMEA

Table 1 Linguistic variables

Linguistic variables	Fuzzy numbers	Occurrence (O)	Severity (S)	Detection (D)
Very low (VL)	(0, 0, 0.2)	Rare incidence	No fatality	Always detectable
Low (L)	(0.1, 0.3, 0.5)	Once for a long time	No absent injury	A very high probability to detect
Moderate (M)	(0.3, 0.5, 0.7)	More than one occurs	One-day absent injury	A moderate probability to detect
High (H)	(0.5, 0.7, 0.9)	More frequent than one	More than one-day absent	A small probability to detect
Very high (VH)	(0.8, 1, 1)	Several times	Fatal of employee	Impossible to detect

Table 2 Linguistic variables of risk priority numbers

Linguistic variables	Fuzzy numbers	Risk priority number (RPN)
Very low (VL)	(0, 0, 0.2)	The hazard risk is minimal, and there is little need for preventive or remedial measures.
Low (L)	(0.1, 0.3, 0.5)	The hazard risk is low and acceptable; thus, no prevention or improvement is needed.
Moderate (M)	(0.3, 0.5, 0.7)	The hazard risk is moderate and acceptable. However, general prevention and improvement are needed.
High (H)	(0.5, 0.7, 0.9)	Th hazard risk is considerable, so prompt preventative and improvement measures are needed to increase monitoring and reduce risk.
Very high (VH)	(0.8, 1, 1)	The hazard risk is extremely high, necessitating the immediate cessation of building until the risk is mitigated.

$$\mu(y)_{\tilde{C}'_i} = \min[\alpha, \mu(y_i)_{\tilde{C}_i}], \quad \forall i \in \{1,2,\dots,m\} \tag{8}$$

$$\alpha = \min[Hight[\tilde{A}_i \cap \tilde{A}_j]] \tag{9}$$

where $\mu(y)_{C_i}$ is the membership function of the derived risk $\widetilde{C}'_i$ for rule $i, \forall i \in \{1,2,\dots,m\}$, is the membership function of the assigned risk $\tilde{C}_i$ for rule $i, \forall i \in \{1,2,\dots,m\}$, and $\alpha =$ the minimum height for the intersected results. The aggregated outputs $\tilde{C}$ from all rules is then $\tilde{C} = \tilde{C} \cup \tilde{C} \cup \cdots \cup \tilde{C}$, where $\tilde{C}$ is the aggregated risk level of a failure mode.

The third sub-step defuses the TFNs using the center of gravity method as shown in Eq. (10).

$$y^* = \frac{\int y \cdot \mu_{\tilde{C}}(y)}{\int \mu_{\tilde{C}}(y)} \tag{10}$$

where y^* is the defuzzification value of the risk $\tilde{C}$ and $\mu_{\tilde{C}}(y)$ is the membership function of the risk $\tilde{C}$.

4.2 A Case Study

A construction site in Kunming was a field study of this research. The occupational health and safety supervisor participated in this study. The construction site is a residential building. However, the size and its location are confidential. There are ten functions in the construction phase: site clearing (CF1), laying the foundation (CF2), plinth beam and slab (CF3), superstructure (CF4), bricklaying (CF5), lintel and roof coating (CF6), plumbing and electrical wiring (CF7), exterior and interior jobs (CF8), flooring (CF9), and painting (CF10).

The supervisor identified 11 hazard factors corresponding to the construction steps. The causes were pointed out as follows: unsafe environment (C1), substandard construction site (C2), substandard facility (C3), protective gear (C4), equipment and tools (C5), work procedure (C6), coordination and communication (C7), and personal health (C8).

Our study process is structured around a five-step procedure, detailed in section 4.2. The first step, illustrated in Fig. 3, is followed by the generation of a super-matrix, which relies on a comparison questionnaire. The questionnaire, a key tool in our research, was used by the supervisor to conduct 55 pairwise comparisons of the hazard factors. Please note that due to space constraints, we are unable to include the completed questionnaires in this manuscript.

Table 3 Parts of questionnaire for submatrix W_1

	AU	SU	WU	EI	WI	SI	AI
HF1 vs HF2					✓		
HF1 vs HF3						✓	
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
HF9 vs HF11				✓			
HF10 vs HF11							✓

Other matrices were conducted in the same manner. The super-matrix was built as Eq. (2). The weights of elements are calculated using Eq. (3). The matrix was consistency tested using Eq. (4) to (6). The relative importance of hazard factors and causes was calculated. We can rank the HF, CF, and C using (7). Finally, the fuzzy-RPNs can be calculated using Eq. (8) to (10).

5. Result and Analysis

5.1 Ranking

The HF, CF, and C vectors are shown below.

$$W_{HF} = \begin{bmatrix} (0.038,0.079.0.576) \\ (0.044.0.070,0.432) \\ (0.038.0.057.0.417) \\ (0.017,0.032,0.178) \\ (0.037,0.055,0.410) \\ (0.045,0.068,0.421) \\ (0.030,0.049,0.399) \\ (0.042,0.066,0.422) \\ (0.033,0.050,0.398) \\ (0.029,0.047,0.215) \\ (0.015,0.029,0.160) \end{bmatrix}, W_{CF} = \begin{bmatrix} (0.014,0.063,0.199) \\ (0.015,0.066,0.198) \\ (0.017,0.070,0.277) \\ (0.020,0.096,0.295) \\ (0.016,0.065,0.270) \\ (0.022,0.075,0.284) \\ (0.014,0.077,0.235) \\ (0.013,0.064,0.169) \\ (0.012,0.063,0.170) \\ (0.012,0.058.0.166) \end{bmatrix}, W_C = \begin{bmatrix} (0.006,0.048,0.543) \\ (0.007,0.069,0.648) \\ (0.007,0.056,0.633) \\ (0.009,0.085,0.897) \\ (0.009,0.076,0.788) \\ (0.006,0.032,0.497)) \\ (0.004,0.139,0.292) \\ (0.004,0.275,0.324) \end{bmatrix}$$

The ranking of attributes is shown in Table 4 to 6.

Table 4 Ranking result of hazard factors, construction functions, and causes

Hazard functions	Risk level	Ranking	Construction functions	Risk level	Ranking	Causes	Risk level	Ranking
HF1	0.1067	1	CF1	0.0408	7	C1	0.0953	5
HF2	0.0826	2	CF2	0.0411	6	C2	0.1148	3
HF3	0.0782	5	CF3	0.0546	3	C3	0.1111	4
HF4	0.0343	10	CF4	0.0607	1	C4	0.1578	1
HF5	0.0768	6	CF5	0.0528	4	C5	0.1389	2
HF6	0.0807	3	CF6	0.0568	2	C6	0.0861	7
HF7	0.0737	8	CF7	0.0483	5	C7	0.0639	8
HF8	0.0804	4	CF8	0.0360	8	C8	0.0869	6
HF9	0.0739	7	CF9	0.0359	9	-	-	-
HF10	0.0431	9	CF10	0.0347	10	-	-	-
HF11	0.0308	11	-	-	-	-	-	-

Table 4 shows the most critical hazard factor is 'working at height'. The second order of the hazard factors is 'moving objects.' The least important hazard factor is 'site security.' The most important construction function is 'superstructure.' The second order is 'lintel and roof coating.' The least essential construction function is 'painting.' The most crucial cause is 'protective gear.' The second important order is 'equipment and tools.' The least essential cause is 'coordination and communication.'

5.2 Risk Priority Numbers

The RPNs are calculated by using three sub-steps in step 6. The rule base is constructed by the occupational health and safety supervisor. The ranking of hazard factors by considering the risk priority numbers compared to the conventional FMEA method is shown in Table 5.

Table 5 Comparison between fuzzy-FMEA and conventional FMEA.

Hazard functions	Fuzzy-FMEA	Conventional FMEA
HF1: working at heights	1	1
HF2: moving objects	2	5
HF3: slips and trips	5	8
HF4: noise	10	9
HF5: hand arm vibration syndrome	6	7
HF6: material handling	3	4
HF7: excavations	8	2
HF8: asbestos	4	10
HF9: electricity	7	6
HF10: airborne fibers and materials	9	11
HF11: site security	11	3

Table 5 shows that the ranking results of hazard factors from fuzzy-FMEA and the conventional FMEA differ. The first rank, 'working at height,' is the only factor that is the same. The reasons of different ranking is explained in the next paragraph.

Conventional FMEA often uses the risk priority number (RPN) to ascertain the risk priorities of failure modes. The RPN is generated by multiplying the probability of occurrence (O), the severity of the failure (S), and the likelihood of failure detection (D). Nevertheless, this computational approach has faced criticism for multiple reasons. For example, the relative significance of the three components (O, S, and D) needs to be taken into account; the value of RPN may not be the product of these three factors, and accurately estimating the three factors is challenging. In order to address the limitations above, this study employed the fuzzy inference approach to calculate the Risk Priority Number (RPN) instead of the multiplication of the three components.

6. Conclusion

This study deployed muti-criteria decision-making tools to assess occupational hazards in construction projects. Due to the problematic and substantial construction sites, safety management in construction is a challenge. The conventional FMEA is modified using the concepts of the analytic network process, the analytic hierarchy process, the fuzzy rule base, and fuzzy inference to obtain more reasonable risk factors. The case study showed that the priority hazard factor was 'working at height' while the priority was 'protective gear.' The results were different from the conventional FMEA. Finally, the assessment results can be used to form the occupational hazard mitigation strategy for the construction site.

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Analytic Network Process Approaches Green Supplier Selection:

A Case of a Construction Project

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ABSTRACT

Supplier selection is an embedded issue in decision science. It is complex and vague sometimes. This study aims to solve a complicated decision problem, green supplier selection. Since green materials are scarce, uncertain, and interdependent, the analytic network process technique is appropriate to solve this problem. The study started with a review of the green supplier selection factors in the literature. Then, five decision-makers of the sample construction company validated five clusters with fifteen criteria using the item objective congruence index. Next, the four-step analytic network process procedure evaluated three green suppliers: local, regional, and international. The results show that the regional supplier had the highest local weight of 0.4503. Additionally, the material price criterion was the highest weight among the criteria. The following three orders were GHG emission technology, ordering cost, and delivery cost, with global weights of 0.1360, 0.1148, and 0.1010, respectively. This study shows the benefits of the analytic network process, which can be used to solve complex multi-criteria decision-making, especially when the criteria are not independent.

KEYWORDS: Analytic network process, multi-criteria decision analysis, decision science, construction industry, green supply chain

1. Introduction

Green supply chain management (GSCM) is an economic and environmental concerns-oriented subset of supply chain management (Ibrahim and others, 2020). The objective of the GSCM concept is to mitigate environmental impacts and pollution resulting from supply chain operations (Tseng and others, 2019). A component of GSCM is the selection of suppliers with an eye toward the environment; this is commonly referred to as "green supplier selection" (Abdallah and Al-Ghwayeen, 2020). Green suppliers are expected to mitigate the effects of global warming, a worldwide menace, in this age of globalization. As a result, green suppliers are appropriate for mitigating environmental issues. Conversely, suppliers assume a critical function within the construction sector by ensuring the accessibility of raw materials in accordance with criteria such as product quality, price, production timeliness, cost-effectiveness, and product defects (Alone, 2021). The supplier selection criteria in question exclusively emphasize the economic aspect.

Many studies have been suggested regarding supplier selection problems in the construction sector. Yazdani and others (2020) developed a combined approach using a decision-making trial and evaluation laboratory (DEMATEL) and evaluation based on distance from average solution (EDAS). The study focused mostly on analyzing the economic and environmental factors. Eshtehardian and others (2013) utilized the Analytic Network Process (ANP) and Analytic Hierarchy Process (AHP) techniques, focusing on the economic aspect. Wang and others (2017) established the Gray Relational Analysis (GRA) method, sometimes referred to as AHP, to address the issue of identical dimensions. Other techniques that give priority to the economic component are the Grey Combined Compromise Solution (CoCoSo-G) and the Analytic Hierarchy Process (AHP) (Haeri and Rezaei, 2019). Basar (2018) employed ANP, focusing on the environmental and economic dimensions. Based on the literature assessment, most studies focus on the economic component. The environmental component has received insufficient attention. Moreover, previous inquiries overlooked the association that existed between the criteria. In the meantime, the correlation between different criteria also has an impact on the significance of certain criteria.

This study aims to deploy the analytic network process technique to evaluate supplier performance and select material supplier in green supply chain management. A simple and practical framework to help managers evaluate green suppliers is proposed.

2. Research Objective

To propose a practical multi-criteria decision-making tool, the analytic network process, for green supplier selection in the construction industry.

3. Literature Review

3.1 Supplier Selection

The partners within a logistic and supply chain management (LSCM) play a crucial role in shaping the behavior of the supply chain. The selection of a partner and the long-term viability of the cooperation are crucial factors in establishing and maintaining a supply chain (Chai and others, 2013).

The decision about supplier selection problem (SSP) is crucial for the success of production management in today's highly competitive economy (Yildiz and Yayla, 2015). In highly competitive markets, enterprises need to collaborate with dependable suppliers. Hence, companies strive to collaborate with suppliers who can provide services at the desired level of quality, are cost-effective, and are adaptable to fluctuations in demand. Enterprises often need help selecting suppliers due to the diverse and numerous requirements of sister companies collaborating with these providers. Supplier selection is commonly encountered in multi-criteria decision-making (MCDM) problems. MCDM approaches are widely applicable for organizing various options based on several criteria. MCDM, or Multi-Criteria Decision Making, is a systematic approach to identifying the optimal choice from a set of viable options. The proliferation of criteria for comparing alternatives has grown prevalent in practically all problems. Decision-makers aim to address the several challenges presented by MCDM.

Multi-objective decision-making approaches are analytical techniques. These tools facilitate the concurrent evaluation of numerous quantifiable and non-quantifiable strategic and operational variables while involving a wide range of individuals in decision-making. These strategies aid managers in evaluating several options during the decision-making process, facilitating a more efficient allocation of their company's resources.

These are any MCDM approaches used to solve the supplier selection problems. The selected approaches will be reviewed in the following section. In this section, the criteria of supplier selection in literature are re-examined and the supplier selection in construction industry is reviewed next.

3.2 Multiple Criteria Decision-Making

Multiple criteria decision-making (MCDM) or multiple criteria decision-analysis (MCDA) is a branch of operations research that systematically assesses many competing criteria in decision-making, both in everyday situations and in various domains such as commerce, government, and medicine. It is referred to as multiple attribute utility theory, multiple attribute value theory, multiple attribute preference theory, and multi-objective decision analysis.

Conflicting criteria commonly arise while evaluating options. Cost or price is typically a primary criterion, while quality is often another factor that can easily clash with cost. Cost, comfort, safety, and fuel efficiency are typically the primary considerations when buying an automobile. It is uncommon for the least expensive car also to be the most comfortable and safest option. Portfolio managers aim to achieve high returns while mitigating risks (Franco and Montibeller, 2010). However, equities with the potential for significant returns sometimes have a high risk of financial loss. Customer happiness and service cost are the primary opposing objectives in the service business.

Individuals often subconsciously consider several factors when making judgments in their everyday lives, and they may feel content with the outcomes of these choices, even if they rely solely on intuition. Conversely, in situations where a lot is at stake, it is crucial to organize the problem and thoroughly assess several factors carefully (Weistroffer and Li, 2016). When deciding whether or not to construct a nuclear power plant and determining its location, there are many considerations involving various factors, as well as multiple stakeholders impacted by the outcomes.

Effectively organizing intricate situations and specifically considering many factors results in more knowledgeable and superior decision-making. Significant progress has been made in this field since the inception of the current multiple-criteria decision-making discipline in the early 1960s. Various methodologies and methods, often implemented through specialist decision-making software, have been created for use in various fields, including politics, business, environment, and energy (Kylili and others, 2016).

3.3 Analytic Network Process

The Analytic Network Process (ANP) extends the Analytic Hierarchy Process (AHP). The fundamental framework consists of an influence network comprising clusters and nodes encompassed inside the clusters. Priority determination follows the same methodology as the Analytic Hierarchy Process (AHP), utilizing pairwise comparisons and subjective judgment. Several choice issues cannot be organized hierarchically due to the

interplay and reliance of higher-level elements in a hierarchy on lower-level elements. The significance of the criteria not only determines the significance of the alternatives in a hierarchical manner, but also the significance of the alternatives themselves determines the significance of the criteria. The brief foundation and procedure of ANP will be described in this section.

1) ANP background

The analytic hierarchy process (AHP) is a practical and widely used methodology in multi-criteria decision-making. It empowers decision makers (DMs) to determine the priority of compared aspects, thereby aiding them in making well-informed decisions. Its effective implementation in real-world scenarios underscores its reliability. Within the AHP, decision makers (DMs) express their preferences for paired comparisons of elements using a scale ranging from 1 to 9 at each level of a hierarchy. The AHP follows a linear top-down structure consisting of distinct levels that are independent from each other. Additionally, the elements inside each level are likewise independent.

Within the Analytic Hierarchy Process (AHP), it is essential to utilize prioritizing methods to determine the relative importance of the items being compared at each level of the hierarchy. These approaches include the eigenvector method (EVM), the logarithmic least squares method (LLSM), and the logarithmic goal programming method (GPM) (Zhu and others, 2015). Because of the inherent disparity among the DMs, their preferences may be contradictory. The EVM is the only method that considers the constancy of preferences. Utilizing alternative prioritization methods can result in erroneous conclusions by inverting the order of rankings. Hence, ensuring consistency and enhancing the AHP are crucial to ensure meaningful outcomes.

A drawback of the Analytic Hierarchy Process (AHP) is its inability to address interconnections and dependencies among the elements within the hierarchy's levels. To illustrate, while forecasting the market share of cellular providers, the factors that impact a company's market share include costs and services, with the services potentially also affecting the costs. In order to address this constraint, Saaty (2001) took into account the interdependencies and reciprocal influences of the elements and subsequently devised the analytic network process (ANP).

The Analytic Network Process (ANP) is not just a theoretical concept, but a highly practical tool. In an Artificial Neural Network (ANN), the network enables clusters of elements to exert mutual influence, or contains loops if the elements inside the clusters have internal dependencies. The network expands in a radial manner, with its pieces forming a cluster that lacks a specific arrangement. The ANP's ability to handle dependencies and feedback makes it highly valuable in numerous practical situations. The ANP has been applied in several domains such as election projects for interdependent information systems, selection of research and development projects, choosing logistics service providers, planning product mix, conducting SWOT analysis, forecasting financial crises, and performing multi-criteria analysis, demonstrating its relevance and applicability in real-world scenarios.

2) ANP procedure

The ANP algorithm builds intricate connections between decision factors by substituting a hierarchical structure with a network structure. The Analytic Network Process (ANP) possesses all the advantageous characteristics of the Analytic Hierarchy Process (AHP), such as its straightforwardness, adaptability, capability to incorporate both quantitative and qualitative criteria, and ability to assess the consistency of decisions. The ANP approach views each problem as a complex system of criteria, sub-criteria, and possible solutions. Every piece inside a network can communicate with one another in a multitude of ways. Clusters in a network can provide feedback and connect. The process of ANP can be succinctly described in four steps: Step 1 involves constructing a model and transforming a problem into a structured network of topics; Step 2 involves creating a matrix for pairwise comparisons and calculating priority vectors; Step 3 takes creating a super-matrix and transforming it into a weighted super-matrix; Step 4 is the final stage, where the optimal option is chosen. Please note that the mathematical models and equations grounded in the ANP will be shown in the next section.

4. Research Methodology

The research method follows the ANP procedure by using a survey technique with five decision-makers of the sample construction company.

Step 1: ANP network generation

The sample construction project is a green construction site. Green materials are needed for building the residence building, which is certified by the local government. However, the size, location, number of employees, and organizational structure are confidential. This research project's five decision-makers (DMs) are the management and operation-level managers. It is a group decision-making which we need an accuracy reciprocal number in opposite element in the comparison matrix. Thus, a geometric mean, as is shown in Eq. (1).

$$\bar{a}_k = (\prod_{k=1}^{K} a_k)^{\frac{1}{k}}, \forall k \in \{1,2,..,K\} \tag{1}$$

First, the unstructured interview is conducted. It tries to find criteria for a green supplier of construction materials. Then, the criteria are precisely defined and compared to the criteria in the literature. The comparison prevents this study from overlooking some essential criteria. Lastly, the five decision-makers will review the well-defined criteria using the item objective congruence (IOC) index. The result shows that IOC = 1.00, which means the criteria are congruent. It was found that the IOC value equals 1.00. Table 1 shows the factors and their criteria, and Fig. 1 shows the network among criteria on the Super Decisions package (www.superdecisions.com).

The Super Decisions package is decision-making software based on the analytic hierarchy and analytic network processes. It was created by Thomas Saaty's team and funded by the Creative Decision Foundation. An interested reader can find the details on www.superdecisions.com. Please note that there are four objectives in this experiment: economy, environment, service, and performance.

Table 1 Criteria for construction green supplier selection

Clusters	Codes	Nodes	Influences
Economy (A)	A1	Material price	A2, B1, B2, B3
	A2	Ordering cost	A1, C3
	A3	Delivery cost	C1
Environment (B)	B1	Green material certification	A1, D3
	B2	Green innovation material	A1
	B3	Life-cycle material management	A1, A3, C3
Service (C)	C1	On-schedule delivery	A3
	C2	Defect material replacement promptly	A1, C3
	C3	Warranties and after-sale service	C2
Performance (D)	D1	Fast response to the customer's request	A2, C1
	D2	Keep agreement rigorously	A1
	D3	Technical capability	E1, E2, E3, B1
Technology (E)	E1	Renewable energy technology	A1, B1, B2, D3, E3
	E2	Energy efficiency technology	A1, B1, B2, D3, E3
	E3	GHG emission technology	A1, B1, B2, D3, E1, E2
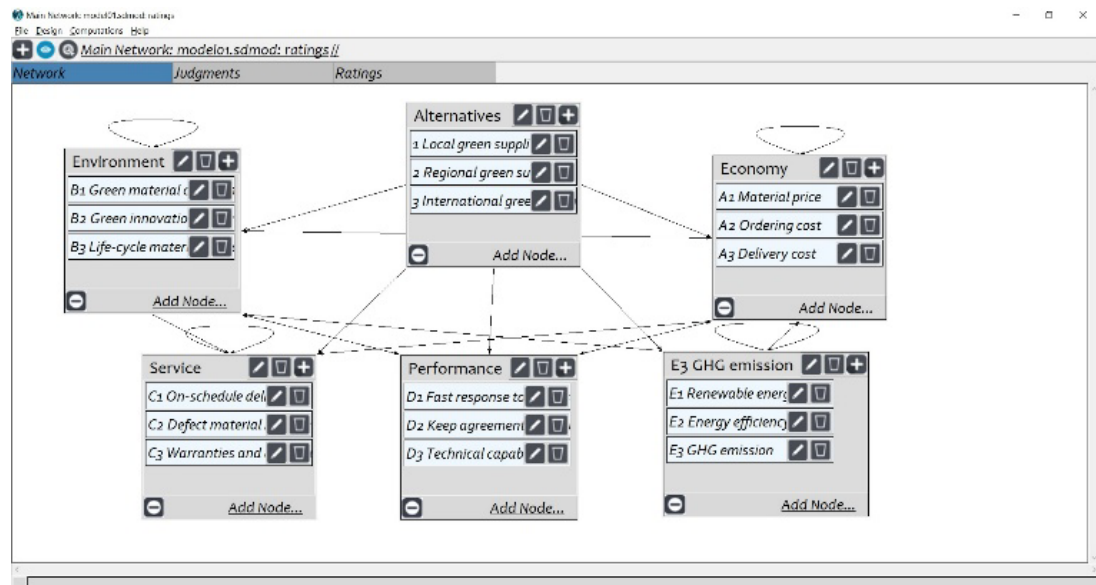
Figure 1 ANP network

There are three green suppliers in this study: local (S1), regional (S2), and international (S3) suppliers. The loop connection of a cluster is the inner dependence which a node affects to another node in the same cluster; while, the connections between the clusters are the outer dependences.

Step 2: Pairwise comparisons

Table 1 shows the scale of 1-9 interpretation, giving the criteria i over criteria j, as a_{ij} where j is the row element and j is the column element. Table 1 shows the scale and their interpretation. As mentioned, five decision-makers are a group decision-maker. We deploy geometric mean to calculate the average, e.g., 3, 5, 5, 6,

and 7, are the score from the member; thus, the mean is $\sqrt[5]{3 \cdot 5 \cdot 5 \cdot 6 \cdot 7} = 5.01$ instead of an arithmetic mean of 4.2. The geometric mean is more accurate in terms of reciprocal score. Please note that due to the complex problem, it needs to conduct the pairwise comparison 88 times.

Table 1 Interpretation of entities in a pairwise comparison matrix

Value of a_{ij}	Interpretation
1	Factors i and j are of equal important.
3	Factor i is slightly more important than factor j.
5	Factor i is more important than factor j.
7	Factor i is strongly more important than factor j.
9	Factor i is absolutely more important than factor j.
2, 4, 6, 8	Intermediate values (a value between two adjacent consideration values).

We conduced to pairwise comparison on the Super Decision program, as shown in Fig. 2.
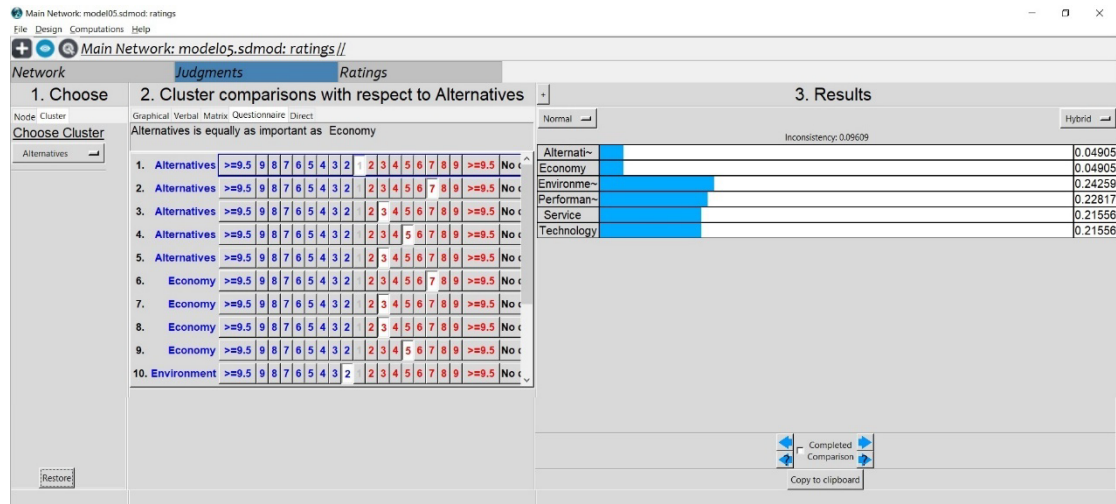
Figure 2 Pairwise comparison operations

To express an example of the comparison and its consistency Fig. 3 shows the comparison matrix of cluster comparison with respect to economy (A).

	A	B	C					Avg
A	1	4.317	2.048		0.581	0.599	0.572	0.584
B	0.232	1	0.530	$\Rightarrow$	0.135	0.139	0.148	0.140
C	0.488	1.888	1		0.284	0.262	0.280	0.275
	1.720	7.206	3.577					
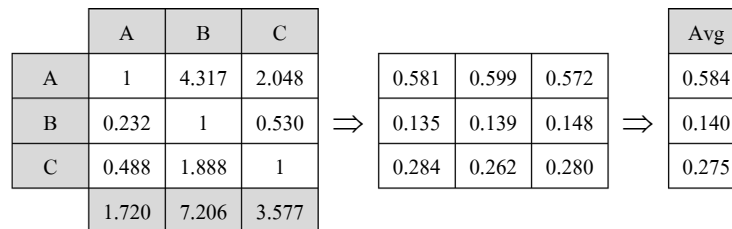
Figure 3 A pairwise comparison respect to economy cluster

To check its consistency, the comparison matrix is multiplied by vector of average = (0.584 0.140 0.275). The result is show in Fig. 4.

	A	B	C		Avg		
A	1	4.317	2.048		0.584		1.754
B	0.232	1	0.530	×	0.140	=	0.421
C	0.488	1.888	1		0.275		0.825
	1.720	7.206	3.577				

Figure 4 The eigen value of the comparison matrix

The eigen vector is calculated next by using Eq. (2).

$$\frac{1}{n}\sum_{i=1}^{i=1}\frac{i^{th} \text{ entry in } Aw^T}{i^{th} \text{ entry in } w^T} \tag{2}$$

From the illustrated example, we obtain 3.00. Then, the consistency index (CI) is $3.00 - \frac{3}{3-1} = 0.00$. As a result, the CI is lower than random index (RI = 0.58), see Winston (2004). Additionally, it is said the group decision-makers perfectly made a consistent decision. Table 2 shows the random index numbers.

Table 2 Random index number

n	2	3	4	5	6	7	8	9	10
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Source: Winston (2003).

However, we could not show all the comparisons of this study because the problem is too large and complex to show the details. We want to show the Super Decision program result instead. Figure 5 shows the unweighted super matrix.

Figure 5 The unweighted matrix on Super Decision program

Step 3: Weighted matrix calculation

The concept of super matrix is putting all relevant comparisons in one gigantic matrix. All clusters, criteria, and alternatives are included in the super matrix. This matrix can also show the inner and outer dependences simultaneously. Let W_{ij} is the $n \times n$ unweighted super matrix and $w_{i,j}$ is the relative importance vector of the clusters. Thus, the weighted super matrix is calculated by Eq. (3).

$$W' = \begin{array}{ccc} \text{Cluster 1} & \text{Cluster...} & \text{Cluter } n \\ \left| \begin{array}{ccc} w_{1,1}W_{11} & ... & w_{1,n}W_{1n} \\ \vdots & \ddots & \vdots \\ w_{n,1}W_{n1} & ... & w_{n,n}W_{nn} \end{array} \right| \end{array} \tag{3}$$

Step 4: Limit matrix calculation

The limit matrix can be calculated by using Eq. (4).

$$\lim_{k \to \infty} (W')^k \tag{4}$$

Step 5: Alternative selection

Ultimately, the optimal choice is made. In this scenario, if the final matrix (obtained in Step 3) covers the whole network, the column representing the alternatives in the normalized super-matrix is utilized to determine priority weights. The alternative with the highest weight is considered the optimal choice. However, if a super-matrix consists solely of interconnected clusters, then determining overall priorities would necessitate extra calculations, after which the optimal choice can be made.

5. Result and Discussion

Step 1: ANP network generation

The designed network is shown in Fig. 1.

Step 2: Pairwise comparisons

Table 2 illustrates it the readable version of the pairwise comparison and the unweighted super matrix from Fig. 5.

Table 2 Unweighted super matrix

Clusters	Nodes	S1	S2	S3	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3	E1	E2	E3
Alternatives	S1	0.0003	0.5000	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	S2	0.8333	0.0000	0.1667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	S3	0.1667	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Economy	A1	0.7731	0.6909	0.4721	0.0000	1.0000	0.0000	1.0000	1.0000	0.7500	0.0000	1.0000	0.0000	0.0000	1.0000	0.0000	1.0000	1.0000	1.0000
	A2	0.0876	0.0914	0.0836	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	A3	0.1391	0.2176	0.4442	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
Environment	B1	0.6337	0.7142	0.7731	0.5278	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.7500	0.0000	0.6667
	B2	0.1919	0.1428	0.1381	0.3325	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.6667	0.3333
	B3	0.1743	0.1428	0.0876	0.1396	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3333	0.0000
Service	C1	0.6955	0.4434	0.2000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	C2	0.2290	0.3873	0.2000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
	C3	0.0754	0.1692	0.6000	0.0000	1.0000	0.0000	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Performance	D1	0.7731	0.6909	0.1428	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	D2	0.1391	0.0914	0.7142	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	D3	0.0876	0.2176	0.1428	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000
Technology	E1	0.2000	0.0936	0.0750	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1396	0.0000	0.0000	0.5000
	E2	0.2000	0.2796	0.3574	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3325	0.0000	0.0000	0.5000
	E3	0.2000	0.6266	0.5674	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5278	1.0000	1.0000	0.0000

Step 3: Weighted matrix calculation

By using Eq. (3), we obtain the weighted super matrix, as shown in Table 3.

Table 3 Weighted super matrix

Clusters	Nodes	S1	S2	S3	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3	E1	E2	E3
Alternatives	S1	0.0000	0.2452	0.0408	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	S2	0.0408	0.0000	0.0081	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	S3	0.0081	0.0245	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
Economy	A1	0.0379	0.0338	0.0231	0.0000	0.6667	0.0000	0.7042	1.0000	0.5930	0.0000	0.8185	0.0000	0.0000	0.0000	0.0000	0.3084	0.3084	0.3084
	A2	0.0043	0.0048	0.0041	0.8000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8226	0.0000	0.0000	0.0000	0.0000	0.0000
	A3	0.0068	0.0106	0.0217	0.0000	0.0000	0.0000	0.0000	0.0000	0.1976	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Environment	B1	0.1537	0.1732	0.1875	0.1055	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4682	0.1013	0.0000	0.0900
	B2	0.0465	0.0346	0.0337	0.0665	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0337	0.0000	0.0450
	B3	0.0423	0.0346	0.0212	0.0279	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0900	0.0000	0.0000
Service	C1	0.1499	0.0955	0.0431	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1773	0.0000	0.0000	0.0000	0.0450	0.0000
	C2	0.0493	0.0835	0.0431	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	C3	0.0162	0.0364	0.1293	0.0000	0.3333	0.0000	0.0000	0.0000	0.2092	0.0000	0.1814	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Performance	D1	0.1764	0.1576	0.0325	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	D2	0.0317	0.0208	0.1629	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	D3	0.0200	0.0496	0.0325	0.0000	0.0000	0.0000	0.2957	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3569	0.3569	0.3569
Technology	E1	0.0431	0.0201	0.0161	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0742	0.0000	0.0000	0.0000	0.0997
	E2	0.0431	0.0602	0.0770	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1768	0.0000	0.0000	0.0000	0.0997
	E3	0.1293	0.1350	0.1223	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2806	0.1995	0.1995	0.0000

Step 4: Limit matrix calculation

By using Eq. (4), we obtain the limit matrix. However, we would like to show it as the criteria weights, as shown in Table 4.

Table 4 Criterial weights

Code	Limiting	Normalized	Global weight	Code	Limiting	Normalized	Global weight
S1	0.0552	0.1533	0.0391	C1	0.0325	0.4977	0.0230
S2	0.1621	0.4503	0.1148	C2	0.0087	0.1332	0.0062
S3	0.1427	0.3964	0.1010	C3	0.0241	0.3691	0.0171
A1	0.2511	0.6940	0.1778	D1	0.0445	0.6046	0.0315
A2	0.0377	0.1042	0.0267	D2	0.0055	0.0747	0.0039
A3	0.0730	0.2018	0.0517	D3	0.0236	0.3207	0.0167
B1	0.1295	0.6034	0.0917	E1	0.0520	0.1542	0.0368
B2	0.0527	0.2456	0.0373	E2	0.0932	0.2763	0.0660
B3	0.0324	0.1510	0.0229	E3	0.1921	0.5695	0.1360

Step 5: Alternative section

Figure 4 shows the radar chart of all nodes' normalized values in the network. These values are called the local weights. By considering the supplier cluster, the regional (S2) supplier is the highest local weight. The international (S3) and local (S1) suppliers are the second and the third orders, respectively. The global weights show that the most weight among all criteria is 'material prices' and the less weight is 'keep agreement rigorously.'
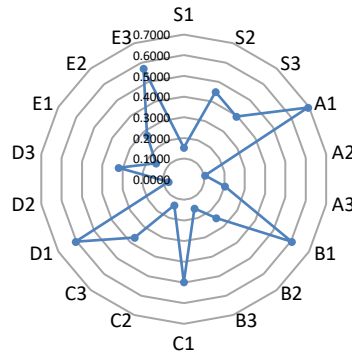
Figure 6 Radar chart for alternative selection

6. Conclusion

This article presented the framework of using the analytic network process technique to solve a green supplier selection of a sample construction company. The problem falls into decision science, which involves multiple attributes or multi-criteria decision-making. Five clusters with fifteen criteria proceeded through a four-step analytic network process technique. The interdependences among criteria were cautious regarding. This is the advantage of the analytic network process technique. The results obtained using the Super Decisions program (www.superdecisions.com) illustrated the traceable and quantified technique. The regional supplier has chosen a reasonable, quantified, and traceable scientific technique.

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Thai Emotional Semantic Markup Language

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ABSTRACT

Story generation refers to the principle of enabling computers to automatically create stories according to human requirements, following the approach of natural language processing. It is highly significant in various fields of computing related to linguistic processing. The most crucial necessity is to first construct sentences, and then arrange these sentences into a coherent story. Moreover, there is an increasing emphasis on generating sentences that can convey human emotional expressions. This research presents the design of a new data structure language that meets these requirements. The language, named TESML (Thai Emotional Semantic Markup Language), has been developed to store Thai words with emotional semantics within the structure. This new language can store words, phrases, and word groups related to expressing emotions according to the basic emotion wheel. The data structure language inherits concepts from WSML (Word Semantic Markup Language), which in turn is derived from AIML (Artificial Intelligence Markup Language). Additionally, this research also proposes algorithms for generating words, phrases, and word groups imported from files that classify words or phrases that express emotions, to be stored in the newly developed language structure.

KEYWORDS: TESML, Emotional NLP, Semantic Language, Semantic Data Structure, Thai NLP

1. Introduction

Story generation refers to the principle of enabling computers to autonomously create various stories by utilizing artificial intelligence algorithms based on natural language processing (NLP). This principle has been widely applied in fields of computer science related to linguistics, such as the creation of narratives, tales, novels,

literature, documentaries, and academic articles. In the context of Thai language story generation research, this includes the design and experimentation related to the development of a Thai text corpus for use in narrative creation [1], the creation of software machinery for generating Thai sentences using fixed patterns [2], and the introduction of new software machinery for generating Thai sentences using SQL commands [3], among others.

Additionally, research [4] has classified the emotions of Thai text by assigning weight values and using machine learning to create a model that classifies text from web boards and social networks. The machine learning data analysis employed methods such as Support Vector Machine, Naïve Bayes, Decision Tree, and K‑Nearest Weight, among others. The best result was achieved using a framework based on Support Vector Machine, yielding an accuracy of 77.86%. Research [5] classified Thai text emotions using Latent Semantic Analysis by creating two models for classification: a single‑word model and a bi‑words model. The experiments were conducted on emails, blogs, topics, and web boards, with the results evaluated using Naïve Bayes, Support Vector Machine, and Decision Tree methods. The bi‑words model demonstrated higher efficiency, particularly when evaluated with Naïve Bayes. Research [6] classified Thai emotion words using interjection words from the Thai Royal Institute Dictionary (1999) to apply the experimental results to text‑to‑speech. The experiments were conducted using words from the dictionary alone, as well as in combination with words expressing opinions collected from various sources. It was found that the combined approach yielded better results. International research has presented a theoretical concept for creating a Basic Emotion Model. The model explains the computational processes used to detect various emotions, consisting of two components: a keyword‑based component and a Learning System component. Experiments conducted on web blogs using the Support Vector Machine algorithm achieved an accuracy of 96.43%.

The research article presents the development of a new data structure language designed to store Thai semantic words used for sentence construction, serving as a crucial mechanism in story generation. This language focuses on storing words, phrases, and word groups that express emotions in the Thai language. It extends the capabilities of the WSML (Word Semantic Markup Language), which is derived from AIML (Artificial Intelligence Markup Language), and develops it into a structure called TESML (Thai Emotional Semantic Markup Language). This language primarily aims to store words, phrases, and word groups that express emotions in Thai. It is capable of processing words, phrases, word groups, and reading from files that categorize emotion‑expressive words, phrases, and word groups in Thai. The language can capture emotion expressions at three levels. Additionally, algorithms are proposed for handling words, phrases, word groups, and emotion‑expressive files according to the emotion wheel.

The presentation in this article is structured as follows: Section 2 presents the structure of WSML (Word Semantic Markup Language) and the concept of the human emotion wheel. Section 3 covers emotion analysis and language design. Section 4 introduces the TESML (Thai Emotional Semantic Markup Language) structure and provides examples of importing emotion‑expressive words, phrases, and word groups. Section 5 presents algorithms for storing words according to the language structure. Finally, Section 6 provides conclusions, discussions, recommendations, and suggestions for future research.

2. Theory and Related Research

2.1 WSML Structure

The WSML（Word Semantic Markup Language）[10] is a concept that considers the parts of speech, allowing individual words to be combined to form new words, phrases, or even sentences, depending on the context in which they are used. The main word serves as the central term, and then other words that can connect with the main word, maintaining meaning within the same context, are added. Words that are farther removed from the main word are considered actions of the main word（Action of Word）. This concept is illustrated in Figure 1.
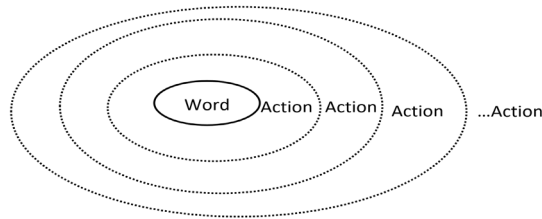
Figure 1: Hierarchy of Word and Action

From Figure 1, any word can be used to construct phrases or sentences by defining Word + Action + Action of Action + Action of Action of Action + Action of …+… . Additionally, the research team [10] has introduced some structural enhancements to further expand its capabilities. An example of the WSML（Word Semantic Markup Language）structure, which inherits features from AIML（Artificial Intelligence Markup Language), is as follows:

```
1 <WSML>
2 <HEAD>
3   <CLASS> Group Name </CLASS>
4   <SUBCLASS> Subgroup Name </SUBCLASS>
5   <CONTEXT> Context Name" </CONTEXT>
6 </HEAD>
7 <WORD>  Word   //Word 1
8   <WHEAD>
9     <TYPE> Type of Word (Part of Speech) </TYPE>
10    <PRE> Types of words that can precede this word </PRE>
11    <POST> Types of words that can be appended to this word </POST>
12    <JOINDOWN> Words that can be directly appended to this word </JOINDOWN>
13    <JOINUP> Words that can directly follow this word </JOINUP>
14  </WHEAD>
15  <ACTION>
16    <PATTERN> Action 1 </PATTERN>
17    <TEMPLATE>
18        Action 1 of Action 1
19      <TEMPLATE>
20        Action of Action 1 of Action 1
21          …
22      </TEMPLATE>
23        ….
24    </TEMPLATE>
25    …
26    <TEMPLATE> Action 2 of Action 1 </TEMPLATE> …
```

```
27    <TEMPLATE> Action 3 of Action 1 </TEMPLATE> …
28    <TEMPLATE> Action 4 of Action 1 </TEMPLATE>
29    ….
30    </ACTION>
31    <ACTION>
32    ….
33    </ACTION>
34    </WORD>
35    <WORD>                //Word 2 …
..    …
..    …
..    </WORD>
..    </WSML>
```

2.3 Emotion Wheel

In the study of emotion models, Robert Plutchik developed the Human Emotion Wheel in 1980 [8], categorizing basic emotions into 8 types: joy, trust, fear, surprise, sadness, disgust, anger, and anticipation. In article [9], a review of Robert's work [5-7] is presented, utilizing these emotional characteristics to develop a Thai sentiment resource based on ontology for effectively classifying emotions in Thai children's stories. The innermost circle of the emotion wheel used in the research for designing the language structure is illustrated in Figure 1.

Figure 1: Innermost Circle of the Emotion Wheel

English Translation:

The Emotion Wheel is a diagram that represents various types of human emotions. This tool helps individuals identify their emotions and guides them in managing their feelings during intense emotional moments. Developed by Robert Plutchik, his theory posits that there are eight primary emotions: joy, trust, fear, surprise, sadness, anticipation, anger, and disgust. The wheel displays these eight types of emotions and asserts that they are the foundation of all feelings. Secondary emotions, which are located around the edges of the wheel, are either less intense experiences of these eight primary emotions or combinations of two primary emotions. The center of the wheel represents the most intense experiences of the primary emotions.

Components of the Emotion Wheel:

1. Colors: Each emotion category is represented by a different color. The more intense the emotion, the more intense the shade.

2. Layers: The outer layers show less intense emotions. Moving inward, you encounter the primary emotions, and at the core of the wheel are the more intense versions of these primary emotions.

3. Relations: Emotions relate to each other in two ways. Categories combine to create secondary emotions in the spaces between them, while emotions that are opposite each other on the wheel represent contrasting feelings.

Purpose of the Emotion Wheel:

The Emotion Wheel provides clarity and guidance during challenging emotional experiences. It offers a visual representation of possible emotions, their combinations, and their contrasts. By using the wheel, one can label primary emotions, identify potential secondary emotions, and learn how to balance negative emotions with their positive counterparts.

Using the Emotion Wheel for Self-Awareness:

The Emotion Wheel is a valuable tool for enhancing self-awareness. When overwhelmed by intense emotions, it provides a visual aid to understand what is happening. Increased awareness of your emotions helps avoid destructive reactions and enables more empowering responses.

How to Use the Wheel to Improve Self-Awareness:

Plutchik's theory suggests that all emotions follow a pathway from stimulus to behavior:

Stimulus $\longrightarrow$ Perception $\longrightarrow$ Feelings $\longrightarrow$ Physiological Change $\longrightarrow$ Impulse $\longrightarrow$ Reaction $\longrightarrow$ Behavior.

Understanding this process helps improve awareness of emotions and regulate responses. Begin by recognizing the stimuli that trigger negative emotions, and then adjust your reality to address these triggers. In the context of this research, the team has designed and applied Thai language terms to classify emotions according to an initial set of six basic emotions on the Emotion Wheel, as shown in Table 1.

3. Analysis of Thai Emotional Expression for Designing a Data Structure Language

3.1 Basic Emotions and Levels of Emotion

Emotion analysis according to the research presents six basic emotions: anger, sadness, fear, joy, excitement, and calmness, categorized by levels of emotion. Examples are illustrated in Table 1.

Table 1: Classification of Emotion Levels and Initial Examples

Emotions	Level of Emotions		
	Low (1)	Medium (2)	High (3)
โกรธ (anger)	ขุ่นเคือง เคือง	โกรธ โมโห	กริ้ว เกรี้ยวกราด
เศร้า (sadness)	เศร้า เสียใจ	โศกเศร้า อาดูร	อนาถ ปิ่มว่าจะขาดใจ

Emotions	Level of Emotions		
	Low (1)	**Medium (2)**	**High (3)**
กลัว (fear)	กลัว หวั่น	ตระหนก อกหักขวัญเสีย	ภัยสังหรณ์ ขวัญหนี
ดีใจ (joy)	ดีใจ ชื่นใจ	สุขใจ ยินดี	ยินดียิ่ง อิ่มเอมเปรมปรีดิ์
มีพลัง (excitement)	มุ่งมั่น เด็ดเดี่ยว	มั่นใจ ภาคภูมิใจ	กระตือรือร้น ตื่นตัว
สงบสุข (calmness)	สงบ สุขสงบ	ใจเย็นเป็นน้ำ นิ่งเป็นหลับ ขยับเป็น	สันติ ปราศจากความขัดแย้ง

3.2 Design Concept

1) Identify emotions, specify levels, and list words that express those emotions, such as:

Sadness

Low (1) -> เศร้า, เสียใจ, หดหู่, ซึม, เหงา, ว้าเหว่

Medium (2) -> โศกเศร้า, อาดูร, วิโยค, โศกาอาดูร, สลดใจ, หม่นหมอง

High (3) -> อนาถ, ปิ่มว่าจะขาดใจ, รันทด, ตรอมใจ, ร้าวราน

Based on the emotion intensity levels provided, the following is the classification of single words according to their emotion levels:

Sadness

(1) -> เศร้า

(2) -> โศกเศร้า

(3) -> อนาถ

2) Consider the relationship between:

Emotion Type->Emotion Intensity Level->Emotion Words

Examples of the words with assigned intensity can be written according to their relationships as follows:

Sadness-> 1->เศร้า

Sadness -> 2->โศกเศร้า

Sadness -> 3->อนาถ

When considering the presentation of various words in their entirety, the relationships are as follows:

Sadness-> 1->เศร้า, เสียใจ, หดหู่, ซึม, เหงา, ว้าเหว่

Sadness -> 2->โศกเศร้า, อาดูร, วิโยค, โศกาอาดูร, สลดใจ, หม่นหมอง

Sadness -> 3->อนาถ, ปิ่มว่าจะขาดใจ, รันทด, ตรอมใจ, ร้าวราน

3.3 Definitions

Definition 1: Let $E_1, E_2, E_3, \ldots, E_k$ represent each emotion in the innermost circle of the Emotion Wheel, where E_b denotes each individual emotion in the Emotion Wheel.

Definition 2: Let $W_1, W_2, W_2, \ldots, W_p$ represent single words/phrases related to emotions, where W_j is a single word/phrase that is a member of any set E_b.

Definition 3: Let $L_0, L_1, L_2, \ldots, L_q$ represent the levels of emotion, where L_i denotes each level of emotion for each W_j.

The structure for each word is as follows:

$$E_b \rightarrow L_i \rightarrow W_j$$

The design approach for the structure of single words and phrases, based on Definitions 1-3, is as follows:"

```
<Emotion>
    E_b
  < Level>
    L_i
  < Level >
    <Word> W_1 <Word>
    <Word> W_2 <Word>
        …
    <Word> W_k <Word>
</Emotion>
```

Example 1 illustrates the part of the emotion 'sadness' at level 1 according to the structure defined in Definitions 1-3.

```
<Emotion>
    เศร้า
  < Level>
    1
  < Level >
    <Word> เสียใจ <Word>
    <Word> หดหู่ <Word>
    <Word> ซึม <Word>
    <Word> เหงา <Word>
    <Word> ว้าเหว่ <Word>
</Emotion>
```

4. Structure of TESML

The WSML language structure, which inherits the properties of TESML, uses the WSML language concept for its header structure. This allows for the storage of contextually meaningful Thai words. Additionally, it utilizes the emotional design component to store words and phrases related to emotions, as defined in Section 3.3. The language structure is illustrated as follows:

```
1 <TESML>
2 <HEAD>
3   <CLASS> Group Name </CLASS>
4   <SUBCLASS> Subgroup Name </SUBCLASS>
5   <CONTEXT> Context Name" </CONTEXT>
6 </HEAD>
7 <Emotion> // Emotion 1
            Eᵦ
      < Level>
            Lᵢ
      < Level >
          <Word> W₁ <Word>
          <Word> W₂ <Word>
                    …
          <Word> Wₖ <Word>
      </Emotion>
…  <Emotion>                    //Emotion 2
…   …
…   …                                    // Emotion 3
38 </Emotion>
39 </TESML>
```

Example 2 illustrates the emotion 'sadness' using TESML.

```
1 <TESML>                    //เทียบกับ <AIML/WSML>
2 <HEAD>
3   <CLASS> มนุษย์ </CLASS>
4   <SUBCLASS> อารมณ์ </SUBCLASS>
5   <CONTEXT> บรรยาย</CONTEXT>
6 </HEAD>
7 <Emotion>
8       เศร้า
9       < Level>
10        1
11      < Level >
12        <Word> เสียใจ <Word>
13        <Word> หดหู่ <Word>
14        <Word> ซึม <Word>
15        <Word> เหงา <Word>
16        <Word> ว้าเหว่ <Word>
17    </Emotion>
18 <Emotion>              // อารมณ์ระดับ ที่สอง
..  …
..  …                            // อารมณ์ระดับ ที่สาม
.. </Emotion>
.. </TESML>
```

5. Algorithm for Creating the Data Structure of TESML

To understand the algorithm presentation, it is necessary to define additional terms as follows.

Definition 4: Let WS_1, WS_2, WS_2, ..., WS_m represent single files of TESML that are in the same context. Each WS_c contains words $(w_1, w_2, w_3, ..., w_n)$, where w_i is any semantically meaningful word as defined in Definition 1.

Definition 5: Let RS represent a structure file that contains a collection of structural files, WS_c, used to create phrases/word groups according to the formats available in TESML.

Definition 6: Let rs_1, rs_2, rs_3, ..., rs_m, where rs_j represent files containing any W_j from the words, phrases, or word groups of any E_b.

Initially, a single file WS_c can be used, or files from WS_1 to WS_m can be utilized depending on the format of WS_c. The result in rs_j will be a result file containing a data structure with words representing various emotions, one at a time, as shown in Algorithm 1. If there is data imported from files that classify words, phrases, or word groups expressing emotions, it can be used to create a large file according to the language structure, as outlined in Algorithm 2.

5.1 Algorithm for Creating a Structure from Word Type Files

Algorithm 1: SingleWSGenerator

Input: WS_c=(W_1, W_2, W_2, ..., W_m), *empty rs_j*, Group name, Subgroup name, Context name

Processing:

1. Create Head with Group name, Subgroup name and Context name to head of rs_j
2. For *i=1 To m* Do
3. rs_j $\leftarrow$ W_j -> L_i -> E_b
4. End of For

Output: rs_j

5.2 Algorithm for Creating a Structure from Multiple Files

This algorithm reads the values WS_1- WS_m and the sentence pattern of WS_c by invoking the single‐file creation algorithm. In Algorithm 1, the algorithm is presented as follows.

Algorithm 2: MultipleWSGenerator

Input: (WS_1, WS_2, $WS_{3,...,}$ WS_m), *Empty RS*

1) For j=1 To m Do
2) $rs_j$$\leftarrow$ call SingleWSGeneration(W_j)
3) RS $\leftarrow$rs_j
4) End of For

Output: *RS*

6. Conclusion and Future Work

The primary necessity of story generation principles is to develop a data structure for storing words, phrases, and groups of text in a meaningful format. This is essential before employing it as a crucial mechanism for story generation, which enables computers to automatically create stories according to human requirements using natural language processing methods. This research presents a new data structure language for storing Thai words with emotional semantics used for sentence generation, focusing on expressing Thai emotions. This new data structure language, called TESML (Thai Emotional Semantic Markup Language), can be further developed or used similarly to XML, which is commonly used today. Additionally, this research proposes algorithms for creating words, phrases, and word groups to be stored in this structure.

Recommendations for this research suggest that the data can be presented using existing popular data structures, such as XML or JSON formats. For future research, the team is currently working on programming and developing the structure from this research to advance the mechanism for generating stories according to the principles of story generation.

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The Potential of Thailand in Advancing Classic Car
EV Conversions: Strategic Transition

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ABSTRACT

The adoption of electric vehicles (EVs) in Thailand has been growing steadily, with 1.53 million EVs accounting for 8.12% of all vehicles in 2023. This growing industry has a significant impact on Thailand's GDP, highlighting the need for a strategic transition to support the development of the EV conversion industry. A particular focus is on the conversion of internal combustion engine vehicles that are over 10 years old. These debt-free vehicles, with simpler technology, present an ideal opportunity for modification as part of a broader strategy to prepare the domestic automotive sector for EV production and usage. Thailand's efforts are backed by a strong legal framework promoting the EV sector and EV conversion. The country is already a major automotive manufacturing hub, ranked 11th globally, with a robust automotive parts industry. Additionally, Thailand has a significant stock of older and classic vehicles, with 18.26% of its cars in 2023 being over 20 years old. The absence of laws restricting vehicle lifespan further facilitates the EV conversion process. Thailand's legal measures also promote economic growth by supporting industries related to classic cars, with tax incentives designed to stimulate these sectors. The EV conversion business in Thailand attracted over US$ 300 million in investment in 2023, with a survival rate of 97.33%, reflecting continuous year-on-year growth. These developments indicate that Thailand is well-positioned to become a leading hub for classic cars and EV conversion in Southeast Asia.

KEYWORDS: EV conversion, Classic car, Transition strategy

1. Introduction

It is estimated that by 2036, Thailand will consume 220 million tons of oil equivalent energy, up from 120 million tons in 2013. This indicates that Thailand will continue to face an increasing dependency on imported energy (Suthee & Weerin, 2019). A review of Thailand's energy use in January 2023 revealed that primary energy

production stood at 704 thousand barrels per day, while consumption reached 1,995 thousand barrels per day. Daily imports totalled 1,585 thousand barrels (Energy Policy and Planning office, 2023). Additionally, it was found that CO_2 emissions from transportation energy use in January 2023 amounted to 7.3 million tons, making transportation the largest contributor to CO_2 emissions, followed by other energy-consuming sectors (Energy Policy and Planning office, 2023). Furthermore, electric vehicles (EVs) are projected to emit between 7.826×10^5 to 1.069×10^6 tons of CO_2 equivalent (tCO_2e) by 2050, similar to other energy consumption sectors. However, EV can also reduce greenhouse gas emissions by 1.076×10^6 to 1.804×10^6 tCO_2e (Shen et al., 2023). Thus, reducing transportation energy use plays a crucial role in lowering overall CO_2 emissions (Rashid et al., 2024).

Thailand is committed to the Sustainable Development Goals (SDGs). In January 2022, the United Nations in Thailand signed the United Nations Sustainable Development Cooperation Framework for 2022-2026 (UNSDCF) with the Thai government, aiming to achieve the SDGs by 2030. This framework allows Thailand to pursue a high-value, low-carbon society that is environmentally sustainable (United Nations Thailand, 2022). Consequently, a revolutionary policy shift is necessary, along with significant structural changes. These efforts align with key Thai government policies, such as the National Strategy 2018-2037 (Office of International Affairs, 2018) and the Thirteenth National Economic and Social Development Plan (2024–2027) (Office of the Prime Minister, 2023). Thailand has introduced several policies, including the EV policy, which currently promotes the use of EVs. However, challenges remain, such as high purchase costs, limited driving range, long charging times, and battery degradation, making EVs less convenient to use (Yang et al., 2024).

The global EV market is expected to grow to 3.2 million units in 2023 and 10 million units by 2024. Bloomberg predicts that global sales of plug-in hybrid EVs (PHEVs) will reach 14 million units by 2023, with 75% of these vehicles being powered by electricity, most of which are personal vehicles. China is emerging as a global leader in EV sales, having sold over 8 million personal EVs (Office of the Energy Regulatory, 2023). Additionally, EV penetration in China is projected to reach 27.31% by 2025, 42.40% by 2030, and 52.97% by 2035 (Liu et al., 2023). In the United States, EV sales totalled 1.6 million units in 2023 (Office of the Energy Regulatory, 2023). While the U.S. has introduced measures, such as transferable tax credits For EV purchases to boost consumer confidence (Stekelberg & Vance, 2024), the European Union has experienced moderate sales growth, as major automakers are awaiting the implementation of emissions regulations in 2025. meanwhile, Chinese automakers have continued to expand aggressively. It is evident that EVs play a pivotal role in the rapidly evolving energy landscape (Office of the Energy Regulatory, 2023; Liu, et al., 2023). Despite global and domestic economic fluctuations, the classic car market is also expanding. The global classic car market is projected to grow at an annual rate of 9.6% through 2026, with revenue reaching $31.6 billion in 2022 (United Nations Thailand, 2022). Classic cars represent a significant part of the automotive industry, reflecting past historical and technological achievements (Murta et al., 2024). Many classic car owners prefer to preserve their vehicles in their original form for sentimental reasons, though pollution from older engines is an undeniable source of global emissions. The EV conversion industry, which retrofits classic cars with electric powertrains, offers a way to reduce this pollution while reviving these vehicles. This aligns with the Thai government's policy of transforming

the internal combustion engine industry into a fully EV‑based industry. However, a sudden transition could disrupt Thailand's traditional automotive industry, impacting the supply chain, including parts manufacturers and repair shops that may struggle to adapt in the short term. Therefore, the **EV conversion industry** provides a viable solution, which should be supported by the Thai government for next 5‑10 years (The Committee on Energy, 2021; National Electronics and Computer Technology Center, 2023).

Abbreviations

ABI1	Announcement of the Board of Investment No. 5/2017 dated May 3, 2017 regarding investment promotion policy for the production of electric vehicles, parts and equipment.
ADLT1	Announcement of the Department of Land Transport on specifying the power of electric motors used to drive vehicles. According to the law on automobiles, B.E. 2020.
AED1	Announcement of the Excise Department regarding criteria and conditions for passenger cars or passenger cars with seats not exceeding 10 people, energy-saving type, electric power (Electric Powered Vehicle), announced on June 8, 2022.
AED2	Announcement of the Excise Department on the determination of criteria, methods and conditions for notifying recommended retail prices for automobiles and motorcycles that are entitled to the measures to support the use of Electric vehicles in the category of cars and motorcycles, announced on March 23, 2022.
AED3	Announcement of the Excise Department on determining the criteria, methods, and conditions for receiving rights under measures to support the use of automobiles. Electric cars and motorcycles, Phase 2, announced on December 28, 2023.
AED4	Announcement of the Excise Department on determining the criteria, methods, and conditions for receiving rights under measures to support the use of automobiles. Electric cars and motorcycles announced on March 21, 2022.
AED5	Announcement of the Excise Department on criteria, methods and conditions for passenger cars or passenger cars with seats not exceeding 10 people, energy-saving type. A hybrid model that uses fuel and electricity (Hybrid Electric Vehicle) and an electric power vehicle (Electric Powered Vehicle) that receive investment promotion. according to the investment promotion law) announced on June 8, 2022.
AMF1	Announcement of the Ministry of Finance on reducing excise tax rates (No. 138) dated June 14, 2017.
AMF2	Announcement of the Ministry of Finance on the reduction of duty rates and exemption of customs duties for imported complete battery electric cars, announced on April, 22 2022.
AMF3	Announcement of the Ministry of Finance on exemption of customs duties for electric vehicle parts or a boat with electric power from batteries, announced on May 16, 2023.
AMI1	Announcement of the Ministry of Industry Subject: Setting standards for electric-powered automotive industry products - Testing requirements for lithium‑ion battery systems combined with lead‑acid batteries or capacitors. Announced on March 15, 2022.
AMI2	Announcement of the Ministry of Industry Subject: Setting product standards for the road vehicle industry that are powered by electricity - Testing requirements for lithium‑ion battery drive sets and systems, Volume 4, performance testing, announced on March 15, 2022.
AMI3	Announcement of the Ministry of Industry Subject: Setting standards for electrically powered road vehicle industry products - Testing requirements for electrically powered components, Volume 7, Load testing of DC/DC converters, announced on March 15, 2022.
ATISI1	Announcement of the Thai Industrial Standards Institute regarding setting industrial standards Electric vehicle modification services announced on November 22, 2022.
EBA2007	Energy Business Act B.E. 2007.
MR1	Ministerial regulations specifying components and equipment for vehicles, B.E. 2008.

2. Literature Review

Thailand's automotive industry, aligns with the strategy of transitioning from the internal combustion engine vehicles to **EVs conversion**, operates as follows: (House of Representatives of Thailand, 2023).

2.1 Thailand's EV industry group

Currently, EV conversion is expensive and lacks sufficient government support, particularly in areas such as taxes and subsidies. Additionally, there are no clear standards for EV modifications, leading to public scepticism. Therefore, the government needs to provide support to stakeholders in the EV conversion industry (House of Representatives of Thailand, 2023). The automotive industry in Thailand is divided into two groups of entrepreneurs or stakeholders, as shown in Figure 1 (National Science and Technology Development Agency, 2017).
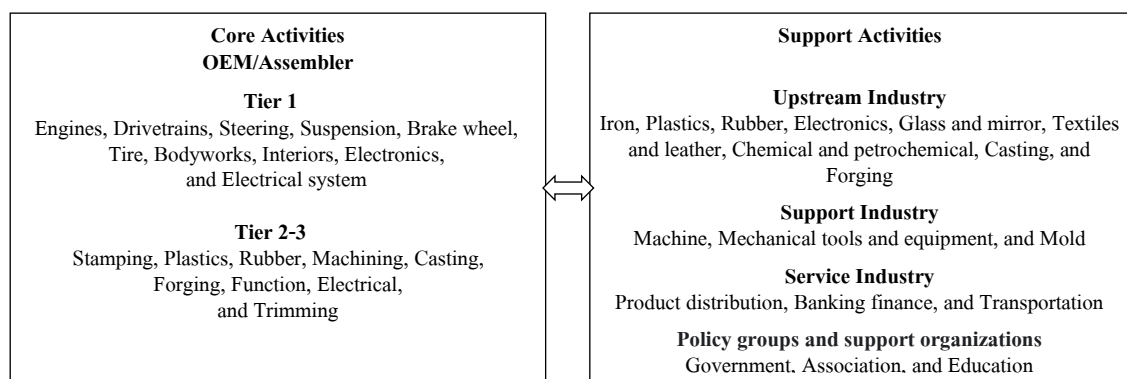
Core Activities **OEM/Assembler** **Tier 1** Engines, Drivetrains, Steering, Suspension, Brake wheel, Tire, Bodyworks, Interiors, Electronics, and Electrical system **Tier 2-3** Stamping, Plastics, Rubber, Machining, Casting, Forging, Function, Electrical, and Trimming	**Support Activities** **Upstream Industry** Iron, Plastics, Rubber, Electronics, Glass and mirror, Textiles and leather, Chemical and petrochemical, Casting, and Forging **Support Industry** Machine, Mechanical tools and equipment, and Mold **Service Industry** Product distribution, Banking finance, and Transportation **Policy groups and support organizations** Government, Association, and Education

Figure 1 Structure of Thailand's automotive industry

Figure 1 illustrates how Thailand's automotive industry is interconnected with various other industries. to the automotive sector significantly contributes to the GDP and serves as a vital source of employment in the country, with each industrial chain employing between 800,000 and 900,000 people (National Science and Technology Development Agency, 2017; Bank of Thailand, 2020). It also highlights the importance of the Thai automotive industry within the country's economic framework, providing income, job opportunities, and connections to other sectors. However, in recent years, the automotive industry has faced numerous challenges, including global and national economic volatility and the emergence of new competitors.

2.2 Transitioning to EV to create a domestic industry

Thailand has the potential to establish a new industry, specifically in EV conversion, due to its diverse needs and favorable conditions. Upgrading the combustion engine market to an EV conversion industry is viewed as a transition strategy（Figure 2）that will prepare the domestic sector to fully produce and utilize EVs. It is critical to build confidence among entrepreneurs and consumers by creating domestic demand for EVs, which will, in turn, lead to increased supply and investment in the production of key EV components. Furthermore, this industry can evolve to produce various types of EVs, such as electric trucks and electric buses, or to design and manufacture entirely new models（Figure 2）. The Thirteenth National Economic and Social Development Plan（2024–2027）aims to convert at least 40,000 internal combustion engines to EVs by 2027（Office of the Prime

Minister, 2023). Consequently, upgrading and developing the EV conversion industry has become an important and urgent step toward achieving the government's goals.

Building consumer confidence in switching to EV conversions remains a significant challenge in meeting the government's targets. The high cost of converting internal combustion vehicles to EVs contributes to user's uncertainty about the benefits of making the switch. Support for the EV conversion industry should focus on accelerating the transition to a sustainable industry that will last no more than 5 to 10 years (House of Representatives of Thailand, 2023; Office of Transport and Traffic Policy planning, 2020).

Therefore, the EV conversion industry should receive government support for at least a period of 5 to 10 years, with a focus on converting internal combustion vehicles that are more than 10 years old. These vehicles are typically debt‑free and utilize simpler technology, making them ideal candidates for conversion. Supporting this industry will also facilitate the development of other downstream sectors throughout the supply chain, including the EV motor manufacturing industry, battery production, control systems, and the EV aftermarket.

Supporting the development of the EV conversion industry is a crucial strategic step in the technological transition aimed at promoting the widespread use of EVs in Thailand, aligning with the country's objectives. The EV conversion industry will serve as an essential mechanism for increasing domestic demand for EVs and instilling confidence in consumers looking to transition to EVs in the long run. Stimulating the establishment of the EV conversion industry will not only foster the growth of related sectors but also create a knowledge base and enhance the capability to rapidly develop technology and innovation in Thailand. This initiative presents opportunities for developing targeted technologies and products for both domestic and export markets, particularly within the EV conversion sector (House of Representatives of Thailand, 2023).

The impact of the EV conversion industry on the transition strategy poses challenges and concerns for automotive parts manufacturing businesses worldwide, including those in Thailand. This is particularly true for Thai automotive parts manufacturers in Tier 2 and Tier 3, which account for 77% of all SME entrepreneurs. The technological shift from internal combustion engine vehicle production to EV production will lead to changes in the demand for automotive parts, notably in terms of the reduced number of parts required per vehicle and the need to adapt production technology for EV components. The production of a single EV requires only 2,000 to 3,000 parts, which is nearly ten times fewer than the number needed for internal combustion engine vehicles, where each vehicle can contain between 20,000 to 30,000 parts. If EVs are produced in sufficient quantity to replace internal combustion engines in the future, certain segments of automotive parts manufacturers will be significantly affected, particularly those involved in the powertrain, cooling system, engine system, emission control system, fuel system, and brake system (Krungthai Compass, 2023).
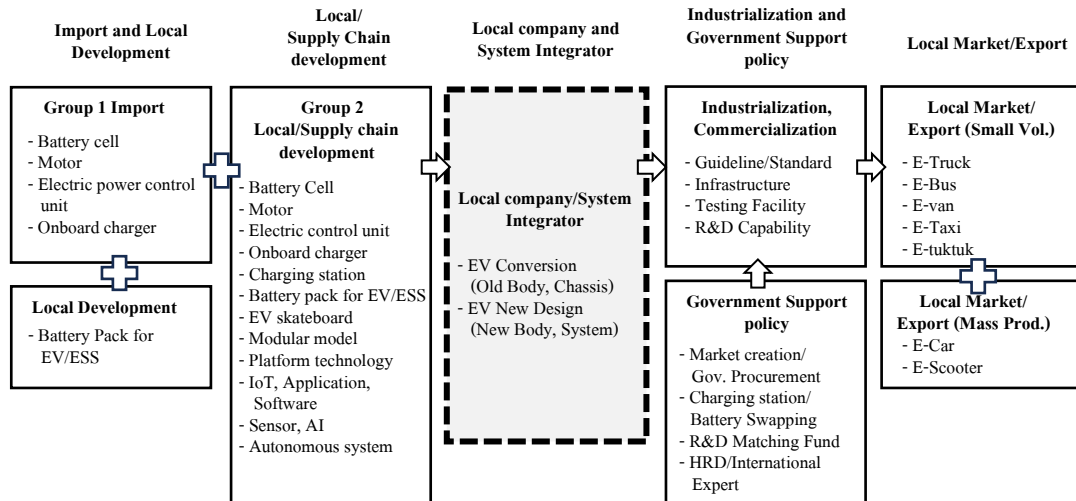
Figure 2 Strategy for transitioning to EV to create a domestic industry.

2.3 Laws related to EV

Laws related to EVs in Thailand's legal system can be categorized into various support measures, detailed as follows:

The Latin phrase "ubi societas, ibi jus," meaning "Where there is society, there will be law," highlights the necessity of laws for any community to establish guidelines for conduct. This concept is where the idea of the hierarchy of law originated (Oxford Constitutional Law, 2016; Jumpa, 2022). Generally speaking, nations have a legal hierarchy that ranges from the most to the least prevalent laws. (Clegg et al., 2016). The following are the laws, regulations, and measures related to EVs in Thailand:
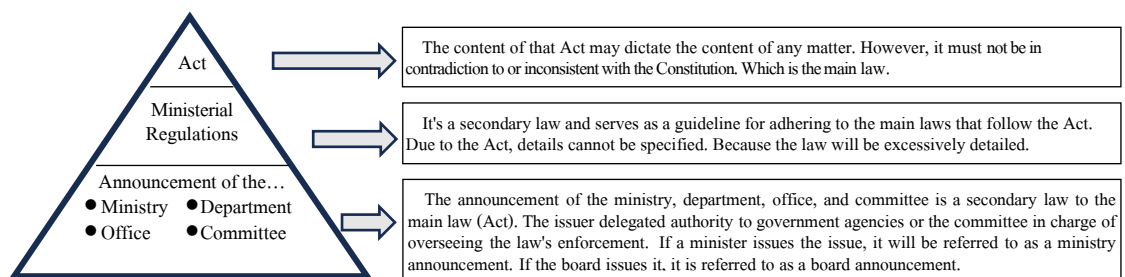
Figure 3 Hierarchy of laws, related to EV in Thailand.

2.4 Review laws related to EV in Thailand

2.4.1 The main laws for EVconversion

This includes the Ministerial Regulations specifying components and equipment for vehicles, B.E. 2008 **(MR1)** (Legislative institutional Repository of Thailand, 2008). According to these regulations, personal cars must have and utilize all necessary vehicle fixtures and equipment, such as the structure and body, power generator, transmission system, steering system, brake sripatum, accelerator, weight support system, fuel systems, or other energy systems, electrical systems, and exhaust systems. Additionally, there is an announcement from

the Department of Land Transport specifying the power of electric motors used to drive vehicles, In accordance with the Law on Automobiles, B.E. 2020 **(ADLT1)** (Legislative institutional Repository of Thailand, 2021). This law allows certain types of cars with an appropriate rated power for electric motor to be registered and sets the terms for vehicles powered by electric motors to comply with international standards. The important details are as follows:

- The "electric motor power" must be capable of maintaining a continuous operation for at least 30 minutes at maximum speed.

- For personal cars with no more than seven passengers powered by an electric motor, The motor must have a power output of at least 15 kW and be able to drive the vehicle at maximum speed of no less than 90 km/h.

- For personal cars with no more than seven passengers, if the electric motor has a power output of at least 4 kW, it must be able to drive the vehicle at a maximum speed of no less than 45 km/h.

- The electric motor must be able to drive the vehicle at the maximum specified speed, even when the total weight of the vehicle (including the load) is at the manufacturer's specified limit, and it must maintain this speed for at least 30 continuous minutes.

- For personal cars with no more than seven passengers that were registered before March 18, 2017, and were previously declared inactive or had their registration suspended, the vehicle can be re-registered if it is equipped with an electric motor of at least 15 kW that can drive the vehicle at a maximum speed of no less than 45 km/h.

2.4.2 Measures for promoting investment to create supply

This section includes the announcement of the Board of Investment No. 5/2017, dated May 3, 2017, regarding the investment promotion policy for the production of EVs, parts, and equipment **(ABI1).** The announcement supports policies that promote investment in the production of EVs, components, and equipment, encouraging the production of Hybrid EVs (HEVs), Plug-in Hybrid EVs (PHEVs), battery-powered EVs, battery-powered electric buses, and EV charging stations (Thailand board of investment, 2017). Following this, the Ministry of Finance issued an announcement on June 14, 2017, **(AMF1)** reducing excise tax rates (No. 138) for HEVs and PHEVs by half from the normal rate, and for the battery EVs, reducing the excise tax rate 2 %. All such vehicles must use batteries produced or assembled by manufacturers who have received investment promotion from the Office of the Board of Investment. These include lithium-ion or nickel-metal hydride batteries, or other types of batteries that provide a higher specific energy per weight (Wh/g) than lithium-ion or nickel-metal hydride batteries. (Ministry of Finance, 2017) Later, the Excise Department issued an announcement on March 21, 2022 (AED4), outlining the criteria, methods, and conditions for receiving benefits under measures supporting the use of EVs, such as cars and motorcycles, for industrial businesses located in duty-free zones according to Thai law, such as those in the Industrial Estate Authority of Thailand (Excise Department, 2022). Furthermore, the Ministry of Finance issued another announcement on April 22, 2022 (AMF2) regarding the reduction and exemption of customs duties for fully imported battery electric cars. The essence of this

announcement is the reduction or exemption of duties for fully assembled EV batteries, effective from the date of the announcement until December 31, 2023, are as follows:

- Ready‐made battery EVs with a recommended retail price not exceeding US$ 58,500 are eligible for a reduction in duty rates or an exemption from duty.

- Ready‐made battery EVs with a capacity of 3 0 kilowatt hours or more and a recommended retail price of more than US$ 58,500, but not exceeding US$ 204,800, are eligible for a reduction in duty rates or an exemption from duty (Ministry of Finance, 2022).

The Excise Department issued an announcement regarding the criteria, methods, and conditions for passenger cars or vehicles with no more than 10 seats, including energy‐saving types such as hybrid models that use both fuel and electricity (HEVs), as well as fully electric vehicles that receive investment promotion. This was announced on June 8, 2022 **(AED5)**. The key point is that electric vehicles or passenger cars with no more than 10 seats will be taxed at a special rate according to the ministerial regulations outlining the excise tax tariff (Excise Department, 2022). Additionally, the Ministry of Finance issued an announcement on May 16, 2023 **(AMF3)**, regarding the exemption of custom duties for EV parts, including electric‐powered boats using battery technology. This announcement exempts duties on various components, regardless of type, such as batteries, EV motors, and EV compressors (Excise Department, 2022).

2.4.3 Measures to stimulate the domestic market

This section includes the measures include an announcement by the Excise Department regarding the criteria, methods, and conditions for notifying the recommended retail prices for automobiles and motorcycles entitled to the measures supporting the use of EVs, particularly in the categories of cars and motorcycles. This was announced on March 23, 2022 **(AED2)**. Essentially, it is intended for those eligible under the measures supporting EV use in the car category. They must inform the Excise Department of the recommended retail price and price structure, as well as notify any changes to the recommended retail price using the specified notification form, in accordance with the Excise Department Act (Excise Department, 2022). Later, the Excise Department issued another announcement on December 28, 2023 **(AED3)**, outlining the criteria, methods, and conditions for receiving rights under measures supporting the use of electric cars and motorcycles, Phase 2. The main points are as follows:

1. Passenger cars with a retail price not exceeding US$ 58,500, sold by December 31, 2024, and registered under automobile law by January 31, 2025, will be eligible for subsidies as follows:

a) Battery capacity of 10 kWh or more but less than 50 kWh: Eligible for a subsidy of US$ 1,400 per vehicle.

b) Battery capacity of 50 kWh or more: Eligible for a subsidy of US$ 2,900 per vehicle.

2. In the case of imports or domestic production, if they are sold by December 31, 2025, and registered under automobile law by January 31, 2026, they will be eligible for subsidies as follows:

a) Battery capacity of 10 kWh or more but less than 50 kWh: Eligible for a subsidy of US$ 1,000 per vehicle.

b) Battery capacity of 5 0 kWh or more: Eligible for a subsidy of US$ 2,100 per vehicle. (Excise Department, 2023)

2.4.4 Infrastructure preparation measures

This section includes the Energy Business Act B.E. 2007 **(EBA2007),** which outlines regulations for the operation of EV charging stations. According to this act, operating an EV charging stations is considered an energy business that requires a license from the Energy Regulatory Commission. The need for a license depends on the nature and size of the installation:

- EV charging stations with a total transformer or current converter capacity (Grid-Connected Inverter) of 1,000 kVA or more must apply for a license to operate an electricity distribution business. Entrepreneurs are required to submit supporting documents in accordance with the regulations set forth by the Energy Regulatory Commission.

- If the total capacity is less than 1,000 kVA, the station is exempt from the requirement to apply for a license to operate an electricity distribution business under Thai law (Energy Policy and Planning Office, 2007).

Furthermore, the announcement of the Excise Department on criteria and conditions for passenger cars or passenger cars with seats not exceeding 10 people, focusing on energy-saving type and electric power vehicles, was issued on June 8, 2022 **(AED1)**. This announcement applies to the import of EVs with a recommended retail price not exceeding US$ 58,500 and with a battery capacity of 10 kWh or more. The key condition is that, for every imported EV, manufacturers must produce an equivalent passenger car or bus with seats not exceeding 10 people within Thailand, at a 1:1 ratio by December 31, 2024 (Excise Department, 2022).

2.4.5 Establishing standards for EV

The announcement of the Ministry of Industry on Setting Standards for Electric-Powered Automotive Industry Products was issued on March 15, 2022 **(AMI1)**. This announcement outlines the testing methods and requirements for lithium-ion battery systems combined with lead-acid batteries or capacitors for use in automobiles with specific voltage systems (Legislative institutional Repository of Thailand, 2022). Another Ministry of Industry announcement **(AMI2)**, issued the same day, set product standards for the road vehicle industry powered by electricity, focusing on testing requirements for lithium-ion battery drive sets and systems. for the fourth volume of this announcement covers performance testing, specifying the methods for evaluating basic performance characteristics, reliability, and electrical functions of battery packs and systems used in high-power or high-energy EV applications, particularly BEVs (Legislative institutional Repository of Thailand, 2022). Subsequently, there was another Ministry of Industry announcement on the testing requirements for electrically powered components, Volume 7, specially load testing of DC/DC converters, issued on March 15, 2022 **(AMI3)**. This focuses on the testing methods and criteria for DC/DC converters designed for electrical drive systems that use Class B voltage for electric road vehicles (Legislative institutional Repository of Thailand, 2024). In addition, the Thai Industrial Standards Institute (TISI) issued an announcement on EV modification services, dated November 22, 2022 **(ATISI1)**. The essence of this standard is to regulate automobile modification services

to ensure that electric motors are used solely as energy generators for propulsion. It includes guidelines for modifying EVs by altering, adding, or replacing components or equipment to enable the electric motor to function as the vehicle's driving energy source (Thai Industrial Standards Institute, 2022).

Table 1 Summary of a review of laws, for EV in Thailand.

Laws related to EV in Thailand	2007	2008	2017	2020	2022	2023
Establishing standards for EV					AMI1 AMI2 AMI3 ATISI1	
Measures for promoting investment to create supply			ABI1 AMF1		AED4 AMF2 AED5	AMF3
The main laws for modifying EV		MR1		ADLT1		
Measures to stimulate the domestic market					AED2	AED3
Infrastructure preparation measures	EBA 2007				AED1	

Table 1 shows that since 2022, Thailand has implemented policies to support the development of EVs. These policies and measures include: 1）Main laws for EV modifying, 2）Investment promotion measures to boost supply, 3）Measures to stimulate the domestic market, 4）Infrastructure preparation measures, and 5）Establishing standards for EVs. From 2022 to the present, Thailand has been highly successful in rapidly expanding its EV sector, outpacing other developing countries such as India, Turkey, Brazil, and Malaysia. (International Energy Agency, 2024)

2.5 Laws related to EV abroad

Standard Australian Design Rules（ADRs）under the Commonwealth of Australia's Motor Vehicle Standards Act 1989（effective August 2,1989）set the safety standards for all types of vehicles on the road, including modified and newly built cars. ADRs must meet key specifications for components such as seats and seat anchorages, anchorages for seatbelts, steering columns, instrument panels, external noise of motor vehicles, brake systems for passenger cars, and commercial vehicle brake systems. (Government of South Australia, 2023; Transport and Infrastructure Council, 2019)

Automotive Industry Standard (AIS), Republic of India: In 2021, the Government of Delhi permitted the conversion of older diesel cars (10 years and older) to EVs aligning with the National Green Tribunal, which manages the protection of natural resources and the environment. This body was established under the National Green Tribunal Act in 2010 (EV reporter, 2022). For EV modifications, the Indian government requires that conversion kits be certified by the Automotive Research Association of India (ARAI). ARAI has established the Automotive Industry Standard (AIS), Specifically the AIS 123-Part 1 standard, which applies to the modification of small cars with a gross vehicle weight (GVW) not exceeding 3,500 kg. The key requirements this standard includevehicle weighment, visual indication, mass emission test procedures, brake performance, traction motor

testing, and requirements for rechargeable energy storage systems (REESS) (Ministry of Road Transportation & Highway, 2013).

Key considerations for EV conversion in Japan: To modify an EV in accordance with Japanese regulations, the vehicle must meet the structural and equipment standards specified under the Road Transport Vehicle Act. Guidelines for EV conversion was issued by the Kanto District Transportation Bureau, Ministry of Land, Infrastructure, Transport, and Tourism on September 29, 2010 (Association for the Promotion of Electric Vehicles, 2020). The main specifications include the following equipment: General Electric devices, drive batteries, motors and drive trains, speed controllers and accelerators, DC/DC converters and in-vehicle battery chargers, as well as measures to prevent sudden starts due to incorrect operation (Ministry of Land, Infrastructure, Transport and Tourism, 2024).

Conditions for Replacing Thermal Engines with Electric Engines or Fuel Cells: In the Republic of France, vehicles that run on gasoline or diesel can be converted to electric or hydrogen-powered engines. This conversion is limited to cars that have been registered in France for more than 5 years, and applies to regular cars, commercial vehicles, trucks, buses, as well as two-wheeled vehicles and tricycles that are more than 3 years old. Conditions for replacing thermal engines with electric engines or fuel cells include requirements for the power transmission system, battery (including electrical and thermal management systems and disconnection and protection systems designed specifically for power and traction), network connection for charging the battery, and other subsystems necessary for the proper operation of the EV conversion (Ministry of Ecological and Solidarity Transition, 2020).

Thailand has promoted laws, regulations, and measures related to supporting EVs and the continuous modification of EVs since 2017, when compared to international efforts. On March 12, 2024, the Cabinet approved measures to promote antique cars through of the preservation of art and classic automobiles. It is expected that Thailand will have the potential to expand its economy through industrial sectors related to art and antique vehicles. The measures being promoted include tax incentives for antique cars and measures to promote the manufacturing or restoration of antique within the country. These initiatives aim to support Thailand's medium-sized and small businesses by applying excise tax to antique car products and exempting import duties on antique car components, specifically for passenger cars. (Not including motorcycles and other vehicles) (Royal Thai Government, 2024).

2.6 Supporting the conversion of old cars (classic cars) into EVs of transition strategies.

According to data analysing the number of cars by age in Thailand from 2012 to 2023, the proportion vehicles over 20 years old has steadily risen, with over 2.0 million cars falling into this category. Additionally, it is estimated that by 2023, 3.45 million cars, or 18.26% of all vehicles, will be over 20 years old. This trend presents a significant opportunity for transitioning to electric vehicles (EVs) by converting older cars, which aligns with transition strategies. The total number of EVs in Thailand has also continued to grow, as illustrated in Figure 4.
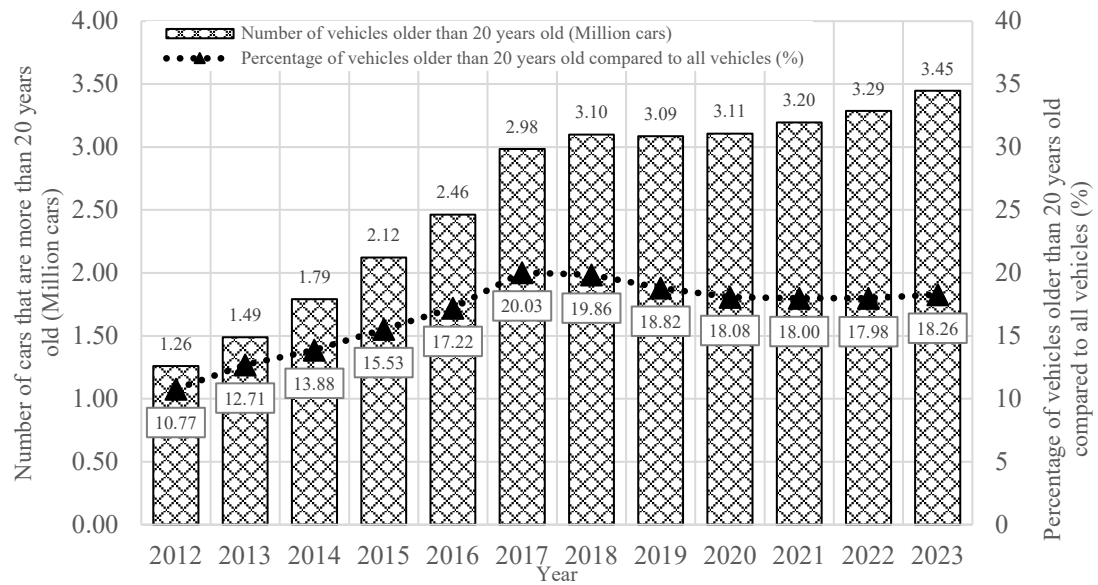
Figure 4 Trends of vehicles that are older than 20 years old compared to all vehicles.

(Department of Land Transport, 2024)

From 2017 to the present, the number of EVs has been steadily rising, reaching a total of 1.53 million cars in 2023, which accounts for 8.12% of all vehicles. This indicates a consistent growth in the use of EVs, as illustrated in Figure 5.
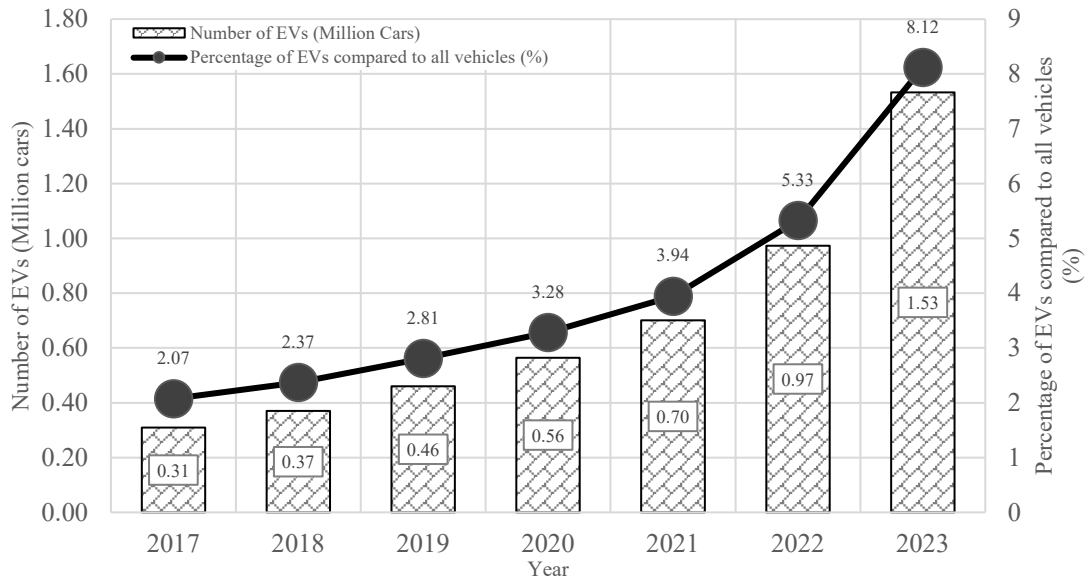
Figure 5 Growth of EVs compared to all vehicles.

(Department of Land Transport, 2024)

Cars with a lifespan of more than 5 to 20 years can be classified into three categories: vintage cars, antique cars, and classic cars. This article distinguishes between these types, defining a classic car as one that is at least 20 years old but no older than 45 years. Several factors contribute to the value of classic cars, such as their

rarity, high demand for ownership, or being produced during a specific era. Antique cars are vehicles that are 45 years or older (LaFontaine Automotive Classic Car, 2024).

Vintage, antique, and classic cars are classified based on three factors: price, history, and the age of the car. The car types are categorized by age as follows: (American Collectors Community, 2023).

- Vintage cars: produced between 1919 and 1930.
- Antique cars: produced in 1975 or earlier (age >45 years).
- Classic cars: produced in 2000 or earlier (>20 years old).

However, price is not a determining factor in vehicle classification. While it is difficult to distinguish between vintage, antique, and classic cars, price can influence how valuable and desirable a vehicle is. A car's price is determined by factors such as its make and model, rarity, desirability, condition, and level of restoration, and mileage. In 2020, the United States held the largest share of classic car sales at (48%), followed by Germany (8%), Italy (5%), the United Kingdom (2%), and other countries (37%). The global classic car trading market was valued at 31.6 billion USD in 2022, with further growth anticipated (Statista, 2023).

In Thailand, there are no precise statistics on classic car ownership. However, according to the Vintage Car Club of Thailand (Vintage Car Club of Thailand, 2024), they are divided into seven categories based on the standards of the International Antique Car Federation (Fédération Internationale des Véhicules Anciens or international, 2024). FIVA defines the term "Classic" in two periods: 1961-1970 and 1971-present.

Only classic cars were considered when compiling the information for this article. Classic cars are typically defined as those that are more than 20 years old. In Thailand, the database includes information on the number of collector cars that have been in use for more than 20 years since 2012 (Figure 5). Additionally, classic automobiles are also part of the transition strategy supporting their conversion into EVs (Figure 2), which aligns with Thailand's main policy. Classic cars are highly valued in the automotive industry, and their repair and maintenance play a critical role in increasing their value (Frederico et al., 2024; Murta et al., 2024).
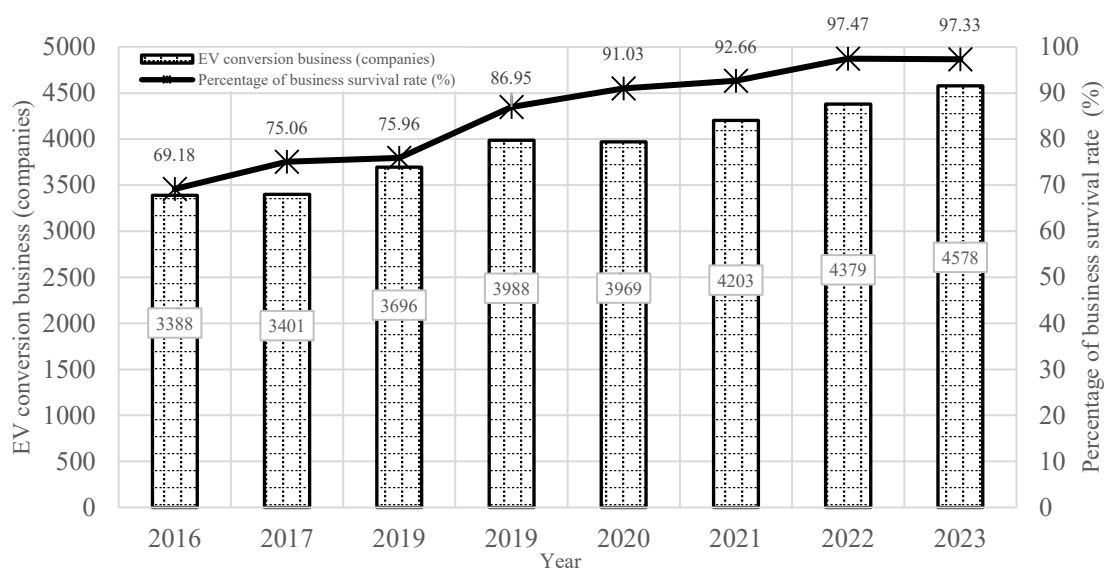

Figure 6 Trends of EV conversion business and their survival rate.

(Department of Business Development, 2024).

According to the information from Thailand's Department of Business Development, if you want to run a business converting cars over 20 years old into EVs in Thailand, they hold a relatively high market value. In 2023, there were 4,578 legal entities operating in this sector, with a registered capital of US$ 351,000,000 and a business opportunity survival rate of 97.33% projected for 2023. This indicates that business opportunities are increasing year after year (Department of Business Development, 2024).

3. Results and Discussion

Thailand has significant potential to develop an EV conversion industry, a transition strategy strongly supported by the Thai government. To facilitate this transition from internal combustion engine vehicles to electric vehicles (EVs) over the next 5 to 10 years, Thailand must support stakeholders in the EV conversion industry across core activities in tiers 1, 2, and 3, along with support activities in the upstream industry, service industry, policy groups, and support organizations.

4. Conclusion

The Thai government has promoted various laws, regulations, and policies to support EVs and their ongoing development in multiple areas (Table 1). As a result, EV conversion in the classic car category is expected to gain momentum. The following factors make Thailand a suitable investment destination for EV conversion:

- Lack of Restrictions on Vehicle Lifespan: Thailand does not impose laws that limit the service life of vehicles. As long as vehicles pass safety inspections, owner can continue to pay annual car taxes. This contrasts with other countries that either restrict vehicle lifespan or lack automobile parts manufacturing industries.

- Robust Automobile Parts Manufacturing Industry: Thailand is home to approximately 1,667 Tier 1 and Tier 2 companies in the automobile parts manufacturing sector, primarily contract production firms that operate on behalf of automobile manufacturers. Many of these companies have not transitioned significantly, as they traditionally produced parts based on foreign companies' designs and orders, rather than conducting independent research and development. Thailand is recognized as the eleventh-largest automobile manufacturing hub in Southeast Asia.

- Abundance of Old and Classic Cars: The average lifespan of a car in Thailand is approximately seven years. Converting old cars are into EVs can transform them into valuable assets that alleviate the financial burden on households and reduce debt levels.

- Supportive Regulatory Framework: Thailand has established laws, regulations, and measures aimed at promoting EVs and encouraging classic cars. This regulatory environment presents opportunities for economic growth through sectors related to art and classic cars. Additionally, tax incentives for classic cars further enhance the potential for development, positioning Thailand as a hub for Southeast Asia's classic car scene.

- Growing Investment in EV Conversion: In 2023, Thailand's EV conversion business is projected to attract over US$ 300 million in investment (USD1 is equal to THB33.225 as of 5 October 2023), indicating a

robust market potential. The automotive modification industry also boasts a survival rate of 97.33%, which reflects typical business operations and demonstrates steady year-on-year growth.

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The Design and Development of a Website Information System Database for job Applications of Eua-Arthon Community (Wat Ku 2) and job Recruitment in the Business and Service Sector in Nonthaburi Province.

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ABSTRACT

This research aims to (1) Study of employment conditions in the Eua-Arthon community (Wat Ku 2) and the labor demand of the business and service sector in Nonthaburi Province. (2) Study the key elements of website design for job applications of Eua-Arthon community (Wat Ku 2) and job recruitment in the business and services sector in nonthaburi province. and (3) Create a website information system based on the work needs of the Eua-Arthon community (Wat Ku 2) and employment according to the labor needs of the business and services sector in Nonthaburi Province. The research results found that (1) Website design must take into account 4 important elements are: content, design, efficiency and safety and benefits. and (2) Got the website https://jobwatku2.com/ which has the following important features: Use small software but high performance. It is open source, so it can be easily developed, improved and maintained. and There is a high possibility of customization to suit other communities as well.

KEYWORDS: Website Information System Database**,** Eua-Arthon Community, Nonthaburi Province.

1. Introduction

Nonthaburi Province is a province with a large number of industrial factories and service businesses, it has created a large number of jobs and labor demand in the industrial and service sectors. However, the industrial and service sectors are facing a major labor problem, namely, the cost of recruiting labor is quite high, the labor skills are not as demanded, and the labor skills are not as efficient as they should be. In addition, the Nonthaburi Housing Community (Eua-Arthon community (Wat Ku 2)), Bang Phut Subdistrict, Pak Kret District, Nonthaburi Province is a community with a population of approximately 20,000 people. Currently, this group of people is facing a major problem, namely, the jobs are not as demanded and the skills are not as skilled as they should be, and some workers are unemployed because they cannot access information sources on labor needs. Therefore, this research aims to design and develop a website information system database for job applications of Eua-

Arthon community (Wat Ku 2) and job recruitment in the business and services sector in Nonthaburi Province to increase employment and income of people in Eua-Arthon community (Wat Ku 2).

2. Research Objective

(1) Study of employment conditions in the Eua-Arthon community (Wat Ku 2) and the labor demand of the business and service sector in Nonthaburi Province.

(2) Study the key elements of website design for job applications of Eua-Arthon community (Wat Ku 2) and job recruitment in the business and services sector in Nonthaburi province.

(3) Create a website information system based on the work needs of the Eua-Arthon community (Wat Ku 2) and employment according to the labor needs of the business and services sector in Nonthaburi Province.

3. Literature Review

3.1 Theory, Concept and Related Research

Thoucharee (2024) to Study of Guidelines for Website Development for Procurement and Employment of Labor According to the Work Needs of Eua-Arthon community (Wat Ku 2) and According to the Labor Needs of Entrepreneurs in Nonthaburi Province. This results in a website system that consists of users are people, entrepreneurs and administrator. Website design must take into account 4 important elements are: content, design, efficiency and safety and benefits. The details can be shown in tables 1 and 2 below.

Table 1 Details of important design elements of a website in the public section

Key aspects of website design	Details
Content	1. There is clarity, accuracy and reliability in presenting information.
	2. The amount of content is sufficient to meet the needs.
	3. Appropriateness of information within the website.
	4. The text on the website is grammatically correct.
	5. The content sequence is step-by-step and continuous, making it easy to understand when reading.
Design	6. The website format is easy to read and use.
	7. Sufficiency of the website menu.
	8. The background color and font color are appropriate for readability.
	9. The colors in the website design are appropriate.
	10. The font size and style are beautiful and easy to read.
Efficiency and Safety	11. The system is easy to use and not complicated.
	12. Website access accuracy.
	13. Accuracy of data search.

Key aspects of website design	Details
	14. Find or access the information you need in a short time.
	15. Effective security management.
Benefits	16. The content is useful for users and can be applied.
	17. It is a source of information that meets the needs of users.

Table 2 Details of important design elements of a website in the business owner section

Key aspects of website design	Details
Content	1. Categorization is appropriate for business needs.
	2. Public relations of news within the website about the business is appropriate.
	3. The company's information is grammatically correct.
Design	4. Sufficiency of the website menu.
	5. The background color and font color are appropriate for readability.
	6. The beauty, modernity and attractiveness of the website.
Efficiency and Safety	7. The system is easy to use and not complicated.
	8. Accuracy of imported data storage.
	9. Accuracy of data search.
	10. Effective security management.
Benefits	11. Facilitate the presentation of business employment data.
	12. The information on the website is clear and can be used as basic information for businesses.

Góngora and others (2023) have studied dataset about information technology governance: A survey in Colombian enterprises. It was concluded that the successful implementation of IT governance can improve efficiency, productivity, decision-making, information security, competitiveness, and customer service quality. However, the Small and Medium-sized Enterprises (SME's) face challenges such as a lack of skilled human resources, resistance to change, and high implementation costs. To address these challenges, strategies such as prioritizing investments, focusing on internal talent, communicating benefits and expected results, and investing in the training of the organization's personnel are suggested.

Trieu and others (2023) have studied Information technology capabilities and organizational ambidexterity facilitating organizational resilience and firm performance of SMEs. The results show that IT capabilities play a crucial role in stimulating organizational ambidexterity, resilience, and SME performance. In addition, the study emphasizes the potential impact of government support in enhancing organizational resilience. These findings provide empirical evidence supporting the Resource base theory with dynamic capabilities view and offer guidance to SMEs on allocating resources effectively and taking advantage of government support. The

study also provides theoretical contributions and managerial implications to enhance business performance and achieve sustainable development.

Asongu and other (2023) have studied Information technology, business sustainability and female economic participation in sub-Saharan Africa. This study contributes to the extant literature by providing actionable thresholds for business sustainability that can be employed by policy makers such that information technology positively influences female economic inclusion in Sub-Saharan Africa.

Zubiena and other (2023) have studied Development and testing of the Health Information Website Evaluation Tool (HIWET) on neck pain websites – An analysis of reliability, validity, and utility. The results show that HIWET is a reliable and valid tool for evaluating the qualities of online health information. *Practical implications:* HIWET has the advantages of being a simple, quick to use and freely accessible tool. It can be implemented into clinical practice, education, and research to evaluate quality of online health information.

Tiwari and other (2023) have studied Determinants of electronic invoicing technology adoption: Toward managing business information system transformation. This study contributes to the existing literature by providing theoretical underpinning to e-invoicing technology penetration literature and toward adopting this innovation in the business-to-business market context. It also offers insights into the implementation of e-invoicing from the perspective of emerging economies.

3.2 Research Framework

Input	Process	Output
- Study of employment conditions in the Eua-Arthoncommunity and the labor demand of the business and service sector in Nonthaburi Province. - Study the key elements of website design.	- Focus group activities between researchers, communities, entrepreneurs and network partners.	- Design and develop a website information system database -Website https://jobwatku2.com/
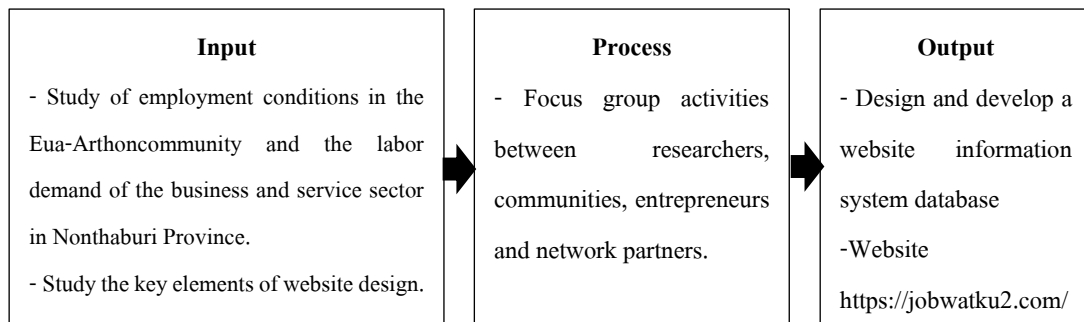
Figure 1 Research Framework

4. Research Methodology

4.1 Research Design

Use Qualitative research method to collect data in 4 important elements of website design for the public and entrepreneurs who use the website.

4.2 Population and Sample

The informants were 80 people from the Eua-Arthon community (Wat Ku 2)), Bang Phut Subdistrict, Pak Kret District, Nonthaburi Province and 20 factories in Nonthaburi Province.

4.3 Research Instrument

For Design a Website Information System Database, Researcher need to create (1) Flow and Wireframes to create diagrams, structures, overviews, blueprints, and interface compositions so that designers,

programmers and users have the same understanding of the overall system. (2) Set color tone and font style. (3) Design the website layout. and (4) Presented in the form of a Prototype which is a sample of the website to be tested with a group of users to see if it can actually be used or not. If there are any errors or problems in use, the website will be fixed or improved immediately.

For Develop a Website Information System Database, Research need to (1) Install WordPress and Elementor. (2) Domain and Hosting. (3) Install SSL and Cloudflare for security. (4) Search and Filter system for categorization. (5) PageSpeed to support SEO. (6) Template for entering information of entrepreneurs. and (7) Responsive Web Design supports all screens.

4.4 Data Collection

The interview and questionnaire methods were used to ask about 4 important elements of website design for the public and entrepreneurs who use the website.

4.5 Data Analysis

Using meetings and focus group activities between researchers, communities, entrepreneurs and network partners to find conclusions in Design and Develop a Website Information System Database for job Applications of Eua-Arthon community (Wat Ku 2) and job Recruitment in the Business and Services Sector in Nonthaburi Province.

5. Research Findings

From the 4 important elements of website design for the public and entrepreneurs who use the website as shown in Table 1 and Table 2 above, the researcher has used them in designing the website https://jobwatku2.com/ as shown in Figure 2 Figure 3 Figure 4 and Figure 5 below respectively.
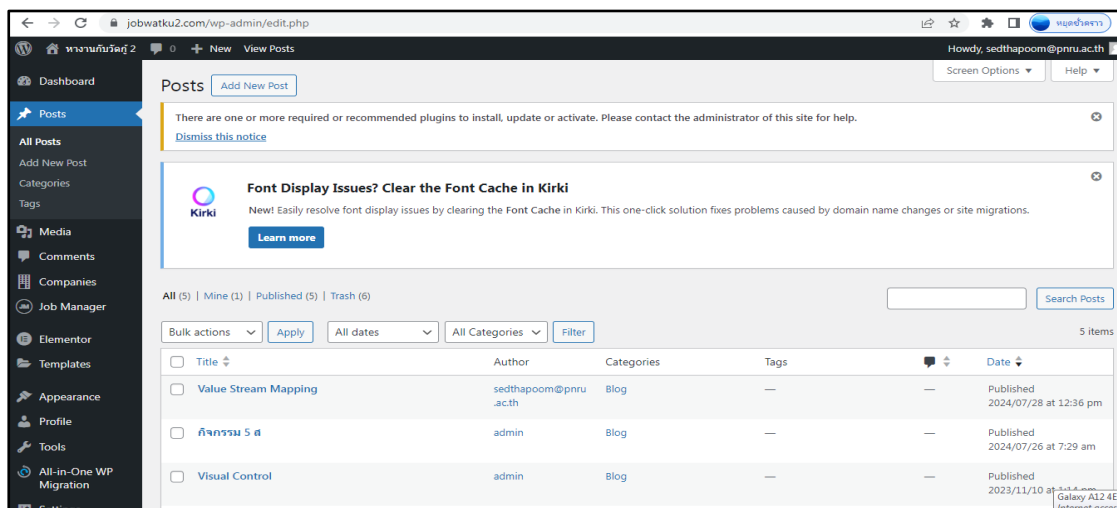
Figure 2 Backend screen of the website https://jobwatku2.com/ in the Posts command section.
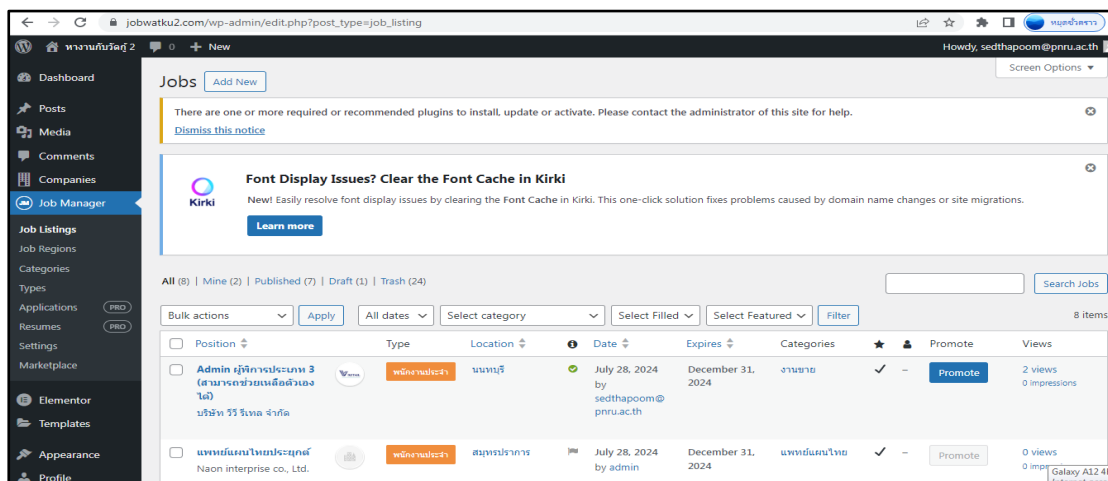
Figure 3 Backend screen of the website https://jobwatku2.com/ in the Job Manager command section
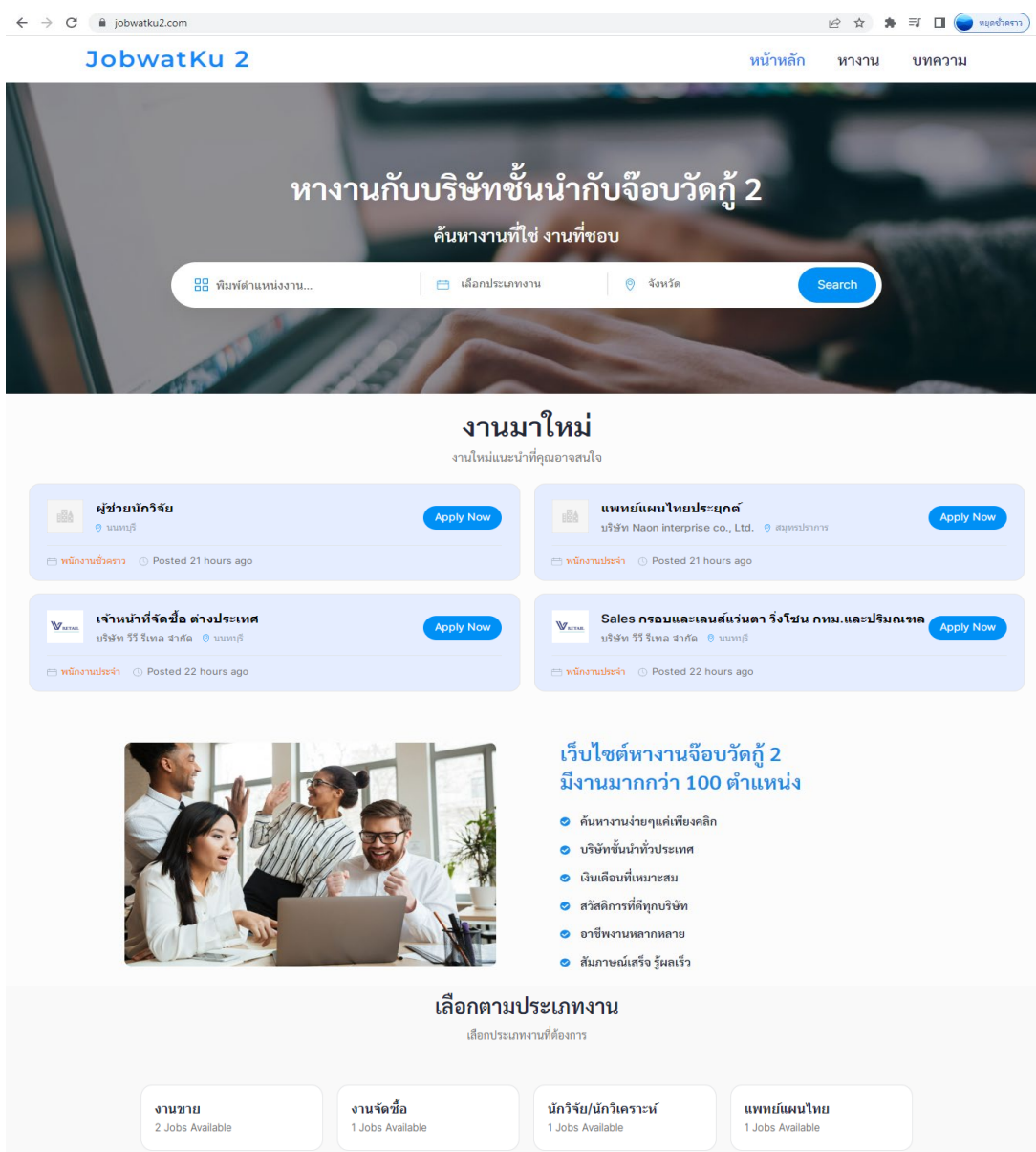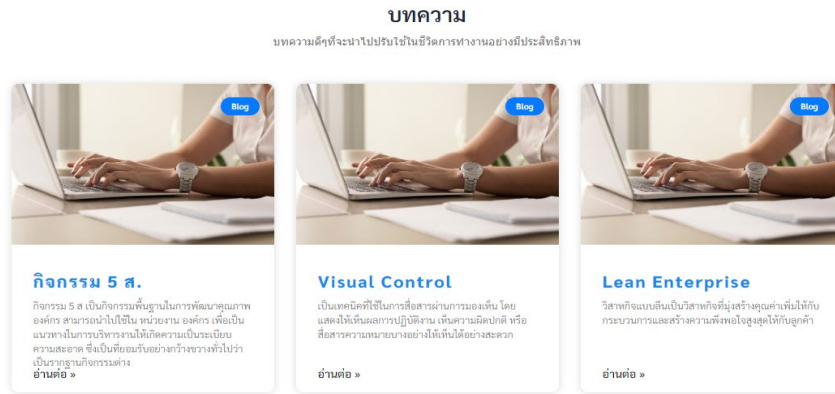
Figure 4 Main screen of the website https://jobwatku2.com/
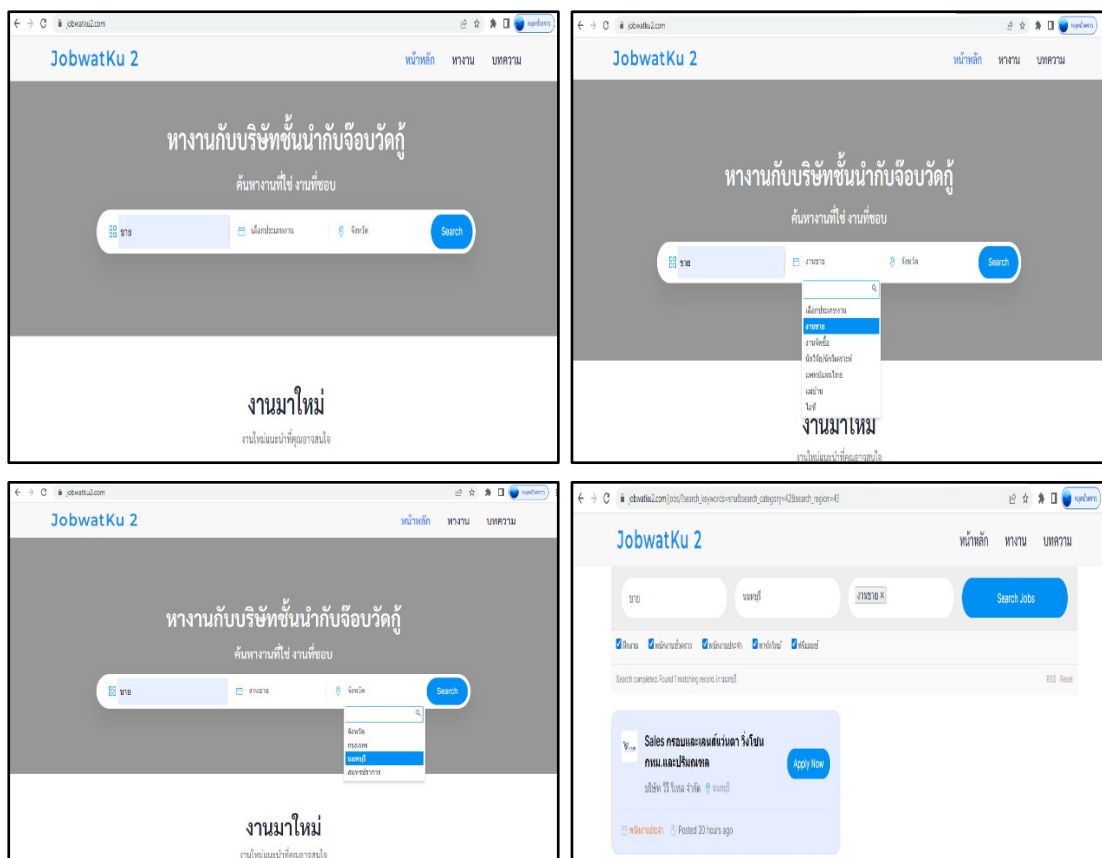
Figure 5 Show search and search results by keyword, job position, job type and province

The results of the comparison between the website https://jobwatku2.com/ and other job application and job recruitment websites can be shown in table 3 below.

Table 3 Comparison results between the website https://jobwatku2.com/ and other job application and job recruitment websites

| Website https://jobwatku2.com/	Other job application and recruitment websites
- Use small software but high performance	- Use large software
- It is open source, so it can be easily developed, improved and maintained.	- It is a closed source with relatively high development, maintenance and improvement costs.
- There is a high possibility of customization to suit other communities as well.	- It is not possible to customize it to suit each community, especially small communities.
- Covering a wide range of entrepreneurs.	- Focus on SMEs and large businesses.
- People who want to apply for a job can use it easily and it is suitable for all ages, especially the elderly.	- People who want to apply for jobs have difficulty using it, especially the elderly.
- There are good articles that can be applied effectively in your working life.	- Focus on advertising and public relations of products and services.
- It is a result of the joint installation and development between companies, research assistants, researchers, academics and community leaders to enable communities to be self-reliant under the globalization.	- It is installed and developed by a company that focuses on profitable performance.

6. Discussion

The results of the research study found that website design must consist of 4 important elements which are consistent with the research results of Thoucharee (2024) to Study of Guidelines for Website Development for Procurement and Employment of Labor According to the Work Needs of Eua-Arthon community (Wat Ku 2) and According to the Labor Needs of Entrepreneurs in Nonthaburi Province. This results in a website system that consists of users are people, entrepreneurs and administrator. Website design must take into account 4 important elements are: content, design, efficiency and safety and benefits. In the section of design and develop a website information system database for job applications of Eua-Arthon community (Wat Ku 2) and job recruitment in the business and services sector in nonthaburi province. The researcher installed WordPress which a ready-made program used to create and manage website content of the Contents Management System type which written in PHP and using the MySQL database management system, which is consistent with the research results of Sonsuwit (2019) to Study Online Information System Development for Innovation and Research of Kamphaeng-Phet Rajabhat University and research results of Sokhom (2021) to study the development website School of Information and Communication Technology, University of Phayao.They have developed online information systems, developed websites using PHP and MySQL. It is expected that the website https://jobwatku2.com/ will respond to the job recruitment in the business and services sector in nonthaburi province and increase employment and income of people in Eua-Arthon community (Wat Ku 2), Bang Phut Subdistrict, Pak Kret District, Nonthaburi Province.

7. Suggestion

(1) It is necessary to apply the website https://jobwatku2.com/ to Eua-Arthon community (Wat Ku 2). Bang Phut Subdistrict, Pak Kret District, Nonthaburi Province effectively.

(2) It is necessary to have a manual for using the website https://jobwatku2.com/ correctly and completely.

(3) It is necessary to improve and maintain the website https://jobwatku2.com/.

8. Acknowledgement

The researchers would like to thank the Eua-Arthon community (Wat Ku 2), the business and service sector in Nonthaburi Province, and related network partners.

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Tiwari, K.A., Marak, R.Z., Paul, J. & Deshpande, P.A. (2023). Determinants of electronic invoicing technology adoption: Toward managing business information system transformation. *Journal of Innovation & Knowledge,* 8(3), 100366.

Trieu, D.X.H., Nguyen, V.P., Nguyen, T.M.T., Vu, T.M.H. & Tran, T.K. (2023). Information technology capabilities and organizational ambidexterity facilitating organizational resilience and firm performance of SMEs. *Asia Pacific Management Review*, 28(4), 544 - 555.

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Ethics, Big Social Data Sharing, and the Attitudes of Thailand's Millennials

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ABSTRACT

The study examines the ethical considerations surrounding big social data sharing attitudes among Thailand's millennials. The millennials generate significant amounts of data, raising concerns about privacy and ethical standards. The study also identifies a gap in existing ethical frameworks, and the current standards do not adequately govern the unique challenges big social data pose. The study used a quantitative research method to collect data from 400 millennials in Thailand through online surveys between July and September 2022. The study explores four ethical theories and their relevance to big social data (consequence-based, duty-based, contract-based, and character-based). Each ethical theory presents strengths and limitations, particularly in addressing privacy, fairness, and the social good. The study also tests two hypotheses related to big data sharing of Thailand's millennials: whether there are significant differences in attitudes based on gender and education levels. The results indicate no significant differences in data-sharing attitudes between genders or education levels. The top three social media platforms were YouTube, Facebook, and Line. Nealy, all millennials used Line multiple times daily, followed by Facebook and YouTube. They connected online services from home, at work, and while traveling. Social networking, streaming, and gaming were the top actions. The findings provide insights for policymakers and organizations in formulating ethical guidelines for managing big social data, especially in light of Thailand's digital transformation goals under the Thailand 4.0 initiative and the 20-year Thai national strategy.

KEYWORDS: big data, social data sharing, ethics, millennial, Thailand

1. Introduction

Big data has been rapidly developing. Its value holds significant importance for Thailand's economy, which has grown by 20% annually since 2014. Furthermore, big data and digital technologies are key factors

influencing Thailand's 20-year national strategy to transform it into a developed country by 2037 (Jantavongso & Fusiripong, 2021).

Moreover, Landrum (2017) reports that the millennial population is Thailand's most active social media user group. Millennials exhibit attitudes that differ from those of other demographic groups. They are also a generation driven by big social data and are the primary generators of big data on social media platforms. Millennials are intensely interested in privacy and seek to maintain positive privacy protection behaviors.

The researchers identify a gap in research regarding ethical theories, standards, big data-sharing attitudes, and behaviors among the millennials (Jantavongso, 2022; Miori & Herschel, 2019, 2020; Saensane & Jantavongso, 2022; Tavani, 2016). Due to a contextual challenge, current ethical standards may not govern big social data. Jantavongso and Fusiripong (2021) claim that there are limited ethical standards for big social data and no "universal ethical standards that apply to all population groups.

Due to the absence of such universal ethical standards, the regulation of data sharing, ethical procedures, and community norms around data sharing have not yet been translated into real-world practices. Big social data's nature also drives data analytics enthusiasm. Big social data can extract insights from online social interactions among users to predict or explain decisions, particularly among millennials. Conversely, big social data diminishes individual privacy, intentionally or unintentionally (Ghani, Hamid, Hashem, & Ahmed, 2019).

Big social data raises ethical issues and questions about privacy, security, and discrimination that need be addressed. The researchers found a discrepancy between expressed concerns and actual behaviors. While millennials express privacy concerns, they often take minimal steps to protect their data (Buchanan, 2020). Thus, millennials tend to compromise their ethical behavior, leading to a conflict between their actual behavior and attitudes toward privacy. Therefore, it is necessary to study critical perspectives on big social data, as this data is crucial to millennials' interactions within digital systems.

Ethics related to big social data are intertwined with users' behavior. More importantly, the ethics of big social data differ from computer ethics due to a lack of specificity and codes of ethics. Therefore, big social data and computer technology are distinct technologies that need ethical policies.

2. Research Objective

    (1) To study existing ethical theories related to big social data

    (2) To study the big social data sharing factors of the millennial population in Thailand

3. Literature Review

The literature review points out a research gap. Our review was done through professional and academic journals recommended by Rangsit University. The review period was from ten years ago to the present. Examples are IEEE Xplore, ProQuest dissertations and theses, Science Direct, Scopus, ThaiLIS, and Wiley Online Library.

Ethics describe the appropriate behavior of individuals or communities. Ethical theories consist of consequence, duty, contract, and character-based theories. The theories that individuals believe in often reflect

complex ethical dilemmas due to conflicting ethical foundations. Moreover, consequence-based, duty-based, and contract-based are considered "consequentialist ethics," where ethics are based on outcomes, while character-based ethics focus on the individual. Predicting behavior depends on understanding the applied ethical theories (Jantavongso & Fusiripong, 2021).

Understanding the prioritization of ethical concerns will lead to a better hold of millennials' intentions to share data. However, current privacy policies and mechanisms are often inadequate for addressing millennials' privacy concerns. Millennials are serious about protecting their privacy and data misuse. However, they lack confidence in the privacy settings provided by service providers, and as the number of participants increases, their desire to share data decreases. Other factors, such as social connections, rewards, and promotions, also play a role (Herschel & Miori, 2017; Miori & Herschel, 2019, 2020).

Although big data is widespread, big social data is a newer term (Jantavongso & Fusiripong, 2021). The definition and scope of big social data are limited. Big data is the broader category, often focusing on infrastructure-related tasks and an infrastructure-centric perspective. In contrast, big social data refers to large volumes of data associated with individuals and their behavior on social media. Big social data focuses on human-generated data. According to Olshannikova, Olsson, Huhtamäki, and Kärkkäinen (2017), big social data is a field that combines data analytics, big data science, computational social science, and various computing systems that support social activities or relationships (social computing). In this study, big social data can be defined as data generated from social media characterized by high volume, dynamism and noise. The three standard practices of big social data include data monitoring, prediction, and sharing.

Like other technologies, big social data is ethically neutral, meaning that big social data does not inherently offer a moral view on what is right or wrong. Ethics are subjective and based on identity, privacy, ownership, and reputational elements; big social data challenges ethical standards. On the other hand, general ethical frameworks and computer ethics are also distinct (O'Leary, 2016). This matter raises issues such as: Is big social data necessary? Can traditional computer ethics be applied? Can general ethics be applied to big social data?

3.1 Four Types of Ethical Theory

The researchers have analyzed the four primary ethical theories by (Tavani, 2016) and identified their strengths and weaknesses. Consequentialist theories, such as those based on outcomes, are beneficial as they emphasize promoting happiness and the greater social good. However, the researchers noted that these theories often overlook the importance of justice and fairness, focusing on maximizing utility for the majority. In contrast, duty-based ethics prioritize obligations and respect for all individuals, highlighting the principles of fairness and justice. Despite this, duty-based theories fail to address the need to raise happiness and social welfare.

The contract-based theory is advantageous because it motivates moral behavior and helps define explicit moral obligations for individuals and society. However, its weakness lies in providing only a minimalistic framework for morality. Character-based ethics focus on individual character development and the cultivation of good habits. Its limitation is its reliance on uniform community standards to define the appropriate virtues. As a

result, each theory has inherent weaknesses alongside its strengths. Table 1 outlines the strengths and limitations of the four ethical theories analyzed.

Table 1 Four major ethical theories

Type	Strengths	Limitations
Consequence-based	Emphasizes the promotion of happiness and social utility	Overlooks justice concerns for minority groups
Duty-based	Prioritizes respect for individuals and duty	Undervalues the significance of social well-being and happiness
Contract-based	Encourages moral behavior	Provides a limited scope of morality
Character-based	Focuses on character development and moral education	Relies on uniform community standards for defining morality

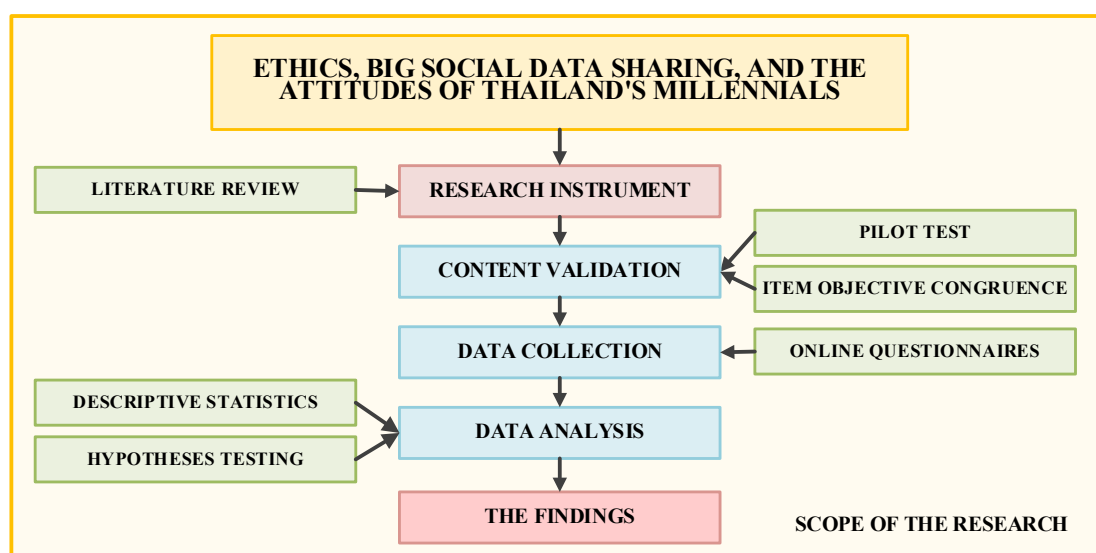**3.2 Research Framework**

Figure 1 Research Framework

3.3 Research Hypotheses

The research hypotheses were applied to test the significance of the results. The hypotheses address the research objectives. The first hypothesis (H1) emphasized that big social data sharing is not affected by gender. The second hypothesis (H2) is that education levels do not affect personal data sharing attitudes.

4. Research Methodology

This section describes the selection of procedures and methodology employed in this study.

4.1 Research Design

A quantitative research method is the research design used in this study. A quantitative research methodology deals with issues or present status that researchers may answer by obtaining and statistically analyzing numeric data. This can help the researchers to perceive results regarding statistics and numbers (Saensane & Jantavongso, 2022).

4.2 Population and Sample

This research focuses on a sample group drawn from the population of Thai millennials residing in Thailand. The sample size was determined through a formula for unknown population sizes, with a 95% confidence level and a margin of error 0.05. The formula used is as follows:

$$n = \frac{z^2 pq}{e^2}$$

Where:

n represents the sample size

e represents the acceptable margin of error, which is 0.05

z represents the confidence level, which is set at 1.96 for a 95% confidence interval (at the 0.05 level)

p represents the proportion of the population of interest

q = 1 - p

Substituting into the formula, with a 95% confidence level where z = 1.96 and an acceptable margin of error e = 0.05:

$$\frac{(1.96)^2(0.5)(1 - 0.5)}{(0.05)^2}$$
$$n = 384.16$$

The calculated sample size for the research is 385 participants. To account for incomplete questionnaire responses, the researcher added 15 participants, bringing the total sample size to 400.

4.3 Research Instrument

The researchers adapted and developed the research instrument from the questionnaire by Jantavongso and Fusiripong (2021). It consists of two sections based on information from literature reviews and related research to ensure the revised questionnaire aligns with the research objectives.

The first section is an open-ended questionnaire containing seven demographic questions, which include year of birth, gender, education level, personality traits, risk, social media platform, and online activities.

The second section collects opinions and attitudes using a 5-level rating scale questionnaire, following the five-point Likert scale method. This section includes three questions focusing on the willingness to share big data on social media platforms, the importance of factors, and the level of representativeness of the decision-making factors regarding personal data sharing on social media platforms. The 5-point rating scale based on the Likert method is as follows:

Table 2 The 5-point Likert-type

Rating Level	Degree of Influence
1	Strongly not influence
2	Not influence
3	Neutral
4	Influence
5	Strongly influence

4.4 Data Collection

The researchers followed the phases below for data collection:

4.4.1 Studied theories, concepts, and relevant research to guide the development of the research framework.

4.4.2 Drafted a questionnaire by determining the topics and scope of questions to align with the research objectives.

4.4.3 Submitted the questionnaire to 3 experts (IOC) at Rangsit University to check its validity.

4.4.4 A pilot test was conducted with 10 participants not part of the sample group to assess the questions' clarity, ambiguity, and potential biases and evaluate the questionnaire's reliability.

4.4.5 Revised and improved the questionnaire to enhance its effectiveness.

4.4.6 Administered the finalized questionnaire to the sample group by collecting responses directly or through Google Forms and distributing it via various social media channels such as Line, Facebook, and WhatsApp between 1 July 2022 and 30 October 2022.

4.5 Data Analysis

In this research, the data was analyzed both during the research process and upon its completion as follows:

4.5.1 Data from the consistency evaluation by three experts was analyzed using the Index of Item-Objective Congruence (IOC):

$$IOC = \frac{\sum R}{N}$$

Where:

IOC represents the Index of Item-Objective Congruence,

$\sum R$ is the sum of the expert opinion scores,

N is the number of experts.

4.5.2 Data was analyzed using mean, percentage, and standard deviation statistics.

4.5.3 Inferential statistics were analyzed using the T-test and F-test to assess the statistical significance of the model.

5. Research Findings

The order of the results is according to the research objectives and hypotheses.

5.1 Results of demographics

Data analysis on demographic factors, including age, gender, education level, and experience in social media platforms, are offered as a table that presents the numbers and percentages, resulting in a successful analysis.

Table 3 Shows the number and percentage of the demographic factors.

Information about personal factors	Number (person)	%
Gender		
Male	192	48
Female	208	52
Total	400	100
Age		
23 – 26 Years	108	27
27 – 30 Years	128	32
31 – 34 Years	100	25
55 – 38 Years	64	16
Education		
High school	12	3
Associate degree	32	8
Bachelor's degree	264	66
Master's degree	80	20
Doctorate	12	3
Personality trait		
Introvert	320	80
Extrovert	80	20

The demographics of the millennials are: 52% of the millennials in the study were female, while 48% were male. The participants' ages ranged from 27-30 (32%), followed by 23-26 (27%), 31-34 (25%), and 35-38 (16%). Regarding education, 66% had a Bachelor's degree, 20% held a Master's degree, 8% had completed an associate degree, 3% were high school alumnus, and 3% had a doctorate.

Table 4 Findings on the usage of the social media platforms.

Platform	Mean	Std. deviation	Std. error
YouTube	4.75	0.53	0.06
Facebook	4.70	0.55	0.07
Line	4.46	0.94	0.11
Facebook Messenger	4.42	1.10	0.13
WhatsApp	3.54	1.69	0.20
Instagram	3.45	1.37	0.16
WeChat	3.30	1.56	0.19
Twitter (X)	3.17	1.41	0.17
LinkedIn	3.04	1.39	0.17
TikTok	2.51	1.52	0.18
Pinterest	2.11	0.95	0.11
Twitch	1.44	0.67	0.08
Tumblr	1.42	0.67	0.08
Skype	1.39	0.82	0.10
Snapchat	1.35	0.66	0.08
Reddit	1.34	0.68	0.08

Millennials were also asked about their social media usage. The top three platforms were YouTube, with an average score of 4.75; Facebook, 4.70; and Line application, 4.46. 80% of participants used Line multiple times daily, followed by Facebook (74%) and YouTube (72%). The majority get into online services from home (83%), followed by at work (54%) and during traveling (21%). Social networking, streaming, and gaming were the most popular actions.

5.2 Results of Hypothesis 1

The first hypothesis is that males and females have no significant difference in attitudes towards personal data sharing.

H_0: μMale = μFemale.

Accept H_0 if T $\leq$ 1.97 at Sig. = 0.05, df = 398; where, df = degree of freedom = 400 participants - 2 genders.

An independent sample T-test was performed. The T-test value is 1.03 with Sig. = 0.31. The T-test value is lower than the critical value, and the Sig. value is higher than 0.05. The result confirms that there is no significant difference between genders regarding the attitude of Thailand's millennials toward big data sharing.

Table 5 Means across the two genders

Gender	No. of participants	Mean	Std. deviation	Std. error
Male	198	4.62	0.49	0.08
Female	208	4.50	0.51	0.19

5.3 Results of Hypothesis 2

The second hypothesis is that There is no significant difference in the attitudes towards personal data sharing between education levels.

H_0: μHigh school = μAssociate degree = μBachelor's degree = μMaster's degree = μDoctorate

Accept H_0 if $F \leq 2.51$ at Sig. = 0.05 with $df_1 = 4$ and $df_2 = 395$, where, $df_1 = 5$ groups – 1, and $df_2 = 400$ participants – 5 groups.

The F value is 1.76 (Sig. = 0.15). The critical value (F table) for F(4, 395), at a 5% significant level, is 2.39. The test F value is lower than the critical value, and the Sig. value is higher than 0.05. The result confirms no significant difference between education levels and big data-sharing attitudes among Thailand's millennials.

Table 6 Means across the education levels

Education level	No. of participants	Mean	Std. deviation	Std. error
High school	12	4.67	0.58	0.33
Associate degree	32	4.80	0.45	0.20
Bachelor's	264	4.46	0.50	0.07
Master's	80	4.80	0.41	0.11
Doctorate	12	4.50	0.71	0.50

6. Discussion

The association between the research objectives and hypotheses is whether Thai millennials' attitudes toward sharing big social data differ between genders and education levels. H1 relates to the impact of gender on the big social data-sharing attitude of Thailand's millennials. Our results show that gender and attitude are related. It was confirmed that there were no significant differences between genders. The result is contradicted by the study by Karatsoli and Nathanail (2020), which found that females have a more favorable attitude toward personal data sharing.

The second hypothesis indicates that our results show no significant differences in big data sharing attitudes across the education levels of Thailand's millennials. This finding contrasts with previous studies by Nuansomsri and Jantavongso (2016) and Jantavongso and Nuansomsri (2019), which suggests that education levels influence individuals' attitudes toward data sharing. Understanding what drives Thailand's millennials to share data remains crucial, as this tech-savvy generation has grown up with nearly unlimited access to information.

7. Suggestion

(1) The Thai government must proactively act on big social data ethics. While it may be possible to influence Thai government policy, setting it is beyond the researchers' capability.

(2) The ethical theories guide acceptable behavior in big social data sharing. The next task is to research the collectors and utilizers. An in-depth study of ethical theories and standards governing each stakeholder's conduct is needed.

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Critical Success Factors for Quantum Technology Adoption in

Logistics and Supply Chain Management: A Case Study of Thailand

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ABSTRACT

Background: Quantum computing (QC) has the potential to revolutionize logistics and supply chain management by effectively handling complex variables and enabling precise decision-making. In Thailand, the Quantum Technology Foundation (Thailand) or QTFT is in the early stages of implementing QC for real-world applications. However, the majority of logistics and transport service providers in Thailand still rely on conventional methods such as experience-based planning and digital tools like Google Maps and MS Excel, resulting in time-consuming processes. This study aims to investigate the barriers and critical success factors for applying QC in logistics and supply chain management in Thailand, with the goal of promoting its widespread adoption.

Methods: Through a systematic review and analysis, industry trends, use cases, and potential risks of QC implementation are examined to identify key barriers and critical success factors specific to the Thai context.

Results: The study identifies five primary factors influencing the adoption of QC in logistics and supply chain management: management, technology, organization, users, and costs. These factors encompass challenges such as data management, technology stability, organizational readiness, user support, and high costs. Overcoming these challenges requires phased approaches, skill development, collaboration with vendors and industry bodies, and supportive policies.

Conclusions: This research provides valuable insights for organizations, vendors, and policymakers to effectively adopt and utilize QC in logistics and supply chain management. Further research will prioritize these factors using Multi-Criteria Decision Making (MCDM) tools, focusing on strategies to overcome potential barriers and promote QC adoption across various sectors in Thailand.

KEYWORDS: Quantum computing; Logistics; Supply chain management; Critical success factors.

1. INTRODUCTION

The 21st century has witnessed transformative changes in global trade, investments, and technological systems, giving rise to new business prospects. The COVID-19 pandemic has had far-reaching economic and social consequences, particularly for regional economies. However, certain sectors, such as transportation and logistics, have experienced positive effects due to their crucial role in business operations and people's livelihoods. The imposition of border closures has also encouraged the growth of the e-commerce market, benefiting carrier and postal delivery companies. To adapt to evolving circumstances, entrepreneurs are investing in specialized workforce training encompassing information technology skills and proficiency in the English language.

Efficient logistics and transportation play a pivotal role in addressing growing demands, cost reduction, risk mitigation, and engaging in value-adding activities. In the transportation industry, the effective management of extensive data sets and the handling of increased transaction volumes have become crucial. Information technology and communication systems have the capacity to enable effective problem-solving and seamless communication among individuals and organizations. Quantum technology, with its rapid processing capabilities for complex problems, holds considerable potential for enhancing transportation systems.

Nowadays, quantum technology is being e applied in various businesses and countries worldwide. Countries like Germany have initiated research projects and allocated funding to nurture the quantum technology ecosystem. In the financial sector, quantum technology is leveraged for tasks such as portfolio optimization and loan loss collection, delivering advantages to banks. The transportation industry is also exploring the utilization of quantum technology, such as in the development of lithium batteries for electric vehicles and the resolution of route optimization challenges.

Although Thailand is yet to widely adopt quantum technology, there exists a desire among Thai businesses to augment their capabilities and competitiveness through the adoption of innovative technologies. This research endeavors to investigate the application of quantum technology in logistics and supply chain management in Thailand, aiming to identify critical success factors and barriers. The findings will provide recommendations for managing these barriers and serve as guiding principles for professionals interested in implementing information technology and communication in transportation management. Ultimately, this study aims to contribute to the advancement of more efficient business practices in the future.

2. LITERATURE REVIEW

An Overview of Quantum Technology

Quantum technology represents a paradigm-shifting advancement that leverages quantum bits (qubits) to carry out computations with greater efficiency compared to conventional computers. Its potential impact spans multiple industries, including finance, logistics, and healthcare, by providing solutions to complex problems that traditional computers cannot handle (Rieffel & Polak, 2011). Quantum computing's capacity to optimize logistical networks, minimize costs, and enhance financial investment strategies significantly enhances operational

efficiency and decision‑making processes (Peng et al., 2020). Furthermore, it offers advanced cybersecurity solutions, although it can break current encryption algorithms, thereby necessitating the development of quantum-based secure communication methods, such as Quantum Key Distribution (QKD) (Pflug & Wozabal, 2021).

However, ethical and societal implications associated with quantum computing demand careful consideration from businesses. To prevent privacy violations and data breaches stemming from the potential compromise of existing encryption algorithms, robust security measures are requisite. The prospect of job displacement is another critical concern, as tasks currently fulfilled by human personnel could potentially be supplanted by quantum‑driven artificial intelligence (Bäumer, Montanaro & Witzel, 2020). Hence, businesses must consider on the implications for their workforce and devise effective strategies for managing this transition.

In summary, quantum computing possesses profound implications across various sectors, encompassing efficiency improvements, decision‑making, cybersecurity, materials science, and energy. By capitalizing on the distinctive attributes of atoms, such as quantum superposition, tunnelling, and entanglement, it facilitates more efficient computational processes. However, considerable technical challenges persist, including the development of reliable qubits, efficient software, and algorithms (Kshetri, 2021). Consequently, businesses must allocate resources and expertise to harness the potential of quantum computing effectively while ensuring the implementation of adequate security measures. Overall, the potential advantages presented by quantum computing are substantial, necessitating that businesses adapt and make appropriate preparations for the adoption of this transformative technology.

The Application of Quantum Technology in Business Sectors

Quantum computing has the potential to revolutionize multiple industries, particularly the software industry. Major players like Google and IBM have made substantial progress in quantum technology, showcasing its immense computational power. By combining quantum computers with AI and machine learning, quantum computing can address complex problems that exceed the capabilities of classical computers, thereby providing solutions for the software industry. Google's breakthrough in 2019 highlighted the remarkable computational abilities of quantum technology, enabling the resolution of problems that would take thousands of years for traditional supercomputers to solve in just a matter of minutes (Arute et al., 2019).

Aside from the software industry, quantum computing holds benefits for various other sectors. In healthcare and pharmaceuticals, quantum technology can assist in disease diagnosis and drug discovery. The energy and petrochemical sector can leverage quantum computing to evaluate new drilling sites and enhance exploration efficiency. Supply chain management can be optimized through quantum computing, facilitating efficient route planning, transportation management, and analysis of proposals and customer requirements. Moreover, industries such as manufacturing, logistics, retail, finance, banking, and securities markets can harness quantum technology for management problem‑solving, derivative securities pricing, automated trading, risk assessment, financial recommendations, and market predictions.

However, it is important to note that the computational power of quantum computing also poses a potential risk to encryption codes, including blockchain encryption used in financial security measures.

Consequently, ensuring robust security measures and developing quantum‑resistant encryption algorithms becomes crucial. Overall, quantum computing offers significant potential for accelerating problem‑solving and decision‑making processes across various industries, with the software industry standing out as a key beneficiary (Fedorov et al., 2018).

The Status of Quantum Technology in Thailand

Quantum technology has gained significant attention in various fields of research and development in recent years due to its diverse applications. In Thailand, there is a growing interest and focus on quantum technology, as efforts are being made to strengthen the country's capabilities in this emerging field.

One area of quantum technology research in Thailand is focused on quantum communication systems. These systems utilize the principles of quantum mechanics to establish highly secure and robust communication channels that are resistant to eavesdropping and hacking. In 2018, the National Electronics and Computer Technology Center (NECTEC) achieved a significant milestone by successfully developing a quantum communication system capable of transmitting data securely over distances of up to 300 meters. This feat was accomplished through the implementation of quantum key distribution, ensuring the confidentiality and integrity of the communication process. Quantum sensing is another significant area of research in Thailand. Quantum sensors with exceptional precision are being developed for diverse applications such as navigation, medical diagnosis, and environmental monitoring.

Thailand's commitment to advancing quantum technology is evident through the establishment of the National Quantum Technology Center (NQTC) in 2022. With a budget of 1.2 billion THB, the NQTC has partnered with the Fraunhofer Institute for Applied Solid State Physics (IAF) in Germany to collaborate on quantum computing, focusing on quantum annealing, control, and simulation (NSTDA, 2021).

Moreover, the Quantum Technology Foundation (Thailand) or QTFT is in the early stages of implementing quantum computing for practical applications. As a prominent organization based in Bangkok, Thailand, the QTFT is dedicated to developing a hybrid digital‑quantum optimization engine called SOR. This engine aims to bridge the gap between cutting‑edge research and the real‑world deployment of quantum and quantum‑inspired technologies.

The progress of quantum technology in Thailand holds significant implications for the country's economy and society. Industries such as finance, healthcare, and logistics stand to benefit from the transformative potential of quantum technology, which can foster the development of innovative products and services. However, challenges persist, including the need to cultivate a skilled workforce of researchers and engineers, as well as address the substantial costs associated with infrastructure development.

3. METHODOLOGY

This article undertakes a methodical examination of the literature, employing the Systematic Reviews and Meta‑Analysis (PRISMA) methodology, to investigate critical success factors and barriers related to the

implementation of quantum technology or cutting-edge innovative technologies. The use of the PRISMA framework, as depicted in Figure 1, facilitates the systematic collection and processing of data for this study.
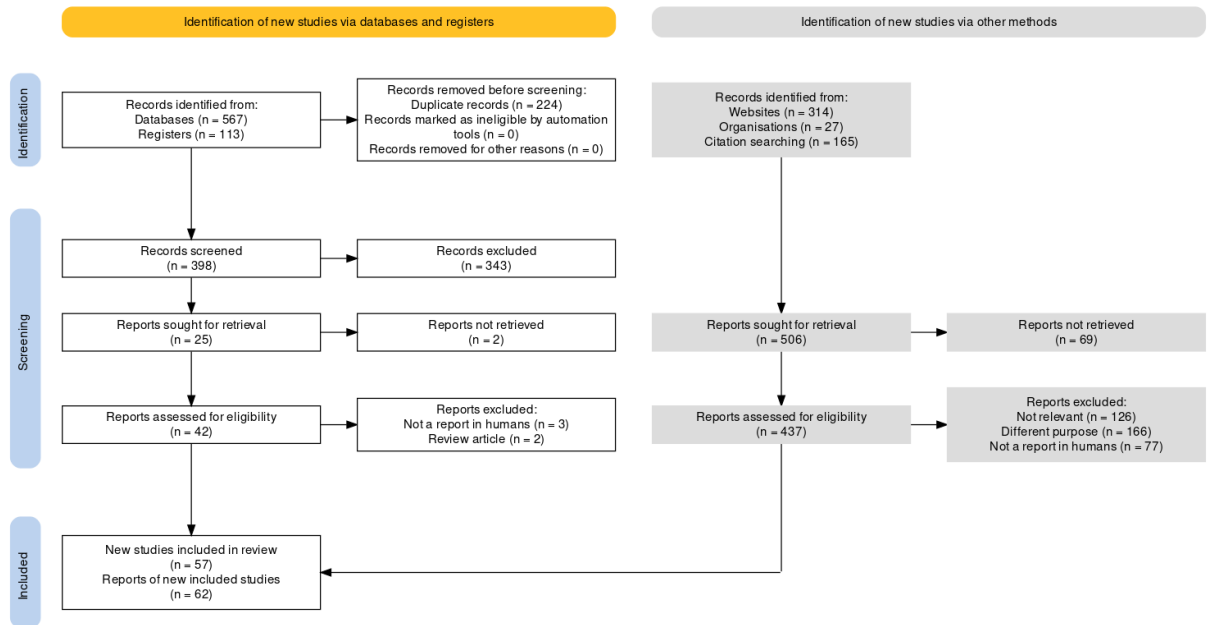
Figure 1 Overview data collection and processing using PRISMA

The data for this research is obtained through an extensive review of secondary sources, primarily focusing on the implementation of quantum technology or state-of-the-art technologies, with a particular emphasis on identifying critical success factors.

4. IDENTIFICATION OF SUCCESS FACTORS FOR QUANTUM TECHNOLOGY ADOPTION

Although still in its early stages of development, quantum technology holds significant potential for transforming various industries. There are several early success indicators that can facilitate the adoption and acceptance of this disruptive technology. Consequently, based on a comprehensive review of secondary sources utilizing the PRISMA methodology, this study aims to synthesize previous research to identify the crucial factors that need to be considered for user acceptance of this new era technology.

Based on the literature review, five primary factors have been identified that significantly impact the success and challenges associated with the application of quantum technology in logistics and supply chain management, as well as technological investment. These factors can be analyzed as follows:

1) Management Factors

Efficient management of organizations is essential in effectively adopting and leveraging the benefits of quantum technology while mitigating associated risks. It is crucial for leaders to possess a clear strategic vision and effective leadership skills to navigate the impact of quantum technology on their respective sectors.

This includes understanding potential opportunities, assessing risks, and developing comprehensive implementation plans.

To promote the advancement of quantum technology and address common challenges, collaboration with academic institutions, industrial partners, and governmental organizations is crucial. Partnerships provide access to knowledge, shared resources, and common infrastructure necessary for successful implementation. Working in cooperation with external stakeholders allows organizations to tap into expertise and leverage collective efforts to overcome obstacles.

Managing intellectual property (IP) plays a pivotal role in the adoption of quantum technologies. Organizations must have robust strategies in place to safeguard their IP rights, including trade secrets, copyrights, and patents. This entails implementing effective IP management plans to protect and capitalize on valuable intellectual assets.

By effectively managing these factors, organizations can position themselves to securely store data, enhance data management efficiency, and harness the potential of quantum technology in logistics and supply chain management (Suebsin & Gerdsri, 2010; Sobragi, et al., 2014). This will ultimately contribute to improved operational performance, competitive advantage, and innovation within the industry.

2) Technological Factors

The study, development, and investment in quantum technology have transformative implications for current lifestyles and societal existence. Its application spans various fields, including finance, where algorithms are used to analyze consumer behavior, or in industrial companies, where technology utilization is on the rise. Examples of notable applications include mobile banking for cashless societies and studying consumer behavior and online shopping trends to assess market demand and purchasing patterns (Lee & Kim, 2018; Liang, Li & Huang, 2016). This enables producers to identify limitations within their supply chain and make informed decisions.

However, a limitation currently faced is the relative instability of existing quantum technology, as well as the high investment required for its future development. These factors pose challenges in applying quantum technology to logistics and supply chain management. The success of quantum technology relies on the creation of reliable and scalable quantum hardware, such as qubits and quantum computers. Advancements in hardware design, manufacturing processes, and error-correction techniques are essential in enabling quantum systems to operate more reliably and efficiently.

Additionally, the utilization of quantum systems necessitates the development of effective quantum algorithms and software tools. The ongoing challenges lie in creating user-friendly software frameworks and quantum algorithms that outperform their conventional counterparts. Maintaining the integrity and dependability of quantum calculations is crucial and can be achieved through robust error correction codes and fault-tolerant algorithms.

By addressing these challenges and advancing the capabilities of quantum hardware, algorithms, and software, the application of quantum technology in logistics and supply chain management can become more

feasible and impactful. It requires continued research and development efforts to enhance the stability, reliability, and efficiency of quantum systems in order to unlock their full potential (Devaraj & Kohli, 2018; Pakin & Coles, 2019)

3) Organizational Factors

Incorporating quantum technology into organizations is not a straightforward process, as it requires individuals within the organization to be open to accepting and learning about new technologies (Cichosz et al., 2020). At the same time, organizations must provide support and invest in the development of quantum technology (Lai & Chen, 2017). However, the application of new technologies, including quantum technology, in developing countries can pose challenges due to infrastructure limitations such as access to electricity and internet connectivity, as well as the immaturity of technology and datasets (Haider, 2020).

The successful deployment of quantum technology relies heavily on the existing corporate culture within an organization. Cultivating a culture of innovation, cooperation, and openness to change is crucial for integrating quantum technology into current workflows. This involves encouraging experimentation and learning, and fostering an environment that supports and promotes innovation. The organizational structure should be flexible enough to adapt to the changes brought about by the implementation of quantum technologies.

To effectively utilize quantum technology, organizations can benefit from the establishment of cross-functional teams, enabling collaboration and open lines of communication across various departments. This collaborative approach facilitates the exchange of knowledge and expertise, ensuring that the potential of quantum technology is harnessed across different organizational functions.

By addressing organizational factors such as culture, structure, and collaboration, organizations can create an environment conducive to the successful implementation and utilization of quantum technology. This paves the way for embracing the transformative capabilities of quantum technology and reaping its potential benefits in logistics and supply chain management.

4) User Factors

Users of technology are the most crucial individuals for the efficient utilization of quantum technology (Andrew, 2018). However, its limitations are significant. Similar to organizational factors, users must be supported by organizations that are genuinely ready to accept new technologies. Sometimes, even with full support, there are obstacles such as being trapped in one's own abilities, excessive self-confidence, lack of experimentation and iteration, unpreparedness to deal with complexity and constant changes, and the absence of appropriate technology adoption and usage (Kane et al.,2018). These factors often occur in the development of quantum technology, especially for digital technology transformation in logistics industries.

The successful implementation of quantum technology relies on user understanding and awareness. Users need to comprehend the underlying principles of quantum physics, be aware of the potential applications and limitations of quantum technology, and recognize the advantages it can offer. The design of the user interface and user experience plays a crucial role in facilitating the adoption of quantum technology. Creating intuitive and user-friendly interfaces, minimizing complexity, and providing appropriate feedback and guidance

enhance user satisfaction and usability. Users must also acknowledge and manage the risks and uncertainties associated with quantum technology, including the potential for inaccurate results or unforeseen consequences.

By addressing user-related factors, organizations can enhance user engagement, adoption, and effective utilization of quantum technology. This involves providing education and training to users, designing intuitive interfaces, and fostering a culture of openness to experimentation and adaptation. Additionally, organizations must address potential concerns and risks associated with quantum technology to instill confidence and trust among users.

By understanding and managing these factors, organizations can maximize the benefits of quantum technology in the logistics industry and ensure that users can effectively leverage its capabilities while mitigating potential challenges.

5) Cost Factors

Cost is a crucial factor that significantly impacts the development and adoption of quantum technology. Currently, the high costs and extensive resource requirements associated with quantum technology pose challenges for logistics companies in adopting it for their transportation systems. In the short term, it may not be cost-effective for medium and small-sized logistics companies to invest in the development of quantum technology for their transportation systems.

Implementing quantum technology often involves substantial capital expenditures. These include investments in quantum hardware, specialized infrastructure, and the establishment of dedicated quantum computing centers. Organizations need to assess the capital resources required to support the adoption and deployment of quantum technology and allocate them accordingly.

One of the key difficulties lies in maintaining cost-effectiveness when scaling up quantum systems. Businesses need to consider the expenses associated with scaling quantum hardware, increasing the number of qubits, and improving error correction techniques to develop cost-effective and scalable quantum solutions.

Commercializing quantum technology applications also requires consideration of economic feasibility. Organizations must evaluate market demand, potential revenue streams, and pricing strategies to ensure that the costs associated with adopting quantum technology align with the expected financial benefits.

5. CONCLUSION AND FURTHER RESEARCH

In conclusion, logistics management plays a vital role in the success of business operations within the broader scope of supply chain management. While the potential of quantum technology in logistics and supply chain management is promising, its practical implementation is currently hindered by resource constraints and inadequate investment. This research aims to contribute to the existing knowledge by providing insights into the challenges and opportunities associated with integrating quantum technology into logistics and supply chain management practices. A thorough understanding of these factors will empower organizations to make well-informed decisions and address critical issues when considering the adoption of quantum technology.

Moving forward, future research will focus on collecting primary data from experts in the software industry, logistics, and supply chain industry through surveys and interviews. The participation of highly knowledgeable and reputable experts will ensure the reliability and credibility of the research findings. Additionally, these factors will be prioritized using Multi-Criteria Decision Making (MCDM) tools to develop strategies that can overcome potential barriers and facilitate the widespread adoption of quantum technology across various sectors.

In summary, the findings of this research offer valuable insights for organizations, vendors, and policymakers to effectively adopt and leverage quantum technology in the field of logistics and supply chain management. By embracing quantum technology and addressing the identified challenges, businesses can enhance their operational efficiency, reduce costs, and meet the evolving demands of the market.

6. ACKNOWLEDGMENTS

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The Pricing Strategy and Financing Mode Analysis for

the Construction Supply Chain of Project X

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ABSTRACT

Under the increasingly powerful conditions of the Internet of Things and information platforms, the competitive advantages of building technology and material costs are weakening. Optimizing engineering management and innovating management concepts will become the main competitive advantage of various construction enterprises, and will also play a crucial role in promoting the progress of engineering management.

On the basis of elaborating and analyzing the current situation of the construction industry, construction project management, construction supply chain, supply chain pricing, supply chain financing theory and research status, this article selects the X residential community engineering project for empirical research. Based on the engineering characteristics of the project, a decision‑making model for the construction supply chain of X residential community was established through the EPC contracting mode and relevant assumptions. Finally, an analysis was conducted on four optimal pricing strategies: financing without funding constraints, financing without funding constraints, financing within the funding constraint chain, and financing outside the funding constraint chain.

KEYWORDS: Engineering management, Construction supply chain, Pricing decisions, Financing model

1. Introduction

(1) Background of the Research

The construction industry has always been a pillar industry in China. A survey conducted by the National Bureau of Statistics in recent years showed that the total output value of the construction industry in China was 311.8 billion yuan in 2022, a year‑on‑year increase of 6.5%.The total construction area of houses in the national construction industry is 15.6 billion square meters. With the continuous development of information technology, advanced information management methods represented by BIM technology are also constantly penetrating the construction industry, and information asymmetry is gradually weakening. The transparency and

openness of information among participants in construction products promote the maximization of common interests.

However, compared to other industrial products, building supply chain products (building products) Due to its long production cycle, scattered work locations, and strong liquidity in construction sites, related enterprises have a high demand for funds, a long turnover cycle, and difficult management. The construction industry is a low profit industry, and funding has always been a prominent problem in the industry. Especially for large-scale projects with huge capital requirements, the time of income generation is very delayed, and the funding gap is difficult to solve. Whether it is construction enterprises, construction enterprises, material suppliers, or subcontracting enterprises, they are all under great financial operation pressure. It is crucial to fundamentally break through the financial constraints of various enterprises in the construction industry and update the traditional management thinking of the industry to seek more stable financial support for construction enterprises. [1]

The research object selected in this article is the X residential community project developed by F Company and constructed using the EPC engineering general contracting model. [2] The Engineering Management Organization Model (EPC Model) is a major contracting model implemented by the Ministry of Construction since 2003 and has a certain degree of represent ativeness.This article will define the main participants of the X residential community project as its supply chain members, and use the building products of the X residential community as supply chain products. This article starts with the supply chain capital flow and studies the pricing and financing decision models of projects under different capital conditions, in order to find decision-making methods to reduce costs and improve efficiency under the premise of stable project capital flow. [3]

(2)Research Objective

①To explore the characteristics of project X and study the definition, connotation, and model architecture of the construction supply chain.

②To explore the pricing mechanism and financing model of the construction supply chain for project X, and define relevant parameters.

③To study the supply chain model and pricing decision-making problem of the above project, and analyze and obtain management suggestions without financing conditions.

④To discuss the pricing strategies of the above construction supply chain under two financing modes: internal and external financing, compare and analyze the financing schemes of the construction supply chain, and obtain management suggestions related to financing.

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[1] Zhao Feng, Wang Yaowu, Jin Ling, et al. (2019). Statistical Analysis of the Development of the Construction Industry in 2018. Journal of Engineering Management, 33 (02): 1-6

[2] Wang Linxue, Du Yueping, Peng Xing, et al (2005) The Application of Cluster Analysis in the Primary Selection of Supply Chain Alliance Partners Journal of Intelligence. 24 (10), 26-28

[3] Koskela l.(1992). Application of the new production philosophy to construction. Technical Report # 72 Center for Integrated Facility Engineering. Department of Civil Engineering. Stanford University. 75: 12-22.

2. Literature Review

Construction engineering refers to the engineering entity formed by a series of construction activities such as the construction of various types of housing buildings and their ancillary facilities, including the installation of their supporting pipelines, which is the construction product mentioned in this article. The core task of construction project management is to add value to the construction and use of construction projects, throughout the entire lifecycle of the project, including planning and management (DM) in the decision-making stage, project management (PM) in the implementation stage, and equipment management (FM) in the use stage. Each of the three stages has different resource management priorities. In the DM stage, it is necessary to determine financing models, contract management models, project resource procurement models, bidding management models, etc; The main tasks of the PM phase are bidding and evaluation, resource acquisition, optimization of configuration, and effective management of contractors; The FM stage focuses on property management after the construction products are put into use.

	Decision stage	Prepare	Implementation phase design	Construction	Practical stage
Construction investor	DM		PM		FM
Designer			PM		
Construction party				PM	
Supplier				PM	
Property management party					FM

Figure 1 Schematic diagram of construction project management stage

Source: Baidu Wenku

Supply chain financing is a form of financing that relies on commercial credit. The seller provides services such as extending payment terms or providing advance payments to customers who purchase products on sale, thereby forming an internal financing of the supply chain. Foreign scholars have conducted extensive research on the premise of transaction credit in the supply chain. Kouvelis et al.[4] studied the pricing problem of retailers using

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[4] Kouvelis p,Zhao wh. (2012).Financing the newsvendor Supplier vs. bank, and the structure of optimal trade credit contracts.

Operations Research, 60(3): 566-580.

bank financing to repay suppliers in advance and delay payment; Zhang et al. [5] analyzed the supply chain coordination mechanism with commercial credit and found that in the case of delayed payment by retailers, manufacturers tend to reduce the quantity of supply in order to obtain more profits.

3. Methodology

（1）Establishing a financing framework for the construction supply chain

The X project plans to adopt the EPC engineering general contracting model. As a seller of construction products, Company F is the only demander of construction products for Company C at this time; Company's C construction products are the manufacturer and the only supplier of F company's demand for construction products.

When the funds come from Company F, based on the contractual relationship of the construction supply chain, Company F can lend the surplus funds to Company C at the interest rate rs. For Company F, not only can it obtain profits greater than the market risk-free return rate R (i.e. R< r_s), but it also solves the financial problem of Company C, which is beneficial for engineering construction and accelerates the efficiency of the construction supply chain; For Company C, compared to external funds in the supply chain, internal financing in the construction supply chain does not require the provision of enterprise credit and other information. The procedures are simple and the funds are obtained quickly. The disadvantage is that the amount is low and sometimes cannot meet the demand. This financing model supported by internal funds in the construction supply chain is shown in Figure 2:
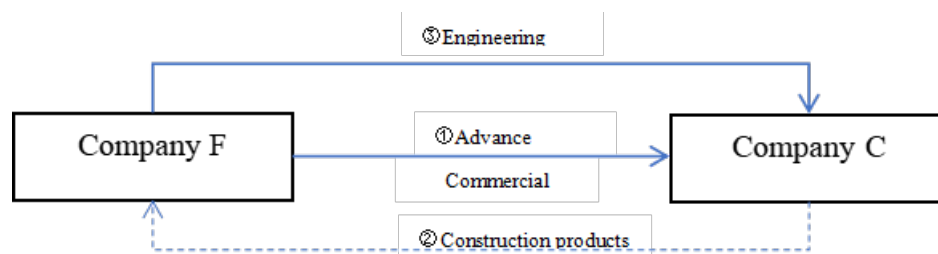
Figure 2 Internal financing structure of the construction supply chain

[5] Zhang Q,Dong M,Luo J. (2014).Supply chain coordination with trade credit and quantity discount incorporating default risk.
International Journal of Production Economics, 153: 352-360
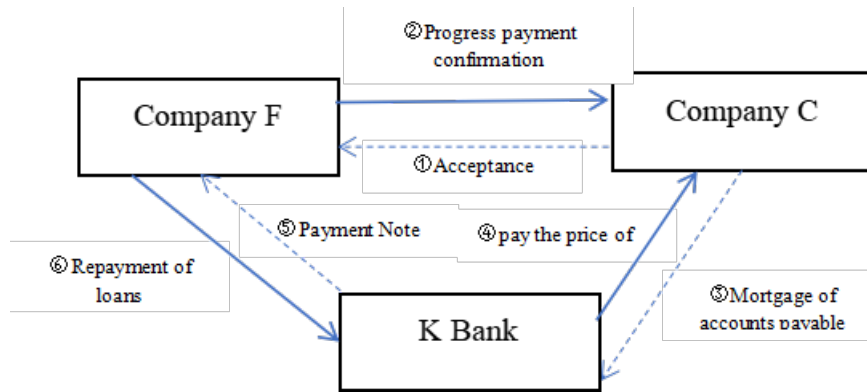
Figure 3 External financing structure of construction supply chain

(2) Parameter Setting of Engineering Construction Supply Chain

Table 1 Parameter setting

Parameter	Representative value
Company F	Sales side of construction products
Company C	Manufacturer
c	EPC contractor's construction cost per square meter
ω	Cost per square meter of construction area approved by construction enterprise accounting
p	Pricing per square meter of building area
q	Completed building area
R	Market risk-free return rate
r	Loan interest rate from banks for construction enterprises
r_s	Interest rate for inter member loans issued by construction enterprises
r_b	Supply chain members borrow interest rates from banks
B	The advance payment amount agreed upon between the construction unit and the construction enterprise before the commencement of construction
f_b	Enterprise owned funds
π	On the Profit Function of Output q
D	On the Demand Function of Price p
a, b	Constant term in the price demand function
d	Land cost per unit area

4. Results and Discussion

The X residential community is invested and developed by F Real Estate Development Company, with plans to sell it as ordinary well decorated commercial housing. The project was planned from the beginning of 2022. After obtaining land information and conducting preliminary market research, the feasibility study report was approved by the company's senior management. In December 2022, the construction land use right of the B2-13 plot located in Wuhua District, Kunming City was obtained through auction transfer. The planned use is commercial and residential land, with a land area of 55597.8 square meters, an assessed price of 70.7013 million yuan, a transaction price of 166.013 million yuan, and a plot ratio of less than 1.8. In May 2023, F Company launched the X residential community project, which is planned to be constructed from May 2023 to May 2024 and delivered for use in December 2024. The plot ratio is set at 1.3, and the estimated construction area of the project is 72300 square meters. Due to the merger and restructuring of the construction investor F company for the X residential community project, there is a shortage of project follow-up personnel, and the project department is required to accelerate the speed of fund recovery. In order to ensure the smooth progress of the project as scheduled, it is proposed to use the IPMT project management mode and adopt the EPC engineering general contracting mode for contracting, and entrust the local bidding agency to conduct bidding. At the bid opening, D company was confirmed as the first candidate for winning the bid, and both parties signed a letter of intent to cooperate, confirming that D company will be fully responsible for the design, construction, and procurement of the project. The residential community building will adopt a frame shear wall structure.

(1)Financing free pricing strategy for the supply chain of X residential community project construction

When there is no financial constraint on the construction supply chain of the X residential community project, all enterprises on the supply chain, namely the construction investor F company and the construction contractor D company, have no financial constraints,Company D can independently pay for all project costs with a completed area of q and a unit area cost of c, which means it has its own funds is : $f_m > cq$.

According to Hypothesis 4, Company F decides the completion area based on the sales area required by the market. Referring to the research in the literature, it is assumed that its supply and demand relationship model is as shown in Equation (4-1)

$$q = D(p) = a - bp \qquad (4-1)$$

(2)Pricing Strategy under Financial Constraints in the Construction Supply Chain of X Residential Community Project without Financing

When D company's financial capacity is insufficient, i.e.$f_m < \dfrac{ac - bc^2 - bdc}{4}$, F company can choose to pay advance payment B to D company through contract agreement to ensure the smooth progress of the project. However, at the same time, F company will consider its own interests and choose to pay the advance payment, which will at least result in losing the market risk-free return with an amount of B and an interest rate of R. In the absence of financing, the production and pricing decisions of Company F and Company D are as follows.

(3) Price and profit analysis when F company does not provide advance payment

On the premise that Company F does not provide advance payment, D will, based on its own financial situation, use all its own funds for production in order to reduce capital costs and maximize benefits. Therefore, the completion area can be determined:$q^{RN} = \frac{f_m}{c}$,At this point is $P^{RN} = \frac{ac-f_m}{bc}$.

When making independent decisions, F Company's decision-making model is:$\pi_s^{RN} = (p - w - d)\frac{f_m}{c}$,The decision model of Company D is $\pi_m^{RN} = (w - c)\frac{f_m}{c}$,Both decision models are monotonic functions. In mathematical theory, if D company's profit π_m^{RN} is maximized, then within the range of w values, the extreme point makes the unit building area pricing equal to the unit building area pricing , and F company, as an investor, is not profitable. This model does not have practical significance, and in this case, the supply chain profit of independent decision-making is the same as that of joint decision-making. Therefore, this article measures the joint decision-making mode, and the joint decision-making supply chain decision-making model is:$\pi_c^{RN} = (p - c - d)q$.

Therefore, in the absence of advance payment and with financial constraints on Company D, the pricing per unit area is $p^{RN} = \frac{ac-f_m}{bc}$,The completed area is $q^{RN} = \frac{f_m}{c}$,At this point, the profit of the supply chain is shown in equations (4-2).

$$\pi_c^{RN} = -\frac{1}{bc^2}f_m^2 + \frac{a-bd-bc}{bc}f_m \qquad (4\text{-}2)$$

(4) Price and profit analysis of F company's payment of advance payment

When F company chooses to pay D company's advance payment, F company will at least lose the market risk-free return with an amount of B and an interest rate of R.

When the advance payment amount can meet the funding gap of Company D's project, The supply chain can achieve maximum profits under joint decision-making, and the decision-making model is:$\pi_{c0}^R = (p - c - d)q - BR$.The calculation shows that:$q_0^R = q_0^N = \frac{a-bc-bd}{2}$,$p_0^R = p_0^N = \frac{a+bc+bd}{2b}$,At this point, the profit of the supply chain is as follows (4-3).

$$\pi_{c0}^R = \frac{(a-bc-bd)^2}{4b} - BR \qquad (4\text{-}3)$$

When the sum of advance payment and self owned funds cannot meet the funding needs of joint decision-making but can meet the funding gap of D company's project，The decision-making model is based on the overall profit of the supply chain is $\pi_c^R = (p - c - d)\frac{B+f_m}{c} - BR$.There is a pricing per unit building area:$q^R = \frac{B+f_m}{c}$,Completion quantity:$p^R = \frac{ac-B-f_m}{bc}$,At this point, the profit of the supply chain is as shown in equation (4-4).

$$\pi_c^R = -\frac{1}{bc^2}(B + f_m)^2 + \frac{a-bc-bd}{bc}(B + f_m) - BR \qquad (4-4)$$

When the sum of advance payment and self owned funds cannot meet the independent decision-making funding needs, that is $B + f_m < cq^N$,To reduce capital costs and maximize benefits, the completion area can be determined as follows:$q_1^R = \frac{f_m+B}{c}$,At this point $p_1^R = \frac{ac-(f_m+B)}{bc}$.Referring to the decision-making model without

advance payment, the joint decision-making supply chain decision-making model can be obtained as follows: $\pi_{c1}^{R} = (p - c - d)$ q.At this point, the profit of the supply chain is expressed as equation (4-5).

$$\pi_{c1}^{R} = -\frac{1}{bc^2}(f_m + B)^2 + \frac{a - bd - bc}{bc}(f_m + B) - BR \qquad (4-5)$$

（5）Pricing Models for the Construction Supply Chain of X Residential Community under Different Financing Models

When F company's own funds f_s can meet D company's funding gap for the X residential community project, there is no financial constraint on the building supply chain based on the X residential community project, that is:$f_s + f_m \geq cq$,Due to the prepayment B being paid before the construction of the project, this amount is not considered as a commercial credit loan. Therefore, for the convenience of calculation, when $f_m + B = \theta$.

When independent decision-making is adopted, the decision model of Company F is Equation (4-6), and the decision model of Company D is Equation (4-7).

$$\pi_s^M = (p - w - d)q + (cq - \theta)(r_s - R) - BR \qquad (4-6)$$
$$\pi_m^M = wq - (cq - \theta)r_s - cq \qquad (4-7)$$

Pricing decisions can be obtained: $w^M = \frac{a+bc(2r_s-R+1)-bd}{2b}$, $q^M = \frac{a-bc(R+1)-bd}{4}$, The optimal completed area at this time is:$P^M = \frac{3a+bc(R+1)+bd}{4b}$.

The maximum profit of Company F can be obtained as Equation (4-8), and the maximum profit of Company D can be obtained as Equation (4-9). At this point, the maximum profit of the supply chain is obtained as Equation (4-10).

$$\pi_s^M = \frac{[a - bc(R + 1) - bd]^2}{16b} - \theta r_s + f_m R \qquad (4-8)$$
$$\pi_m^M = \frac{[a - bc(R + 1) - bd]^2}{8b} + \theta r_s \qquad (4-9)$$
$$\pi_c^M = \frac{3[a - bc(R + 1) - bd]^2}{16b} + f_m R \qquad (4-10)$$

When using joint decision-making, the supply chain profit function $\pi_{C0}^M = (p - c - d)q - (cq - f_m)R$,At this point, the optimal completion area for the supply chain is $q_0^M = \frac{a-bc(1+R)-db}{2}$, Pricing is $p_0^M = \frac{3a+bc(R+1)+bd}{2b}$,Maximizing profits in the supply chain is $\pi_{c0}^M = \frac{[a-bc(R+1-bd]^2}{4b} + f_m R$.

(6)Pricing model for external financing in the construction supply chain

When using independent decision-making, the decision-making model of Company F is:$\pi_s^B = (p - w - d)q - BR$, so $q^B = \frac{a-bw-bd}{2}$.The decision-making model of Company D is:$\pi_m^B = wq - (cq - \theta)r_b - cq$.

By optimizing the solution, the pricing decision can be obtained as follows: The optimal unit area quotation is$w^B = \frac{a+bc(r_b+1)-bd}{2b}$,The optimal unit area pricing is $P^B = \frac{3a+bc(r_b+1)bd}{4b}$,The optimal completed area is $q^B = \frac{a-bc(r_b+1)-bd}{4}$.

At this point, the maximum profit of Company F is shown in Equation (4-11), Company D is shown in Equation (4-12), and the overall maximum profit of the supply chain is shown in Equation (4-13).

$$\pi_s^B = \frac{[a - bc(r_b + 1) - bd]^2}{16b} - BR \qquad (4-11)$$
$$\pi_m^B = \frac{[a - bc(r_b + 1) - bd]^2}{8b} + \theta r_b \qquad (4-12)$$

$$\pi_c^B = \frac{3[a - bc(r_b + 1) - bd]^2}{16b} + \theta r_b - BR \qquad (4-13)$$

When using joint decision-making, the supply chain decision function is $\pi_{c0}^B = pq - dp - \theta - (cq - \theta)(1 + r_b) - BR$,At this point, the optimal completed area is $q_0^B = \frac{a - bc(1 + r_b) - bd}{2}$,The pricing per unit area is:$P_0^B = \frac{a + bc(r_b + 1) + bd}{4b}$,At this point, the maximum profit of the supply chain is expressed as equation (4-14).

$$\pi_{c0}^B = \frac{[a - bc(r_b + 1) - bd]^2}{4b} + \theta r_b = BR \qquad (4-14)$$

Whether independent or joint decision-making is adopted, the external financing interest rate of the supply chain has a direct impact on the profits of Company F and Company D. For Company D,When r_b increases Δr_b ($\Delta r_b > 0$), the profit change is: $\Delta \pi_m^B = \frac{[a - bc(r_b + \Delta r_b + 1 - bd]^2}{8b} + \theta(r_b + \Delta r_b) - (\frac{[a - bc(r_b + 1) - bd]^2}{8b} + \theta r_b$),After simplification, it can be obtained that $\Delta \pi_m^B = \Delta r_b[\theta - c\frac{a - bc(r_b + \Delta r_b + + 1) - bd}{8b}]$,There must be $cq^N > G$,Because our own funds f_m meet $\theta < cq^N$,Therefore, there may be $\theta \geq G$. Among them:$G = c\frac{a - bc(r_b + 0.5\Delta r_b + 1) - bd}{8}$.

By inputting specific numerical values for calculation, it can be concluded that $\theta \geq G$, based on the above analysis, an increase in external financing. interest rates in the supply chain will enable Company D to obtain more profits. For Company F, when the external financing interest rate of the supply chain increases Δr_b, the maximum profit of Company F will decrease, which indirectly indicates that Company D will transfer the increased capital cost to Company F by increasing its unit area quotation w.

5. CONCLUSION

This article takes the X residential community project as an example to study pricing and financing strategies, and proposes management insights and suggestions based on the actual situation. The main conclusions are as follows:

(1) Defined the connotation of the construction supply chain and established a model framework for the construction supply chain. This article compares and analyzes the ideas of supply chain and engineering management, and believes that the construction supply chain is a complex network formed by interactive relationships among various parties in the dynamic network environment of the entire life cycle of construction projects, such as cooperative games and interest coordination.[6]

(2) Based on the actual engineering situation, the parameters for constructing a supply chain model were characterized. Based on the characteristics and background of the X residential community project in this article, a corresponding building supply chain model was constructed, innovatively characterizing parameters such as product pricing, [7]cost, and product quantity in the building supply chain, and organizing actual engineering data as parameters for assignment.

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(3) Construct a supply chain decision-making model for X residential community engineering construction, and obtain decision recommendations: F company should provide advance payment and choose supply chain financing.[8] The supply chain of the X residential community project should adopt a joint decision-making internal financing model to achieve maximum efficiency.

(4) In the research process of this article, it was found that in the internal financing process of the supply chain, the interest rate of funds provided by one party to the other for financing services has no impact on the total revenue of the supply chain, but only serves as a tool for the distribution of interests between both parties in the supply chain. Further research has found that the relative advantages of financing both inside and outside the supply chain will vary with changes in the cost of capital utilization, self-owned funds, and so on.[9]

Although this article has achieved certain research results, there are still shortcomings. If various quantitative models in supply chain management can be applied according to local conditions, it will become a milestone for the maturity of the construction supply chain.

6. Acknowledgement

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Climate Change and the Prevalence of dengue fever
in South Regional of Thailand

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ABSTRACT

Climate change impacts the life cycle and spread of dengue fever vectors, with meteorological factors such as precipitation, temperature, and relative humidity significantly influencing human health. This study investigates how changes in these factors affect dengue fever incidence in southern Thailand, utilizing data on dengue incidence from 2013 to 2023 along with precipitation, relative humidity, and temperature records. Descriptive statistics and stepwise multiple regression were used for analysis. Results indicate that precipitation, relative humidity, and maximum temperature significantly affect dengue fever incidence ($p < 0.05$), with the model explaining 6.5% of the variance in dengue incidence, highlighting the significant relationship between these meteorological factors and dengue outbreaks.

The findings of this study support Sustainable Development Goal (SDG) 3, which aims to ensure healthy lives and promote well‑being for all at all ages. This is particularly relevant for developing strategies to address epidemics in the context of climate change in Thailand. The study underscores the importance of creating policies and public health strategies focused on proactive dengue fever prevention through monitoring meteorological factors and vector surveillance. Applying the predictive data from this study can help the Thai healthcare system respond effectively to outbreaks, reduce impacts on the population, and lessen the burden on the public health system in the future

KEYWORDS: dengue fever, climate change, vector-borne diseases, south regional of Thailand

1. Introduction

Climate change is currently discussed as a global problem that affects every country in terms of the environment, economy, society, and health. Without effective management measures, it will impact national development, posing a threat not only to the present but also to future generations. To address this situation, the international community and Thailand have ratified the Paris Agreement under the United Nations Framework Convention on Climate Change. This agreement aims to create shared responsibility for preserving the planet by limiting temperature increases and enhancing resilience to the impacts of climate change. Furthermore, urgent action has been called for to combat climate change and its effects, contributing to the achievement of the Sustainable Development Goals (SDGs), specifically Goal 3: Good Health and Well-being, and Goal 13: Climate Action (Basic Information on SDGs, 2015).

Climate change leads to alterations in ecosystems and environments, which directly and indirectly impact health, particularly for vulnerable groups such as young children, the elderly, and bedridden patients. Utilizing the climate change impact chain can highlight the risks and facilitate preparations to mitigate health impacts. The World Health Organization (WHO) has predicted that climate change will affect public health globally (Department of Health, 2016). Mosquito-borne diseases likely to spread more in the coming years include malaria, dengue fever, and chikungunya. Annually, over 100 million people contract dengue fever, resulting in approximately 10,000 deaths worldwide. In Southeast Asia, the incidence of dengue fever has increased by nearly 50%, rising from 451,000 cases in 2015 to 658,000 cases in 2019. By 2080, it is estimated that more than 2.25 million people worldwide may be at risk of dengue fever (The Health Aisle Team, 2020).

In Thailand, dengue fever statistics for 2022 reported 45,145 patients and 29 deaths. In 2023, the number of patients increased to 156,097, with 175 deaths. This represents a 3.4-fold increase in dengue fever cases from 2022 to 2023. The figures indicate a significant surge in both the number of cases and deaths in 2023. In January 2024, Dr. Thongchai Keeratihatthayakorn, Director-General of the Department of Disease Control, reported that there were 8,197 dengue fever patients, 1.9 times more than in January 2023 (4,286 patients), and the trend is continuing to rise. The highest number of patients was observed in the 5-14 years age group, predominantly in the Southern and Central regions. There were 13 confirmed deaths across 11 provinces, with the highest number of deaths occurring in individuals over 65 years old (Prachachat Business, 2024).

Mosquitoes thrive in hot weather, and global warming has expanded their habitats beyond their usual areas. The Asian Aedes albopictus mosquito, a known carrier of dengue fever, and Chikungunya has been detected in Eastern countries where it was previously unknown. Warmer temperatures accelerate mosquito maturation and growth. Adult mosquitoes can harbor pathogens and act as disease carriers. Additionally, higher temperatures enhance mosquitoes' ability to acquire and transmit diseases more quickly.

Therefore, this research aims to study the relationship between climate change and the incidence of dengue fever over time in 14 provinces in the southern region of Thailand. These provinces are characterized by frequent dengue fever outbreaks and an increasing trend in the incidence due to various factors such as urban expansion, land use changes, and population movement, which affect disease spread. Additionally, the region's

hot and humid climate with heavy rainfall almost year‑round contributes to the disease's prevalence. The results of this research are expected to enhance understanding of the impact of climate change on dengue fever incidence in this region. This information will be valuable for predicting the increasing number of dengue fever cases in each area and for supporting the planning of preventive measures and health surveillance to manage future outbreaks effectively.

2. Objective

(1) To analyze the trend of dengue fever incidence rates from 2013 to 2023.

(2) To examine the impact of meteorological factors on the incidence rate of dengue fever

3. Method

3.1 Research design

This study utilized secondary data from meteorological sources and dengue fever incidence records for Southern Thailand. All 14 southern provinces were selected as study areas due to their history of dengue fever outbreaks.

3.2 Research population and sample

Population: Precipitation data, relative humidity, and minimum and maximum temperatures from 2013 to 2023, obtained from the Meteorological Department, along with dengue fever patient data from 2013 to 2023, sourced from the Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health of Thailand.

Sample: Precipitation data, relative humidity, and minimum and maximum temperatures from 2013 to 2023, obtained from the Meteorological Department, along with dengue fever patient data from 2013 to 2023, sourced from the Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health for the 14 southern provinces of Thailand.

3.3 Data collection

1) Secondary data on the number of dengue fever cases and incidence rates for all 14 southern provinces, obtained from the Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, during 2013-2023. This data was collected from provincial public health agencies. Dengue fever cases related to climate change were selected for this study by referring to various relevant articles and research

2) Monthly climate data for all 14 southern provinces during 2013‑2023, sourced from the Meteorological Department. The climatic factors analyzed in this study include precipitation, relative humidity, and minimum and maximum temperatures.

3.4 Statistical Analysis

Data processing involved descriptive analysis, including the calculation of mean, variance, and minimum and maximum values. This was followed by an analysis of the relationship between meteorological factors precipitation, average relative humidity, average minimum temperature, and average maximum temperature and the incidence of dengue fever. Precipitation was measured in millilitres (ml), temperature in

degrees Celsius (°C), and relative humidity in percentage (%). To examine the impact of climate change factors on dengue fever incidence, Stepwise Multiple Linear Regression Analysis was employed.

4. Conclusion

The incidence rate of dengue fever in the 14 southern provinces shows an upward trend overall. In 2013, there were 24,787 reported cases. By 2015, the number of cases decreased to 11,744. However, in 2016, the incidence rate rose again to 17,631 cases. In 2021, the rate dropped significantly to 968 cases, but by 2023, it had increased sharply to 26,324 cases, as illustrated in Figure 1.
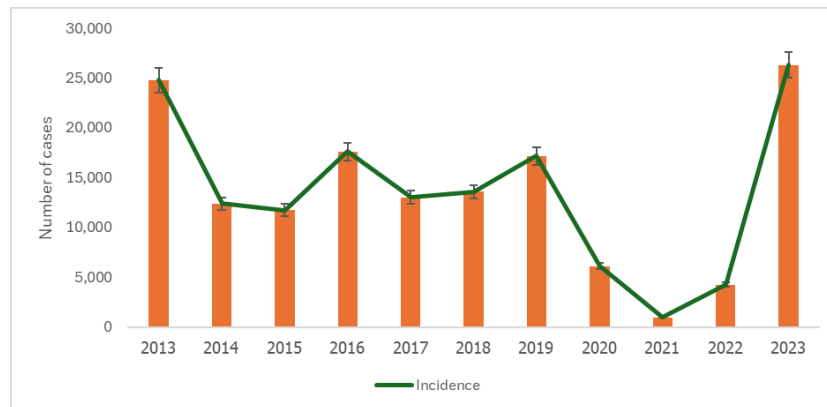
Figure 1 Trends of dengue fever (DF) case and incidence in in South Regional of Thailand during 2013-2023

The highest average temperature in the southern region occurred in 2016, reaching 33.07 °C, while the lowest average temperature was 23.58 °C. The highest average humidity was recorded at 82.80% in 2017, and 80.54% in 2020. The highest average precipitation was 439.45 mm in 2020, whereas the lowest was 280.30 mm in 2019. The highest incidence of dengue fever was observed in 2023, with 26,324 cases, while the lowest was in 2021, with 968 cases, as illustrated in Figure 2.
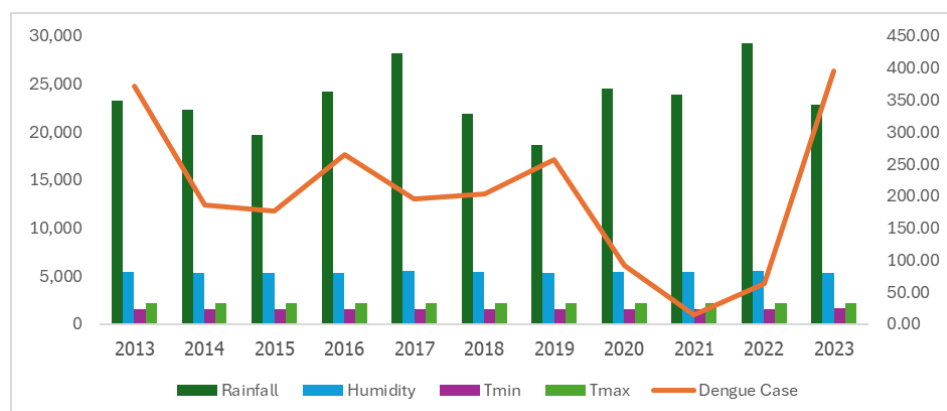
Figure 2 Precipitation, Humidity, Minimum Temperature, Maximum Temperature
and Incidence of DF in 2013-2023

The average precipitation in the southern region is 280.30 mm, with a standard deviation (SD) of 47.33 mm. The minimum recorded precipitation is 280.30 mm, and the maximum is 439.45 mm. The average relative humidity is 81.24%, with an SD of 0.84%. The minimum humidity is 80.31%, and the maximum is 82.80%. The average minimum and maximum temperatures between 2013 and 2023 are 23.93 °C and 32.64 °C, with standard deviations of 0.23 °C and 0.29 °C, respectively. The average incidence of dengue fever is 13,445 cases, with an SD of 7,905.40 cases. The minimum incidence is 968 cases, while the maximum is 26,324 cases, as presented in Table 1

Table 1 Mean, Standard Deviation, and Minimum-Maximum Values of Temperature, Humidity, Precipitation, and Dengue Fever Incidence in the Southern Region of Thailand (2013-2023)

Variable	Mean	SD	Min	Max
Rainfall (mm)	280.30	47.33	280.30	439.45
Humidity (%)	81.24	0.84	80.31	82.80
Minimum Temperature (°C)	23.93	0.23	23.58	24.40
Maximum Temperature (°C)	32.64	0.29	32.22	33.07
Incidence of DHF (Cases)	13,445.00	7905.40	968.00	26,324.00

The study revealed that dengue fever incidence is statistically significant at the 0.05 level (p-value = 0.000 < 0.05). Three independent variables were identified as significant predictors of the incidence rate of dengue fever, as detailed in Table 3

It was found that dengue fever incidence is significantly associated with three independent variables at the 0.05 level, the average precipitation ($b1$ = .084, t= 9.033, p-value=0.00) average relative humidity (b_2 = 1.954, t= 2.424, p-value=0.015) and average maximum temperature (b_3 = 14.083, t= 5.863, p-value=0.00). These variables are significant predictors of the incidence rate of dengue fever. Therefore, the regression equation for predicting the incidence rate of dengue fever is presented in Table 2.

Table 2: Coefficients of Determination for the Dengue Fever Model in the 14 Southern Provinces of Thailand

R	R square	Adjusted R square	Std. Error of the Estimate	Durbin-Watson
0.255	0.065	0.063	119.33491	0.295

Dependent Variable: Dengue Fever Incidence Rate

Independent Variables: average precipitation, average relative humidity, average maximum temperature

Table 3 analysis of variance (ANOVA) for Dengue Fever Incidence

Predictors	Sum of squares	df	Mean Square	F	Sig.
Regression	1822506.971	3	607502.324	42.659	.000
Residual	26260072.39	1844	14240.820		
Total	28082579.363	1847			

Dengue fever incidence rate = -568.175 +(.084) average precipitation + (1.954) average relative humidity + (14.083) average maximum temperature

For each additional millimeter of average precipitation, the incidence of dengue fever in the southern population tends to increase by 0.84 cases.

For each additional percent of average relative humidity, the incidence rate of dengue fever in the southern population tends to increase by 1.954 cases.

For each additional degree Celsius of average maximum temperature, the incidence rate of dengue fever in the southern population tends to increase by 14.083 cases.

When other variables in the equation are fixed and the standardized coefficients in Table 4 are considered, it was found that the independent variables, average rainfall (Beta =.251) and average maximum temperature (Beta =.171), had a greater effect on the incidence rate of dengue fever than average relative humidity (Beta =.077). The equation had an R^2 value of 0.065 as shown in Table 2. The regression equation with variables, average rainfall, relative humidity, and average maximum temperature, can explain the variation in the incidence rate of dengue fever in southern Thailand by 6.5 percent. This analysis indicates that rainfall and maximum temperature are more influential than relative humidity in the spread of dengue fever in southern Thailand. However, the low R² value suggests that these factors account for only a small portion of the variance, and other variables not included in the model likely play a significant role. These may include socioeconomic factors such as population density, living conditions, and access to healthcare services.

5. Discussion

In 2023, the incidence of dengue fever in southern Thailand reached 26,324 cases, marking the highest number in the past decade. Dengue fever incidence is influenced by several factors, including climate change. Rising global temperatures are believed to be associated with increased dengue fever cases transmitted by the Aedes mosquito (Pornpan Soncheu, 2017). Rainfall is also a significant factor contributing to the rise in dengue cases (Uma Langkulsen, 2023). Additionally, increased humidity can prolong the lifespan of adult mosquitoes, facilitating the spread of dengue fever. This study, examining climate change from 2013 to 2023, found that maximum temperature was the most effective predictor of increased dengue fever rates. The optimal temperature range for Aedes mosquito breeding is between 20.0 °C and 35.0 °C. Aedes mosquitoes breed and transmit the dengue virus primarily within this temperature range (Agung Sutriyawan, 2023). In this study, temperatures ranged from a minimum of 20.0 °C to a maximum of 35.0 °C. Increased temperatures enhance mosquito energy

metabolism, egg production, and blood‑feeding frequency, which can lead to severe outbreaks of dengue fever following periods of heavy rain or high temperatures (B.S.S. Wibawa et al.,2024). Furthermore, high temperatures can expand the range of vector species, accelerate mosquito growth and life cycles, and improve their survival rates (Jetten TH, 1994). Higher temperatures not only increase the number of vectors but can also cause new diseases to emerge and spread to previously unaffected areas, as high temperatures are conducive to the breeding and growth of both pathogens and vectors.

The weather becomes hotter, winters shorter, and rainfall more intense, the frequency of Aedes mosquito's increases. After 5‑7 days of rain, the population of Aedes mosquitoes tends to rise, and higher temperatures further increase the frequency of mosquito bites (Supaporn Chuenmuang, 2019). Weather factors such as temperature, rainfall, and humidity significantly influence the number and distribution of insect vectors. Rainfall is a crucial factor affecting the mosquito life cycle, as mosquitoes require standing water for breeding. Consequently, during the rainy season or in areas with heavy rainfall, mosquito populations surge. This increase in mosquito numbers contributes to a higher incidence of infectious diseases transmitted by mosquitoes during the rainy season compared to other times of the year.

Public health plays a crucial role in sustainable development, particularly in managing infectious disease outbreaks that are closely linked to climate change. Recent studies indicate that climate change can elevate the risk of dengue outbreaks, as environmental changes such as rising temperatures and altered rainfall patterns can increase the population of mosquitoes that transmit the disease (A.M. George, R. Ansumana, D.K. de Souza et al., 2024). Consequently, developing preventive measures and educating the public are vital for addressing these impacts. Collaboration between SDG 3 (3.d. Strengthen the capacity of all countries, especially developing countries, on early warning, risk reduction, and management of health risks at both national and global levels) and SDG 13 (13.2. Integrate climate change measures into national policies, strategies, and planning) is essential for sustainable development. This collaboration helps build health systems capable of effectively responding to and mitigating the impacts of climate change.

6. Suggestion

Suggestion to Government Agencies

1. Promote Public Education and Vaccination: During the rainy season, characterized by high humidity and increased temperatures both of which are linked to dengue fever outbreaks the government should enhance public awareness on protective measures against dengue fever. Additionally, providing free dengue vaccinations to at‑risk populations will help reduce the disease's spread.

2. Develop and Implement Policy Models: Government agencies should research and develop appropriate policy models that address the challenges posed by climate change, particularly in the southern region. Adjusting disease prevention and control timelines to account for climatic variations will improve the effectiveness of dengue prevention efforts. Comprehensive operational strategies should be promoted to ensure effective responses to climate change.

3. Support Research and Capacity Building: Support public health institutions and academic units in gaining a deeper understanding of how climate change affects dengue fever outbreaks. This knowledge will enable better planning and preparedness for outbreaks. Strengthening community adaptive capacity is crucial for mitigating dengue fever's impact, through the development of measures and strategies that address health challenges related to climate change.

Suggestions for Future Research:

1. Investigate Additional Climatic Variables: Future research should explore other climatic factors that may influence dengue incidence, such as wind speed, sunlight exposure, and the number of rainy days. Understanding the relationships between these variables and disease incidence will aid in developing more effective prevention strategies.

2. Assess Health and Environmental Risks: Research should focus on evaluating the health and environmental risks associated with dengue fever within the context of climate change. This will provide insights into the factors influencing outbreaks in a changing environment and help in developing and refining prevention strategies to address these evolving conditions.

3. Investigate the Role of Vector Control Measures: Further research should examine the effectiveness of various vector control interventions, such as insecticide‑treated bed nets, larvicides, and community‑based mosquito control programs, in reducing dengue incidence in southern Thailand. This research should consider the influence of climatic factors on the efficacy of these interventions and explore integrated vector management strategies that adapt to changing environmental conditions.

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Evaluation of Civil Construction Project Cost Based on Entropy Weight-Cloud Model: A Case Study of a Health Tourism Center Project in China

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ABSTRACT

This paper proposes a novel cost evaluation model for civil construction projects based on the entropy weight-cloud model. A comprehensive indicator system encompassing 21 indices across four key aspects – installation, construction, decoration, and other expenses – is established for evaluating civil construction costs. The feasibility and unique advantages of this model are demonstrated through a case study of a real-world health tourism center project. This research provides valuable insights and a practical framework for cost control evaluation in similar construction projects.

KEYWORDS: Civil construction projects, Construction cost evaluation, Entropy weight method, Cloud model

1. Introduction

Construction project cost estimation is not only a crucial basis for project decision-making but also an effective tool for establishing investment plans and controlling expenditures. Moreover, it serves as a key indicator for evaluating investment returns. In essence, cost control ensures the rational utilization of project funds and maximizes investment benefits. This process permeates the entire lifecycle of a construction project and receives significant attention from both investors and contractors. Over the years, scholars have conducted extensive research on construction cost management strategies and influencing factors throughout the project lifecycle, yielding substantial advancements in the field. However, the increasing complexity and diversity of modern construction industries have rendered traditional qualitative analyses of cost influences and control inadequate for meeting contemporary project management demands. Therefore, it is imperative to strengthen quantitative evaluations of construction cost management and control based on robust mathematical principles.

2. Research Objective

(1) To construct a coupled evaluation model of entropy weight and normal cloud, and carry out the comprehensive transformation, processing and calculation of qualitative and quantitative data by considering the technical-economic-environmental impact characteristics of the evaluation object.

(2) Taking the construction project of a health tourism center in China as an example, to make a comprehensive evaluation and comparative analysis of the project construction schemes and standardized construction schemes in the bidding stage, and further verifies the effectiveness of the comprehensive evaluation model and evaluation method established in this research.

3. Literature Review

3.1 Concept and Research Progress

3.1.1 Concept and Characteristics of Construction Projects

Within the scope of engineering projects, a construction project refers to an endeavor that requires a certain amount of investment, involving a series of activities from planning, design, to construction, under specific resource constraints, aimed at creating fixed assets in the form of construction. From the perspective of engineering cost and control, this can be understood as a process aimed at constructing that meets quality, functionality, and schedule requirements at the most economical cost. It focuses not only on the final fixed assets but also emphasizes effective planning, control, and management of costs throughout the project's entire lifecycle to maximize investment returns. Here are its notable characteristics:

(1) Complex Cost Composition: The cost structure of housing construction projects is complex, encompassing various specialties and sub-projects such as civil engineering, installation works, and finishing works. This necessitates detailed cost estimation and control for each segment.

(2) Large Investment Scale: Typically, housing construction projects involve substantial investment with a long capital commitment period, placing high demands on fundraising and the efficiency of capital use. Accurate investment estimates and effective cost control are crucial for project success.

(3) Multiple Influencing Factors: The cost of housing construction is influenced by numerous factors including design solutions, fluctuations in material prices, construction techniques, and changes in policies and regulations. The uncertainty of these factors complicates cost control.

(4) High Difficulty in Control: Due to the long duration, involvement of multiple parties, and the complexity of the construction environment, controlling costs in housing projects presents significant challenges. It requires a comprehensive cost management system and the application of scientific cost control methods.

(5) Strong Controllability: Despite numerous influencing factors, the cost of housing construction projects remains highly controllable. Through scientific forecasting, reasonable planning, and effective control measures, it is possible to manage engineering costs effectively, thereby maximizing the return on investment for the project.

3.1.2 Concept and Composition of Project Cost

In October 1996, the Academic Committee of the China Construction Engineering Management Association published an article titled "Opinions on Defining the Concept of Engineering Cost," where they analyzed the concept of engineering cost from two perspectives:

Engineering Cost as the Sum of Project Construction Costs: Here, construction costs include all related expenses such as civil engineering, installation, equipment, personnel, etc. This perspective views engineering cost as the total investment required to bring a project to completion.

Engineering Cost as the Contract Price for Construction Projects: This refers to the price agreed upon between the client and the contractor for undertaking the construction project. It's essentially the contract price for the engineering work.

This document provided a definitive clarification of what engineering cost encompasses, offering significant guidance for theoretical research related to engineering costs. From the viewpoint of investors, owners, or the project entity, engineering cost is referred to as construction cost or project investment. Here, the aim is for investors or owners to achieve higher economic benefits by ensuring project quality and meeting construction requirements at the lowest possible cost. From the contractor's side, engineering cost is termed as the project price, which is the contracted price for which the construction work is undertaken by the contractor.

The main components of engineering cost are construction investment and interest during the construction period. Construction investment includes three parts: engineering fees, other construction costs, and contingency fees. Effective construction project cost control is essential for optimizing project outcomes. By actively managing costs throughout the project lifecycle, using a variety of methods, it ensures projects are completed within budget, resources are used efficiently, and economic benefits are maximized. This vital element of project management directly contributes to higher investment returns, smoother project execution, improved construction quality, a culture of ethical conduct, and a stronger competitive position for construction companies.

3.1.3 Research Progress of construction project cost control

With the advancement of management theories and methods, project cost management has integrated insights from various fields, leading to significant research progress globally. To address cost overruns in residential projects, Khodeir et al. (2019) proposed the Value Management (VM) method, achieving 15-40% savings in total project costs in Egypt. This demonstrates the effectiveness of VM in controlling construction costs. Rosenfeld (2014) identified the top three causes of project cost overruns as hasty bidding document decisions, frequent changes in owner requirements, and low-price bidding. Through a survey of 200 local construction practitioners, these factors were ranked based on their impact. Akintoye (2000) conducted a comparative study of 84 UK contractors, examining factors influencing cost estimation practices. The study found that project complexity, scale, market conditions, construction methods, site constraints, client finances, project feasibility, and location significantly affect cost estimation.

In China, research on construction cost control has evolved from qualitative analyses to quantitative methods. Zhang Shengquan (2020) integrated modern information technology into cost estimation and management for prefabricated buildings, using a BP neural network model to improve cost prediction accuracy and stability. This model proved more suitable for prefabricated buildings, aiding early cost control. Yuan Zheng (2023) identified key cost-influencing factors through literature analysis and the Delphi method, establishing a cost estimation indicator system. By applying a BP neural network model, the study established a

functional relationship between cost-influencing factors and single-item costs, improving cost estimation accuracy and project cost management. This model reduces analysis and scheme adjustment times, ensuring better project cost control and profit realization.

In recent years, many scholars have gradually realized that, considering the diversity and complexity of the factors affecting engineering costs, qualitative research alone cannot meet the needs of project management. Therefore, it is imperative to strengthen research that combines both qualitative and quantitative analysis of factors influencing project costs.

3.2 Research Framework

The framework of this research paper is shown in Figure 1.
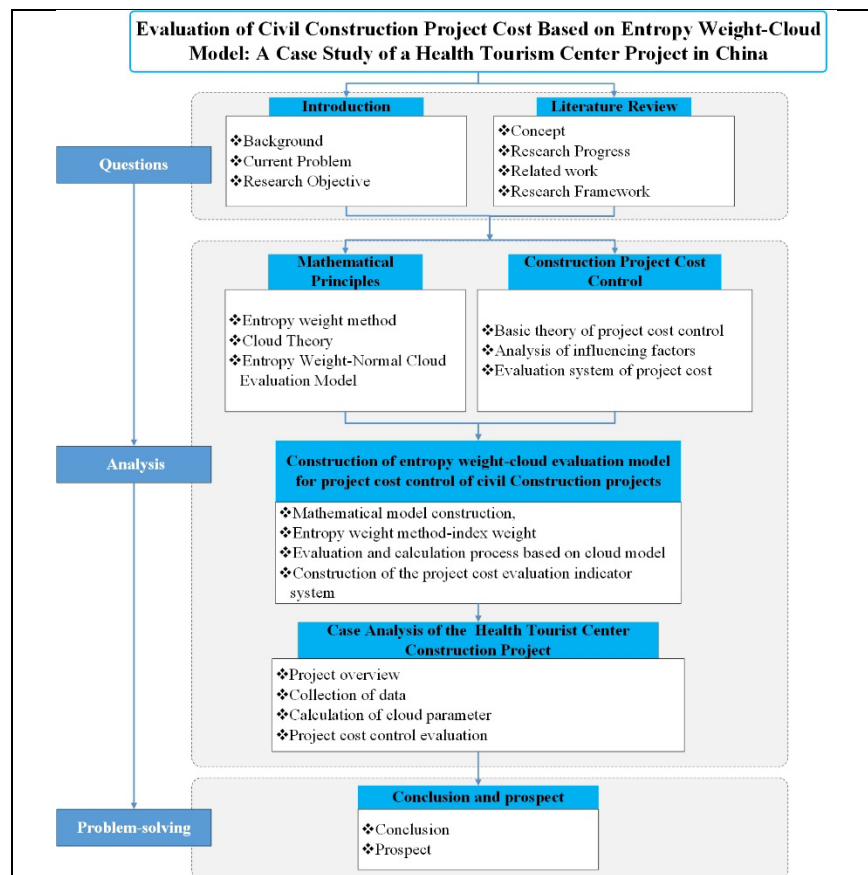
Figure 1 Research Framework

4. Research Methodology

4.1 Entropy Weight Method

The entropy weight method determines objective weights based on the degree of variation among indicators. It leverages information entropy (Zhang Sui, et.al., 2010) to calculate weights for all hierarchical indicators, providing foundational data for multi-indicator comprehensive evaluation systems. The process begins by constructing a standardized matrix of size m x n, where m represents the number of evaluation objects and n represents the number of evaluation indicators. Subsequently, the score of each evaluation indicator is weighted

using the following mathematical formula to obtain its corresponding weight. Finally, the final membership degree is determined by multiplying each indicator's score by its weight, ultimately establishing the final ranking for each evaluated object.

$$p_{ij} = \frac{v_{ij}}{\sum\limits_{i=1}^{m} v_{ij}} (i = 1, 2, \cdots, \mathrm{n}; j = 1, 2, \cdots, \mathrm{m})$$

$$e_j = -\frac{1}{\ln(m)} \sum\limits_{i=1}^{m} p_{ij} \ln(p_{ij})$$

$$d_j = 1 - e_j$$

$$\omega_j = \frac{d_j}{\sum\limits_{k=1}^{n} d_k} (j = 1, 2, \cdots, \mathrm{n})$$

In the formula, e_j, d_j, and ω_j represent the entropy value, differentiation coefficient, and entropy weight value of evaluation indicator j, respectively.

4.2 Cloud Model Theory

The cloud model is a powerful mathematical tool for analyzing uncertainty by transforming qualitative concepts into quantitative ones. It employs three mathematical indices-expected value (E_x), entropy (E_n), and hyper-entropy (H_e)-derived from the transformed quantitative values to represent qualitative concepts, enabling a straightforward and direct conversion between qualitative and quantitative representations.

The primary computational steps of the cloud model are illustrated in Figure 2 and outlined below:
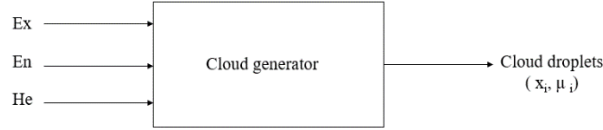
Figure 2 Schematic diagram of forward cloud generator

- Generate a normal random number with E_n as the expected value and He as the variance E'_n.

- Generate a normal random number X with expectation E_x and variance E'_n.

- Calculate the membership degree u of the cloud droplet.

$$u = \left[\frac{(x - E_x)^2}{2(E'_n)^2} \right]$$

- The generated (x, u) is a cloud droplet in the universe of discourse.

- The above steps are repeated until the generation of n cloud droplets stops.

In cloud model, the membership degree is a function value corresponding to a given x, ranging from 0 to 1. By analyzing each evaluation indicator, the membership degree associated with the measured indicator can be determined. This membership degree is then used, in conjunction with a comprehensive certainty degree, to assess the final indicator ranking.

The comprehensive certainty degree is calculated by multiplying each evaluation indicator by its corresponding entropy weight. The formula for this calculation is as follows:

$$S_i = \sum\limits_{j=1}^{m} \omega_j \times p_{ij}$$

In the formula, S_i represents the final certainty degree.

4.3 Construction of the Entropy Weight-Cloud Comprehensive Evaluation Model

Based on the following formula, the digital characteristics of the cloud model corresponding to different evaluation grades are obtained, resulting in a grade evaluation cloud chart. The calculation formula for cloud model digital characteristics is as follows:

$$Ex = \frac{x^{max} + x^{min}}{2}$$
$$En = \frac{x^{max} - x^{min}}{2.355}$$
$$He = kEn$$

In the formula, x^{max}, x^{min} respectively represent the maximum and minimum values of the variable; k is a constant, which is empirically set to 0.1 in the paper.

4.4 Construction of the Project Cost Evaluation Indicator System and Grading

Based on standards such as "Unified Standard for Acceptance of Construction Quality of Building Projects" and "General Specifications for Civil Building Design", the health tourism center project falls under Category I civil construction projects. These projects have the highest requirements for safety and hygiene, relatively low fire hazards, and significant potential impact in case of accidents. Consequently, they are subject to the strictest standards and requirements in design, construction, and operation to ensure a safe and healthy environment during use.

The construction characteristics of the health tourism center project encompass:

- Construction Engineering: Civil engineering, piling and foundation engineering, masonry engineering, concrete and reinforced concrete engineering, metal structure engineering, etc.

- Installation Engineering: Electrical engineering, water supply and drainage engineering, fire protection engineering, building intelligence engineering, ventilation and air conditioning engineering.

- Decoration Engineering: Roofing waterproofing engineering, anti-corrosion, thermal insulation engineering, floor and ground engineering, wall and column surface engineering, ceiling engineering, paint, wallpaper, and door and window engineering.

Based on literature review, this paper adopts the analogy index estimation method. By comparing cost indices with similar domestic cultural tourism projects and incorporating project characteristics and local regulations (such as "Basis for Cost Estimation of Construction Projects," "Comprehensive Quota for Engineering Budget," "Quota for Construction Project Budget," "Quota for Installation Project Budget," "Quota for Decoration and Decoration Project Budget," etc.), a comprehensive cost evaluation index system was established. This system comprises four primary indicators and 21 secondary indicators, classified into four grades: Grade I (Excellent), Grade II (Good), Grade III (Fair), and Grade IV (Passable). This multi-level grading system enables comprehensive analysis, as illustrated in Figure 3.

5. Case Study Findings

This study utilizes a real-world case study of a health tourism center construction project located in the Dongfengyun International Health and Wellness Tourism Resort in Mile City, Yunnan Province, China. The building is designed with six distinct zones: health dining, sports and wellness, traditional Chinese medicine therapy, service showcase, cultural center, and ecological center. It features a reinforced concrete frame structure and encompasses various sub-projects, including electrical, fire protection, gas, water supply and drainage, ventilation and air conditioning, and intelligent building systems.

Leveraging the project data, this paper employs the entropy weight-cloud model to conduct a comprehensive indicator evaluation of the construction cost control for four competing construction companies' proposals (named M1, M2, M3 and M4). Based on the cloud parameter calculations for 21 secondary indicators under four primary indicators, a forward cloud generator is used to randomly generate 2000 cloud droplets for cloud chart visualization. The collected actual measured values (i.e., unit area cost) for the 21 evaluation indicators are summarized in Table 1. Figure 4 illustrates typical cloud charts of the most influential secondary indicators within each primary indicator.

Grading	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
GradeI	66-71	55-57	35-39.5	23-24	375-385	130-137	80-82.5	25-31	205-215	50-55	2-2.4
GradeII	71-73	57-57.8	39.5-42	24-24.6	385-390	137-138	82.5-83	31-34	215-222	55-60	2.4-2.7
GradeIII	73-75	57.8-60	42-44	24.6-	390-398	138-139	83-84	34-36	222-230	60-62	2.7-29
Grade IV	75-80	60-65	44-47	25.5-	398-412	139-147	84-90	36-40	230-246	62-66	2.9-3.3

Grading	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21
GradeI	39.5-41	135-141	505-512	75-81	1.5-1.9	270-277	210-220	26-28	12-13	45-48
GradeII	41-42.5	141-143	512-516	81-82.5	1.9-2.5	277-282	220-233	28-29	13-14	48-49
GradeIII	42.5-44	143-146	516-518	82.5-84	2.5-2.9	282-290	233-235	29-30	14-14.5	49-49.2
Grade IV	44-49	146-152	518-524	84-94	2.9-3.4	290-320	235-250	30-34	14.5-18	49.2-

Figure 3 Schematic diagram of the construction and ranking of the project cost evaluation indicator system.

Table 1 The collected actual measured values for the 21 evaluation indicators

Project Proposal	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
M1	72.1	56.5	43.9	25.0	397.0	136.6	83.4	35.9	242.1	58.0	2.6
M2	75.7	59.3	44.3	25.5	388.5	138.6	84.2	36.3	230.1	58.2	3.2
M3	73.3	57.4	40.8	24.0	400.0	140.6	82.9	33.4	220.0	60.2	3.0
M4	70.8	56.6	39.2	24.1	396.5	137.2	82.2	32.0	234.9	56.6	3.1
Project Proposal	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	-
M1	43.1	142.5	510.0	81.3	2.1	285.7	219.3	29.1	13.8	49.2	-
M2	44.8	145.7	514.8	83.6	3.0	276.4	233.7	29.8	14.4	47.6	-
M3	42.2	147.7	515.3	85.9	2.4	296.7	236.4	31.6	15.0	49.3	-
M4	43.9	145.5	519.3	84.7	2.9	289.3	232.5	30.7	15.0	49.1	-

(a) Cloud of index D3

(b) Cloud of index D8

(c) Cloud of index D11

(d) Cloud of index D18
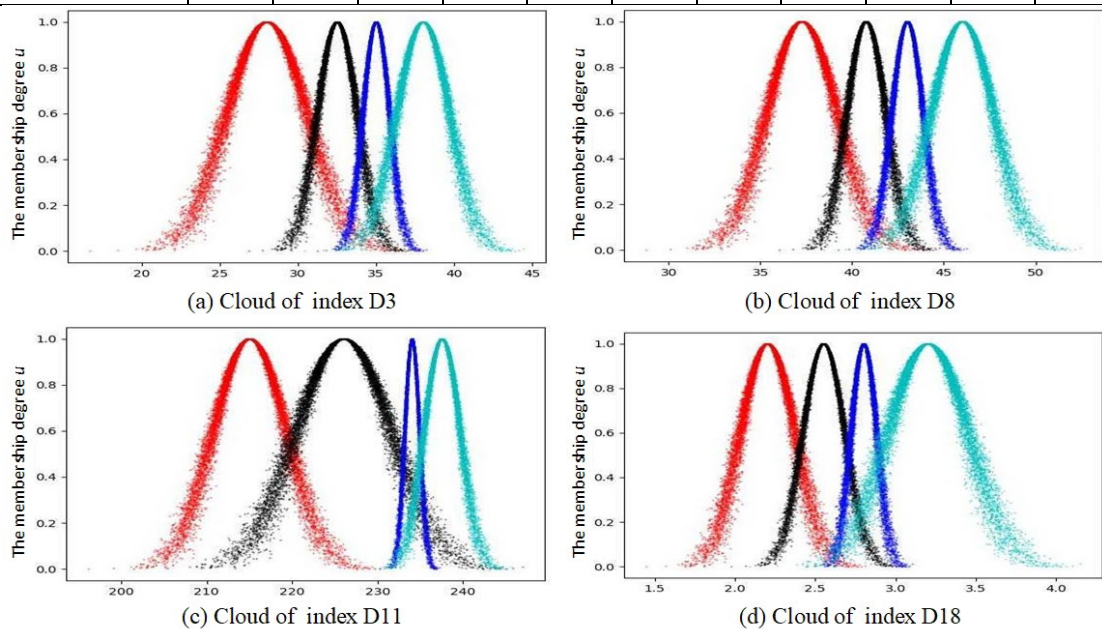
Figure 4 Typical secondary indicator cloud charts for health tourism center construction project cost evaluation based on entropy weight-cloud model.

In the four evaluation indicator cloud charts above, the horizontal axis represents the quantification range of the indicator, while the vertical axis represents the membership degree of the cloud droplets. In the charts, red represents Grade I clouds, black represents Grade II clouds, blue represents Grade III clouds, and cyan represents Grade IV clouds. The grade improves as you move from right to left along the x-axis. A thicker cloud layer and wider tail wing indicate a greater degree of numerical dispersion.

To determine the comprehensive evaluation ranking of each construction proposal, the dimensionless values are located on the corresponding indicator cloud charts to find the certainty degree. This certainty degree is then multiplied by the entropy weight of the evaluation indicator to obtain the final certainty degree, as shown in Table 2.

Table 2 Evaluation Ranking of Construction Proposals

Project Proposal	Grade I	Grade II	Grade III	Grade IV	Evaluation Ranking
M1	0.2225	0.3351	0.4819	0.3425	Grade III
M2	0.1210	0.1799	0.4075	0.4524	Grade IV
M3	0.1210	0.4183	0.2136	0.4956	Grade IV
M4	0.1038	0.1744	0.2116	0.2676	Grade IV

Based on the maximum certainty principle and the results presented in Table 2, Construction Proposal M1 is classified as Grade III (Fair), while Proposals M2, M3, and M4 are classified as Grade IV (Passable). Further analysis reveals that although Proposal M2 achieves a final certainty degree of 0.4075 in Grade III, Proposal M3 exhibits a higher final certainty degree of 0.4183 in Grade II. This indicates that Proposal M3 outperforms Proposal M2 in terms of overall evaluation. Therefore, the final ranking of the four construction proposals is approximately: M1 > M3 > M2 $\approx$ M4.

6. Conclusion

This paper establishes a comprehensive cost evaluation index system for civil construction projects, encompassing 21 indicators, and utilizes the entropy weight-cloud model to evaluate the construction costs of a health tourism center project. The key conclusion are as follows:

(1) From a technical and economic perspective, a practical cost evaluation index system tailored to the needs of civil construction projects is established. The entropy weight-cloud model is constructed, enabling the integration, processing, and calculation of both qualitative and quantitative data.

(2) Using the health tourism center project as a case study, the feasibility and advantages of applying entropy weight-cloud model-based cost control evaluation and analysis in civil construction cost control are demonstrated. Based on this model, Proposal M1 is classified as a Grade III solution, making it a suitable option.

(3) The entropy weight-cloud model effectively transforms qualitative analysis of construction costs into quantitative evaluations. This approach yields objective and transparent evaluation results, with a replicable process. The findings offer valuable insights and guidance for cost control in similar construction projects.

7. Suggestion

(1) Enhance the Evaluation Index System: It is recommended to incorporate environmental impact evaluation indicators into the existing index system to achieve a comprehensive evaluation encompassing technical, economic, and environmental dimensions. This not only enhances the comprehensiveness and scientific rigor of the evaluation but also promotes sustainable development in construction projects.

(2) Expand Model Application Scope: While this study focuses on a health tourism project as a case study, the potential applications of the entropy weight-cloud model extend far beyond this specific domain. Further exploration of its application in cost control for other types of civil construction projects, such as

residential buildings, commercial complexes, and public facilities, is recommended. This will validate its effectiveness and practical value across a wider range of applications.

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Construction Supply Chain Risk Management: A Case Study of Supplier Selection Based on Risk Factors

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ABSTRACT

Supply chain management is not just about delivering goods but also considers the disruption of any uncertainty. Accordingly, supply chain management must proceed with risk analysis and evaluation to pursue a risk mitigation strategy. This article uses a multiple-attribute decision-making technique named the grey relational analysis. Three critical risk factors and fourteen sub-risk factors in construction supply chain management were retrieved from the literature and validated by fifteen experts from the sample construction company in Kunming. Then, five decision-makers from a sample construction project participated as a group of decision-makers to assess five steel material suppliers. The result showed that a regional supplier B2 outperforms other competitors based on time, cost, and quality critical risk factors. The GRA procedure showed that it is a simple technique that can be used in practice. The study also recommended cautiously considering two predetermined parameters.

KEYWORDS: Supply chain risk, Multiple-attribute Decision-making, Grey relational analysis, Construction industry

1. Introduction

Both practitioners and scholars note that construction projects are more susceptible to risks than other industries due to their inherent complexities. The identified risks can lead to decreased performance, higher expenses, delays in scheduling, and ultimately, failure of the project (Shishehgarkhaneh and others, 2024). Inadequate supply chain management (SCM) is a possible cause of the cost overruns and delays associated with the construction sector. While supply chain management is primarily associated with the manufacturing business, organizations in the construction industry can also get advantages by implementing similar best practices in certain operations. However, the construction business must still fully develop its supply chain management. Although the construction industry has significant potential, the use of supply chain risk management (SCRM) principles, a sub-field of supply chain management, needs to be thoroughly investigated.

In recent decades, a multitude of natural and anthropogenic catastrophes, including earthquakes, economic crises, war, terrorist attacks, and sanctions, have caused significant disruptions to supply chain activities. These disruptions are not isolated incidents but a growing trend. Algahtany and other (2016) discovered

substantial data indicating that the occurrence of anthropogenic disasters causing disruptions has been increasing significantly since the 20th century. The frequency and intensity of these disturbances have been reported to be on the rise. This trend underscores the inevitability of supply chain disruptions, making it clear that all supply chains are intrinsically dangerous. This highlights the urgent need for proficiently handling risks in construction supply chains for the successful completion of building projects.

Over the past few decades, a substantial amount of knowledge has been accumulated regarding the field of SCRM. The studies in this text cover three main tasks of Supply Chain Risk Management (SCRM): risk identification, risk assessment, and risk mitigation. The authors cited in the text have researched these tasks and contributed to the understanding of SCRM. Both quantitative and qualitative methodologies have been used to explore these activities. However, to effectively reduce supply chain risks, it is necessary to comprehend how risks are formed, spread through interdependencies, and impact organizations' operations. Some researchers argue that most studies on Supply Chain Risk Management (SCRM) only focus on specific tasks, and there needs to be a comprehensive approach in the current literature that integrates these three tasks. This viewpoint is supported by Qazi and others (2015).

Risk identification work is crucial for the success of risk management efforts in the SCRM process. Karamoozian and Wu (2024) argue that numerous factors, such as cognitive biases, influence managers' perception of supply chain risks. These factors might result in suboptimal decision-making. Hence, to enhance the accuracy and efficiency of the risk management model, it is essential to comprehend managers' perceptions of risks and integrate them into the decision-making process.

This study uses Grey Relational Analysis (GRA) to solve such a complex problem. The rest of this article is organized as follows. Section 2 declares the objective of this study. Section 3 reviews related theory and literature such as supply chain risk, construction supply chain management. This section focuses on the primary decision tool of this study, the grey relational analysis. The case study is shown in section 3. Section 4 shows the result and discussion. Finally, the conclusion and recommendations are drawn in section 5.

2. Research Objective

This study aims to apply the grey relational analysis method to construction supply chain risk analysis, focusing on steel supplier selection for a construction project in Kunming.

3. Literature Review

3.1 Supply chain risk

Supply chain risk management (SCRM) refers to systematically identifying and mitigating any weaknesses or vulnerabilities within a company's supply chain. The objective of SCRM is to mitigate the adverse effects of these risks on a company's operations, reputation, and financial performance (IBM, n.d.).

Product competition often occurs between rival supply chains rather than inside individual organizations. The significance of risk in the supply chain is escalating due to several factors: unpredictability in

supply and demand, the global expansion of the market, decreasing product and technology life cycles, and the growing reliance on outsourcing (Micheli and others, 2008).

The focus of supply chain management has to shift towards supply chain risk management (SCRM). Supply chain management has evolved to encompass responsiveness, leanness, and agility. These three factors contribute to a rise in the complexity of the supply chain and a shift in focus towards risk, see Fig. 1.
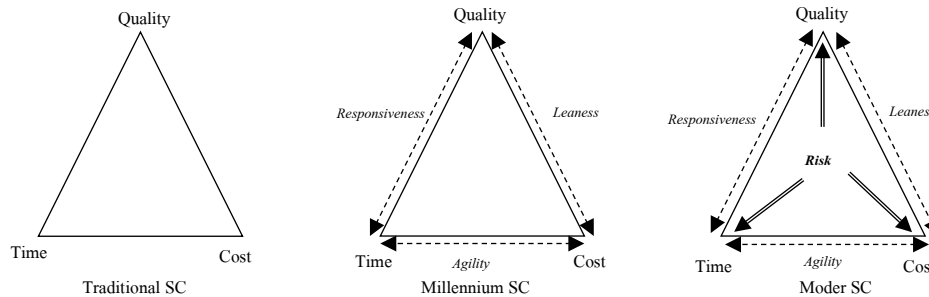
Figure 1 Supply chain management focusing

Source: Norman and Janson (2004)

3.2 Supply Chain Risk Management Process (SCRMP)

Tummala and Schoenherr (2011) propose three-phase of SCRMP: Phase I of the SCRMP consists of risk identification, risk measurement, and risk assessment; Phase II consists of risk evaluation (risk ranking and risk acceptance), risk mitigation, and contingency plans; Phase III consists of risk control and monitoring. In this short report, we would like to focus on the first phase which is significant important to SCRMP.

3.2.1 Risk identification

Risk identification is a thorough and organized assessment of potential supply chain risks linked to the specified issue. The risk categories have been incorporated into our comprehensive framework. Instead of aiming to include every possible risk, this list serves as a representative example of the numerous risks that could exist. It is essential to identify the regions that have been affected and fully understand the repercussions in order to execute policies to reduce the risks effectively.

3.2.2 Risk measurement

Risk measurement entails assessing the potential repercussions of all supply chain risks, together with their respective magnitudes of impact. Consequences refer to the way in which a danger shows its consequences on resources, either in terms of manner or extent. Possible outcomes can encompass the loss or impairment of assets, income reduction, disruption of service levels, exceeding budgeted expenditures, delays in project timelines, subpar process efficiency, liabilities acquired, expenses for repairing damages, or occurrences of injuries. By utilizing a checklist, event tree, fault tree, FMEA, or Ishikawa CEA analysis, it is possible to discover risks related to SC (Ho and others, 2015). Once these risks are identified, the relevant consequences and their severity levels may be evaluated.

3.2.3 Risk assessment

Risk assessment is essentially the evaluation of uncertainties. It involves determining the probability of each risk element. Objective information can be used to analyze uncertainties and probability distributions can be constructed for relevant supply chain risks or outcomes. If objective information is lacking, subjective information, beliefs, and judgment can be employed to estimate distributions. Methods such as the Delphi method or expert focus groups can assist in the determination of probabilities. Additional methodologies encompass parameter estimation, five-point estimation, probability encoding, and Monte Carlo simulation. Alternatively, one can apply probability categories as recommended in the US Military Standard 882C.

3.3 Construction Supply Chain Risk

The construction industry is crucial in stimulating the global economy. Its significant influence on the physical infrastructure and its ability to generate abundant job prospects for both skilled and unskilled workers while promoting economic development is widely acknowledged. Moreover, construction projects commonly exhibit a hybrid characteristic, as they need the utilization of manufactured commodities and vital resources such as raw materials and energy (Bao et al., 2020). The client's satisfaction defines the quality of a construction project. In contrast, the project's success depends significantly on the performance of the project team. The construction supply chain is defined as a sequence of activities that convert raw materials into finished products (such as roads or buildings) and services (such as design or budgeting) for a client, regardless of organizational boundaries.

Moreover, CSCM involves managing information, flow, and financial issues during the development of a building project. Chen and others (2024) defined CSCM as a cooperative system encompassing suppliers, contractors, clients, and their representatives. The goal is to synchronize the installation and exploitation of information to provide resources for building projects, such as supplies, equipment, labor, and temporary works. The notion of CSCM has the potential to significantly improve the value for clients and stakeholders by strategically prioritizing profitability. Moreover, the main objective of overseeing a construction supply chain (CSC) is to strategize and supervise the required quantities of components to be transported to where the final assembly occurs.

As depicted in Fig. 2, the construction business involves many players, including contractors, sub-contractors, designers, consultants, and suppliers. The contractor frequently employs multiple sub-contractors to meet diverse needs in the construction project. These sub-contractors may have expertise in supplying materials, machinery, skilled workers, unskilled workers, or any other unique need that may develop during the project.

Consequently, the contractor industry has many sizes, from small business owners to large multinational enterprises. Therefore, the supply chain in the construction sector is distinct from that in manufacturing and is characterized by more complexity and unpredictability. The implementation of Supply Chain Management (SCM) in construction projects is challenging due to specific project characteristics, such as the temporary involvement of multiple organizations, short-term adversarial relationships, and difficulties in managing networks that involve multiple stakeholders, supply of materials and components, and various services (Abdulla and Nasir, 2017).

3.4 Grey Relational Analysis

Professor Julong Deng's paper titled "The Control Problems of Grey Systems" was published in the Systems and Control Letters journal in 1982, making it the first study on grey systems to be published in that magazine (Liu and others, 2017). In the same year, Professor Deng published a paper titled "Grey Control System" in Chinese, which was subsequently published by the Journal of Huazhong University of Science and Technology. The release of these two influential works signified the emergence of a novel and interdisciplinary field known as gray system theory.
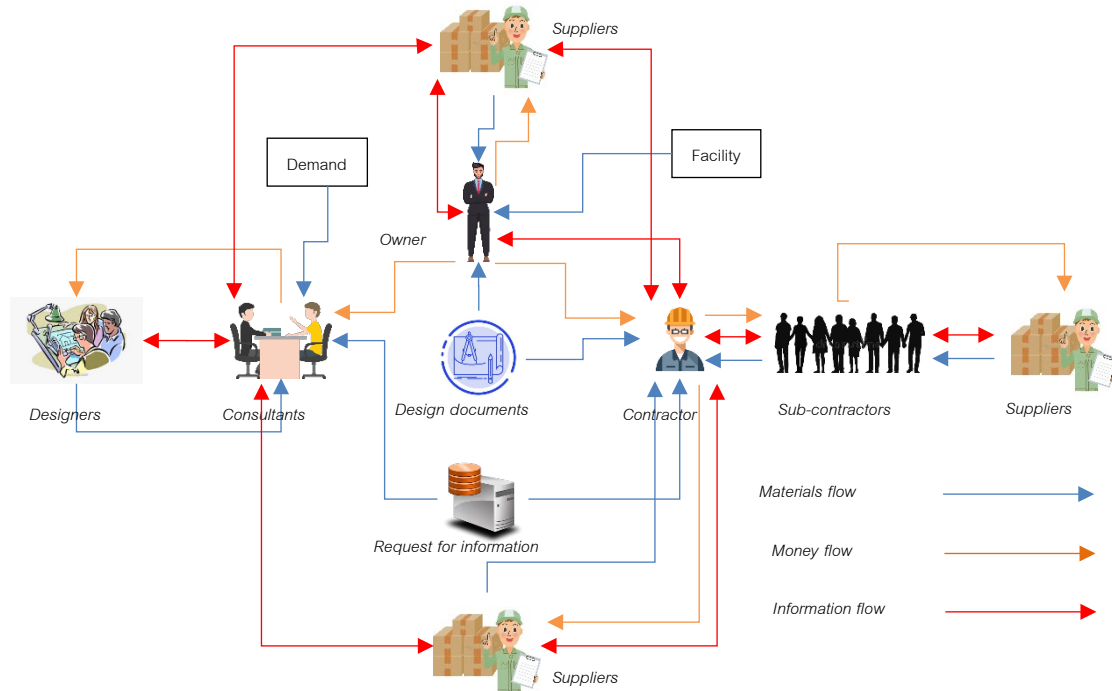
Figure 2 Construction supply chain network

Source: Shishehgarkhaneh and others (2024)

The Grey Relational Analysis (GRA) can solve complex problems involving complicated connections between components and variables. The GRA method has been widely employed to address issues related to ambiguity in situations involving discrete data and incomplete information (Ertugrul and others., 2016). This method initially converts the performances of each alternative into comparability sequences using a mechanism similar to normalization. Then, an optimal or benchmark sequence is established, which will then be employed to compute the gray relational coefficient among all comparable sequences and the benchmark sequence. Finally, the grey relational degree between each comparability sequence and the reference sequence is calculated using the obtained grey relational coefficients, and the alternatives are ranked accordingly. This technique is executed by following a series of steps:

Step 1: Decision-making matrix construction. A decision-making matrix is constructed based on the experts' sentiments. Suppose there are m alternative characterized with n criteria as shown in Eq. (1).

$$G = \begin{bmatrix} G_{11} & G_{12} & ... & G_{1n} \\ G_{21} & G_{22} & ... & G_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ G_{m1} & G_{m2} & ... & G_{mn} \end{bmatrix} \tag{1}$$

where G_{ij} is the performance of choice i corresponding to criterion j.

Step 2: Performance value normalization. Alternatives' performance values are normalized and combined into a comparability sequence $Y_i = (y_{i1}, y_{i2}, y_{i3}, ..., y_{in})$. The larger-the-better criteria and the smaller-the-better criteria are calculated using Eq. (2) and (3), respectively.

$$y_{ij} = \frac{G_{ij} - Min\{G_{ij}, i = 1,2, ..., m\}}{Max\{G_{ij}, i = 1,2, ..., m\} - Min\{G_{ij}, i = 1,2, ..., m\}} \tag{2}$$
$$i = 1,2, ..., m; j = 1,2, ..., n$$

$$y_{ij} = \frac{Max\{G_{ij}, i = 1,2, ..., m\} - G_{ij}}{Max\{G_{ij}, i = 1,2, ..., m\} - Min\{G_{ij}, i = 1,2, ..., m\}} \tag{3}$$
$$i = 1,2, ..., m; j = 1,2, ..., n$$

However, since the risk analysis tends to find the lowest risk, all criteria are considered the smaller-the-better criteria.

Step 3: Reference sequence definition. The definition of reference sequence is constructed in this step. The comparability sequence from the last step will be compared using Eq. (4).

$$y^0 = (y_1^0, y_2^0, ..., y_n^0)$$
$$= \left(\max_{i=1 \to m} y_{i1}, \max_{i=1 \to m} y_{i2}, \max_{i=1 \to m} y_{i3}, ..., \max_{i=1 \to m} y_{in} \right) \tag{4}$$

where y^0 is the target value related to the criterion j, and y_{ij} are the values from the normalized matrix from step 2.

Step 4: Grey relational coefficient calculation. The coefficient is calculated using Eq. (5). It indicates that how close are the values of y_{ij} to the target sequence y^0.

$$\alpha(y^0, y_{ij}) = \frac{\Delta_{min} + \delta\Delta_{max}}{\Delta_{ij} + \delta\Delta_{max}}, \quad \forall i \in \{1,2,..,m\}; j \in \{1,2, ..., n\} \tag{5}$$

where $\alpha(y^0, y_{ij})$ is the grey relational coefficient between y^0 and y_{ij}, and $\Delta_{ij} = |y^0 - y_{ij}|$, $\Delta_{min} = \min\{\Delta_{ij}, \forall i \in \{1,2,..,m\}; \forall j \in \{1,2,..,n\}\}$, $\Delta_{max} = \max\{\Delta_{ij}, \forall i \in \{1,2, ..., m\}; \forall j \in \{1,2, ..., n\}\}$, and δ is the distinguishing coefficient. Please note that $\delta \in [0,1]$. The δ's value shows the important of minimum scores corresponding to the maximum score. It is a pre-determine parameter which defined by the decision maker.

Step 5: Grey relational degree calculation. Then, the grey relational degree is computed as:

$$\Psi(y^0, y_i) = \sum_{j=1}^{n} w_j \alpha(y^0, y_i), \quad \forall i \in \{1,2,..,m\} \tag{6}$$

where $\Psi(y^0, y_i)$ is the grey relational degree between y^0 and y_i. It reflects to the correlationship degree between the target sequence and the comparability sequence. w_j is the criterion weight j, and $\sum_{j=1}^{n} w_j = 1$.

As a result, the higher the grey relational degree, the closer to the target sequence it is. Accordingly, the alternative with the highest grey relational degree is the best in the system.

4. Research Methodology

4.1 A Sample Construction Project

The selected construction company is listed in the stock market. Unfortunately, the company details are confidential. We interviewed fifteen company experts in supply chain management, but the respondent information is confidential. The interview has two stages. The first stage asked about the risk factors in construction supply chain management, which focuses on steel. The data would be compared to the initial risk factors generated from the literature. The second interview asked about the score of the performance of each supplier: local (A1 and A2), regional (B1 and B2), and international (C) suppliers—there were five suppliers—on criteria by giving a five‑point Likert scale: score 1, 2, 3, 4, and 5 means deficient, low, fair, reasonable, excellent performance corresponding that criterion, respectively. The data will be analyzed using the GRA technique.

4.2 Supply Chain Risk Factors

The supply chain risk factors in construction projects were retrieved from the literature that are Rudolf and Spinler (2018), Shojaei and others (2019), Karamoozian and Wu (2024), and Shishehgarkhaneh and others (2024). Then, five decision‑makers, including the site manager, material control supervisors, purchasing manager, site engineers, and site supervisors, validated the proposed factors in a sample construction project. Eventually, this study found three main risk factors and fourteen sub-risk factors. The risk factors are shown in Table 1.

Table 1 Supply chain risk factors in construction projects

Main risk factors	Sub-risk factors	Code
Critical time risk factors	Material delays due to no appropriate communication	R1
	Delay due to material condition and wastages such as weather impacts.	R2
	Machines and equipment are not ready to be used due to lack of maintenance.	R3
	Project delays due to environment effects.	R4
	Deficit of workforce due to workforce market and labor's absenteeism	R5
Critical cost risk factors	Loss due to material condition and wastages such as weather impacts.	R6
	Project delays due to environmental impacts.	R7
	Overtime cost due to workforce deficit.	R8
	Improper planning and scheduling due to defective estimation.	R9
Critical quality risk factors	Incorrect selection of supplier because not knowing the right type of supplier to order.	R10
	Material defects due to weather impacts.	R11
	Project delays due to environmental impact to material quality.	R13
	Project failures due to poor engineering techniques.	R14

4.3 Research Instrument

A questionnaire was designed using risk factors and alternatives from section 4.2. However, in this study, we would like to give w_j to each criterion equally. Thus, Eq. (6) is modified to $\Psi(y^0, y_i) =$

$\sum_{j=1}^{n} \frac{w_j}{n} \alpha(y^0, y_i), \forall i \in \{1,2,\dots,m\}$. Furthermore, the five decision-makers gave the score independently. So, the average score will be calculated as $G_{ij} = \frac{\sum_{k=1}^{K} g_{ij}^k}{K}$ where k is the expert k^{th}, $\forall k \in \{1,2,\dots,K\}$.

4.5 Data Analysis

The analysis follows the grey relational analysis procedure rigorously. However, please note that this is an example of steel material of a construction project.

5. Result and Discussion

Step 1: Decision-making matrix construction.

The decision-making matrix is calculated using the modified equation in section 4.2, which be called a group decision-making matrix and can be shown using Eq. (1), as illustrated in Table 2.

Table 2 A group decision-making matrix.

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
A1	3.60	2.20	2.80	2.40	3.20	2.80	3.20	2.60	2.80	3.00	2.40	2.60	2.20	2.60
A2	3.20	2.80	3.40	3.00	3.00	3.20	2.80	2.80	2.80	3.40	2.20	2.60	2.40	2.20
B1	2.40	2.40	3.00	2.60	3.00	2.80	2.40	2.60	2.20	2.60	2.60	2.80	2.60	2.40
B2	2.60	3.20	3.00	3.00	3.20	3.80	3.20	3.60	2.40	2.60	3.00	3.60	2.80	3.20
C	3.20	2.20	3.00	2.80	1.80	2.40	2.00	3.00	2.40	2.80	2.20	2.00	1.80	2.60

Step 2: Performance value normalization.

The normalized performance value is calculated using Eq. (3), as shown in Table 3.

Table 3 The normalized performance value matrix

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
A1	1.00	0.00	0.00	0.00	1.00	0.29	1.00	0.00	1.00	0.50	0.25	0.38	0.40	0.40
A2	0.67	0.60	1.00	1.00	0.86	0.57	0.67	0.20	1.00	1.00	0.00	0.38	0.60	0.00
B1	0.00	0.20	0.33	0.33	0.86	0.29	0.33	0.00	0.00	0.00	0.50	0.50	0.80	0.20
B2	0.17	1.00	0.33	1.00	1.00	1.00	1.00	1.00	0.33	0.00	1.00	1.00	1.00	1.00
C	0.67	0.00	0.33	0.67	0.00	0.00	0.00	0.40	0.33	0.25	0.00	0.00	0.00	0.40

Step 3: Reference sequence definition.

By using Eq. (4), $y^0 = \left(\max_{i=1 \to m} y_{i1}, \max_{i=1 \to m} y_{i2}, \max_{i=1 \to m} y_{i3}, \dots, \max_{i=1 \to m} y_{in} \right)$, thus, the reference sequence is $y^0 = (1.00, 1.00, 0.86, 0.67)$.

Step 4: Grey relational coefficient calculation.

The grey relational coefficient (GRC) can be obtained by using Eq. (5). Please note that δ is a pre-determined parameter by the analyst which it equal to 0.5 for this study. Table 4 shows the GRC values.

Table 4 The grey relational coefficient matrix

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14
A1	1.00	0.33	0.33	0.33	1.00	0.41	1.00	0.33	1.00	0.50	0.40	0.44	0.45	0.45
A2	0.60	0.56	1.00	1.00	0.78	0.54	0.60	0.38	1.00	1.00	0.33	0.44	0.56	0.33
B1	0.37	0.43	0.49	0.49	1.00	0.47	0.49	0.37	0.37	0.37	0.58	0.58	0.90	0.43
B2	0.38	1.00	0.43	1.00	1.00	1.00	1.00	1.00	0.43	0.33	1.00	1.00	1.00	1.00
C	1.00	0.43	0.60	1.00	0.43	0.43	0.43	0.65	0.60	0.55	0.43	0.43	0.43	0.65

Step 5: Grey relational degree calculation.

The grey relational degree (GRD) can be obtained by using Eq. (6). As mentioned before, W_i is equal for all $i \in \{1, 2, \dots, n\}$. Table 5 shows the GRD values.

Table 5 The grey relational degrees

	A1	A2	B1	B2	C
$\Psi(y^0, y_i)$	0.571330957	0.651648352	0.523840518	0.826105442*	0.574985884

Remark: * is the best performance supplier.

Table 5 shows that regional supplier B2 is the best performance supplier in case of risk corresponding to three dimensions: time, cost, and quality risk factors. The problem is not a complex issue if no sub-risk factors carry out different opinions of decision-makers. The grey relational analysis technique assists the decision-makers in choosing the right supplier for steel material. In this analysis, regional supplier B1 is the highest-performance vendor with a GRD of 0.826105442, and the lowest-performance vendor is regional B2 with a GRD of 0.523840518.

By considering the normalized performance value matrix, regional supplier B1 works well on cost and quality risk factors by significantly dominating other competitors. Additionally, local supplier A2 can be the secondary supplier since it is the second-ranked supplier with high performance in some aspects, such as an efficient workforce, good work scheduling, and high experience in steel material.

6. Conclusion and Recommendations

The grey relational analysis was used to evaluate suppliers' performance based on supply chain risk factors. Five decision-makers were independently scoring each vendor corresponding to fourteen criteria. The GRA procedure can work on group decision and eliminate score deviation by the sequence reference mechanism. The chosen vendor for this construction project was the regional supplier B2 with the highest grey relational degree of 0.826105442. Nonetheless, the second order supplier, local supplier A2, is the interesting choice. The supply chain management may choose it as the secondary supplier since it is the local vendor and works well on some risk factors.

The drawbacks of the grey relational analysis technique are two pre-determined parameters, δ and w_j, which an analyst must consider before proceed the analysis. The δ appears in Eq. (5) while w_j appears in Eq. (6). Technically, $\delta \in [0,1]$. The analyst gives more important on the best practice when $\delta \to 1$; on the other hand,

the analyst gives less important on the best practice when $\delta \to 0$. Merely, it is a subjective parameter. The analyst must carefully select this value. The w_j is the weight of criterion j. The higher w_j means more important criterion than other. We would like to recommend other multi-criteria decision-making tools such as the analytic hierarchy process (AHP) to calculate the weighted criteria before proceed the grey relational analysis technique.

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Financial Risk Assessment for A Construction Project in Kunming

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ABSTRACT

This article demonstrates an application of a multi‑criteria decision analysis tool, named Decision-making Trial and Evaluation Laboratory (DEMATEL). Since the financial risk factors of a construction project are complicated and one factors may affect to other factors with different degree, a conventional decision analysis tool which ignore relationship among risk factor will fail to identify critical risk systematically. This study chose a sample construction project in China and twenty‑six staff members are the decision makers. There are twenty-eight risk factors in nine groups from literature be considered. The result shows that DEMATEL can identify cause‑and‑effect factors evidently. Furthermore, the threshold value of this technique helps us to ignore trivial effects and focus on significant relationship between independent and dependent factors. The results showed that thirteen out of twenty‑eight factors, such as Inflation rate, Household debt, Poor financial market, and 'Poor market research' are the causes. This decision tool can be applied to the case experiment effectively.

KEYWORDS: Safety management, Construction industry, Multi-criteria decision making, DEMATEL

1. Introduction

The construction business is a multifaceted, efficient, and highly demanding sector in the expanding global economy. Successfully achieving the key aims and objectives of the industry demands careful attention to resource management, labor requirements, equipment, processes, contract management, and expert advice (Kumar, 2018). In addition to the multitude of intricate duties inherent in construction, the presence of risks and uncertainties throughout multiple processes is an anticipated aspect of this expansive and essential business. The economic development is contingent upon expanding the construction industry while effectively addressing risks (Srinivasan and others, 2022).

The risk that harms the project is considered from the beginning of the investment process, namely when the contract is awarded after winning the bidding (Gad and others, 2022). The risk level associated with a specific construction contract is a significant determinant in deciding whether to accept or decline the contract. The primary concern revolves around accurately identifying contract risk. The risk factors that substantially influence the project's success and are commonly encountered are further examined. The verification method is contingent upon the company's level of expertise in the construction sector (Singh and others, 2019).

In the last years, China has been suffering from a severe economic crisis, which has affected a large number of businesses and industries, specifically the construction industry (Jiao, 2021). Inevitably, the construction industy is suffering from this factor. Nevertheless, the industry must continue to lead the economic and must be conducted cautiously. To do so, we need to identify, classify, and analyze the most significant risks inherent in a construction project; specifically, on the financial and economic risk category.

This study aims to mitigate financial risk by identifying and analyzing the factors that influence the financing of a construction project. The study contributes to mitigating the financial risk associated with a project and enhancing operational efficiency in the future. It examines the traditional way of evaluating project financing risks and its application to a current building project. The DEMATEL-ISM approach is employed to conduct data analysis to produce project finance risk and evaluate the index system. The rest of the article is organized as follows: Section 2 illustrates the objective of this study; section 3 reviews related theory and their state-of-the-art risk assessment methods. The DEMATEL is described briefly. Section 3 explains the research method and shows the research procedure. Section 4 shows the results and rigorously discusses them. Finally, the conclusion and recommendations for future study are portrayed in section 5.

2. Research Objective

To assess the financial risk factor of a sample construction project in Kunming.

3. Literature Review

3.1 Construction Industry

The construction industry constituted around 6.8 percent of China's total domestic GDP in 2023. A substantial portion of the nation's economy is dependent on the real estate sector and the construction of infrastructure. During periods of economic decline, authorities often rely on infrastructure improvements as a means to stimulate economic growth (Zhang, 2024).

In 2023, the China construction industry was worth USD 2,734.90 Billion. It is expected to grow at a Compound Annual Growth Rate (CAGR) of 5.4% from 2024 to 2030, reaching USD 4,107.20 Billion by 2030. The construction market, often known as the infrastructure sector, plays a crucial role in the economy by managing the whole lifespan of various physical assets, such as infrastructure, buildings, and amenities. This sector comprises a broad spectrum of projects, including residential, commercial, and industrial developments, as well as civil engineering and institutional real estate activities.

The operation relies on the collaboration of various parties, including architects, engineers, contractors, suppliers, developers, investors, and government authorities. The business is set to expand due to a growing focus on environmentally sustainable practices, such as incorporating green construction materials and energy-efficient designs. Moreover, the increasing per capita income in emerging economies and the low interest rates in established nations are expected to boost the growth of the infrastructure industry (Next MSC., 2024).

The infrastructure sector in China is seeing significant expansion, fueled by increasing investments in infrastructure projects throughout the region. According to data from the Global Infrastructure Hub, investments in the infrastructure sector reached a significant amount of USD 942 billion in 2023. The road transport sector receives a substantial amount of investment, at $ 356 billion, with the energy sector closely following at USD 281 billion. The current trend of investment is projected to persist, promoting consistent expansion and progress in the building industry.

In addition, the decrease in inflation rates strengthens consumer preference and purchasing power, potentially increasing demand for new projects, such as residential and commercial constructions. China's inflation rate in 2024 was 0.97%, which is considerably lower than that of other countries like India and Japan. This positive economic indicator contributes to the growth of the infrastructure sector, attracting more investment and promoting overall economic development in the country.

Figure 1 China's construction industry growth forecasting

3.2 Financial Risk Analysis in Construction Projects

3.2.1 Construction project risk management

Risk management refers to the collective mindset, methods, and systems employed to generate advantages while mitigating adverse outcomes proactively. Befrouei and Taghipour (2015) defined risk management in the context of construction project management as a thorough approach to recognizing, evaluating, and dealing with risks in order to accomplish the project's goals and objectives. As to the British Standards BS31100 (2011), risk management is making decisions to address known or quantified risk and taking actions to reduce the impact or likelihood of its occurrence.

Risk management is a crucial responsibility for project managers. Neglecting this job can lead to a range of problems and financial setbacks. Effective dynamic risk management necessitates a meticulous approach and the acquisition of pertinent information, extensive knowledge, and practical experience. The primary rationale behind risk management in construction projects is to provide a secure work environment for the labor force and enhance the achievement of objectives. According to Mihoci and others (2020), risk management is a thorough procedure involving identifying and evaluating risks to determine the necessary measures for effective risk mitigation.

Moreover, it enables a system to effectively manage the typical risks in its daily operations and maintain its processes in a comprehensive and suitable environment, facilitating cost‑effective outcomes. Risk

management involves proactively preparing for future incidents for the same reason. Nevertheless, the neglect of risk management in the building industry has resulted in unfavorable consequences and substandard workmanship. For instance, the lack of effectiveness in managing and the inaccurate assessment of two essential project factors, namely cost and time, which are difficult to measure accurately, can result in project delays and increased expenses.

3.2.2 Financial risk analysis

Financial risk analysis involves evaluating the probability of a potential danger occurring and its potential consequences. Therefore, it is significant in the field of risk management. Financial risk management involves assessing the probable impact and level of exposure to a risk (Mashrur and others., 2020).

Performing this estimate is a complex endeavor, as a particular risk has the potential to initiate numerous consequences. For instance, malfunctioning equipment causes mechanical harm that necessitates repair, disrupts production, incurs financial losses, causes delivery delays, and tarnishes the company's reputation.

The assessment of a company's financial risk begins with the identification of all potential risk occurrences. This article explains the process of identifying them. The analysis not only estimates potential losses but also proactively prevents them. For instance, credit risk analysis, a prominent form of financial risk assessment, evaluates the likelihood that a borrower may be unable to meet their obligations. Armed with this information, the bank proactively takes measures to prevent such incidents or minimize their consequences. Therefore, it is imperative for financial risk management to consider both the internal and external elements that give birth to potential hazards.

Internal factors refer to the factors generated as a result of the company's business operations. Inadequate cash management or production issues pose hazards that can negatively influence a company's financial accounts and market valuation. External variables are political, economic, or social situations that impact a company's performance. These influences can include economic crises, fluctuations in exchange rates, industry changes, or government policy shifts. An efficient approach to performing a financial risk analysis at a company involves integrating the likelihood of a risk event with the potential economic damages it may induce. After identifying the risks and selecting the most suitable instrument to manage them, the organization can determine whether to avoid or accept them based on risk appetite and tolerance level. Risk exposure is quantitatively measured. To evaluate the possible impact of an incident that affects only a specific organization region, we can calculate it by multiplying the chance of the risk occurring by the approximate financial loss. The outcome can provide a graphical representation of functions indicating acceptable and hazardous risks.

Undoubtedly, while making decisions, it is imperative to take into account market trends as well as macroeconomic and financial elements. The financial risk manager can utilize real-time risk detection techniques to effectively manage and proactively address various conditions, hence minimizing potential financial risks. Risk management software is a specific technology used for managing and mitigating risks. Risk management software minimizes the need for manual transaction duties and, as a result, reduces the subjective

nature of analysis. Consequently, it serves as a proficient and user‑friendly instrument in the realm of financial risk management.

3.3 Decision‑making Trial and Evaluation Laboratory (DEMATEL)

The DEMATEL technique possesses the capacity to address intricate and arduous issues in real‑life scenarios. The DEMATEL approach employs graph theory and matrix operations. By examining a system's logical links and direct cause‑and‑effect relationships, we can classify its components into two distinct groups: the group that is influenced and the group that exerts influence. The primary advantage of this technique lies in its ability to incorporate the viewpoints of multiple experts on a particular subject and analyze complex relationships among various parts using a graphical structural model (Ha and Yang, 2018).

The DEMATEL technique can efficiently transform the relationships among the identified components into a tangible structural model of the studied system. This strategy can be executed by classifying the components into cause‑and‑effect categories. Concerning this issue, the identified criteria can be organized in a hierarchical order, and the resulting priority can be utilized for formulating long‑term strategic decisions and devising enhancement initiatives. In essence, DEMATEL cannot address decision‑making issues; its primary purpose is to assess the interconnectedness of cause-and-effect factors.

4. Research Methodology

This section presents the research procedure and details, including the sample construction projects in Kunming, China. However, the participants are only at middle‑ to upper‑management levels. Thus, 26 staff members participated in this study. The details of the participants are described in section 4.1.

4.1 Population and Sample

The sample construction project is in Kunming, China. The project size, value, and number of staff are confidential, so we are not allowed to show them to the public. Furthermore, other quantitative data, such as plot size, project location, and construction equipment, are closed. Table 1. Shows the research respondents and their facts.

Table 1 Research participants

No.	Position	Number	Experience (Years)
1	Project manager	1	15
2	Vice project managers	1	13
3	Financial manager	1	7
4	Marketing manager	1	10
5	Personal manager	1	5
6	Supplier manager	1	7
7	Construction engineers	12	3 - 7
8	Supervisors	8	5 - 10
	Total	26	3 - 15

4.2 Research Instrument

The risk factors were retrieved from the literature and reviewed by three managers from three departments of the sample construction company with at least five years of experience. The risk factors are shown in Table 2.

Table 2 Key risk factors

Class	Elemental description	Code
Pandemic, R_1	Pandemic outbreak	x_1
Political, R_2	War and geopolitical conflict	x_2
	Political corruption	x_3
	Regulation and policy changes	x_4
Economy, R_3	Fluctuation of currency exchange rate	x_5
	Inflation rate	x_6
	Interest rate	x_7
	Household debt	x_8
Credit, R_4	Project's credit risk	x_9
	Equity holder's credit risk	x_{10}
Engineering, R_5	Design change	x_{11}
	Lack of material and qualified suppliers	x_{12}
	Substandard materials	x_{13}
	Substandard equipment	x_{14}
	Project delay	x_{15}
Operation, R_6	Counterparty risk	x_{16}
	Rating risk	x_{17}
	Tax risk	x_{18}
Market, R_7	Client's financial stability	x_{19}
	Poor financial market	x_{20}
	Poor market research	x_{21}
Liquidity, R_8	Lack of cash flow	x_{22}
	Project's liquidity	x_{23}
	Delay payment by client	x_{24}
Others, R_9	Lack of competent staff	x_{25}
	Environmental impacts	x_{26}
	Public impacts	x_{27}
	Poor construction supply chain management	x_{28}

The questionnaire was validated using the index of item-objective congruence (IOC) by three university professors who studied risk analysis, financial management, and construction management over ten years in China. The IOC equals 1.00; that means the questionnaire is congruent with the objective.

4.3 Data Analysis

1) Pairwise comparisons: obtain an initial direct-relation matrix (Z)

The initial direct-relation matrix Z is an average $n \times n$ matrix constructed by pairwise comparisons of m decision-makers. Equation (1) is $Z = [z_{ij}]_{n \times n}$ where Z_{ij} is denoted as an average direct-relation value of x_{ij} and all principal diagonal $z_{ij}(i = j)$ equals to zero, $X^k = [x_{ij}^k]$ is a judgement on causal relationship between x_{ij} by the kth decision maker.

$$Z = [z_{ij}]_{n \times n} = \frac{1}{m} \sum_{k=1}^{m} z_{ij}^k, \quad \forall i, j = 1, 2, \dots, n \tag{1}$$

2) Direct-relation matrix normalization (D)

The normalized direct-relation matrix $D = [d_{ij}]_{n \times n}$ where the value of each factor in matrix D is $0 \le d \le 1$, can be obtained through Eq. (2) and (3). The maximum value of the sums of each row and column is used to calculate a coefficient s.

$$s = \min \left[\frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} |z_{ij}|}, \frac{1}{\max\limits_{1 \le j \le n} \sum_{i=1}^{n} |z_{ij}|} \right] i, j = 1, 2, \dots, n \tag{2}$$

$$D = s \times Z \text{ or } [d_{ij}]_{n \times n} = s \times [z_{ij}]_{n \times n}, s > 0 \tag{3}$$

3) Calculate a total-relation matrix (T) and its sum of rows and columns

The total-relation matrix T is calculated by Eq. (4) as matrix operations on D.

$$T = \lim_{m \to \infty} (D^1 + D^2 + \cdots + D^m) = \sum_{m=1}^{\infty} D^i = D(I - D)^{-1} \tag{4}$$

where I is an $n \times n$ identity matrix. R_i and C_j in Eq. (5) are the sums of rows and columns in the matrix T, respectively, in which t_{ij} denotes the interdependent value of each pair of the investigated factors. Additionally, in Eq. (6), the horizontal axis value pr_i^+ denotes how crucial the ith factor is, whilst the vertical axis value pr_i^- classifies the factors into the cause-and-effect group. If the value of pr_i^- is positive, the factor is classified into the cause group. Alternatively, when the value of pr_i^- is negative, the factor is grouped into the effect group.

$$R_i = \sum_{j=1}^{n} t_{ij} \quad, \quad C_j = \sum_{i=1}^{n} t_{ij} \quad (i, j = 1, 2, \dots, n) \tag{5}$$

$$pr_i^+ = R_i + C_i \quad, \quad pr_i^- = R_i - C_i \tag{6}$$

4) Calculate a threshold value (α)

The threshold value α tends to filter and remove the factors that have trivial relation on others in the matrix T. The threshold value is calculated by the average value of t_{ij}, where N denotes the total number of element ($i \times j$), see Eq. (7). Only the factors whose relation values of t_{ij} are higher than the threshold value can be considered interdependency among the risk factors.

$$\alpha = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} t_{ij}}{N} \tag{7}$$

5. Results and Analysis

There were 100% return rate with 26 decision makers. The followings show some important results of the study.

1) Pairwise comparisons: obtain an initial direct-relation matrix (Z),

The direct-relation matrix is calculated using Eq.（1）as shown in Table 3. Please note that due to the limited space of this manuscript, the matrix is shown in shrink type.

Table 3 Direct-relation matrix of twenty-six decision-makers

	X1	X2	X3	X3	X5	X6	...	X23	X24	X25	X26	X27	X28
X1	0	1.1	1.5	4.2	3.7	4.5	...	3.6	4.1	1.8	1.8	3.4	3.1
X2	1.0	0	2.1	3.7	3.4	4.1	...	2.8	3.1	1.9	1.5	2.7	3.4
X3	1.0	2.5	0	4.1	1.9	2.1	...	3.4	2.2	1.8	1.5	3.5	2.5
X5	1.0	1.4	2.1	0	3.1	3.7	...	3.3	2.7	1.8	1.5	2.7	3.1
X5	1.0	1.3	1.5	3.4	0	4.5	...	3.9	3.1	2.1	1.7	2.3	3.9
X6	1.0	1.1	1.3	2.1	3.1	0	...	3.3	3.6	1.9	1.1	1.6	3.4
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮	⋮	⋮	⋮	⋮	⋮
X23	1.0	1.0	1.0	1.0	1.0	1.1	...	0	2.5	3.2	2.8	2.7	3.8
X24	1.0	1.0	1.0	1.0	1.0	1.0	...	3.8	0	3.7	2.2	2.4	3.6
X25	1.0	1.0	1.0	1.0	1.0	1.0	...	3.7	2.1	0	2.6	2.5	3.3
X26	1.0	1.0	1.0	3.9	1.0	1.6	...	3.5	3.6	1.9	0	4.2	2.7
X27	1.0	1.0	1.0	3.9	1.0	1.4	...	3.3	3.6	1.7	3.9	0	3.3
X28	1.0	1.0	1.0	3.8	1.0	1.1	...	3.3	3.2	2.2	2.7	2.5	0

2) Direct-relation matrix normalization (D).

The normalized direct-relation matrix is determined using Eq.（2）and（3）. Table 4 shows information of the normalized direct-relation matrix.

Table 4 The normalized direct-relation matrix of twenty-six decision-makers

	X1	X2	X3	X3	X5	X6	...	X23	X24	X25	X26	X27	X28
X1	0	1.1	1.5	4.2	3.7	4.5	...	3.6	4.1	1.8	1.8	3.4	3.1
X2	1.0	0	2.1	3.7	3.4	4.1	...	2.8	3.1	1.9	1.5	2.7	3.4
X3	1.0	2.5	0	4.1	1.9	2.1	...	3.4	2.2	1.8	1.5	3.5	2.5
X5	1.0	1.4	2.1	0	3.1	3.7	...	3.3	2.7	1.8	1.5	2.7	3.1
X5	1.0	1.3	1.5	3.4	0	4.5	...	3.9	3.1	2.1	1.7	2.3	3.9
X6	1.0	1.1	1.3	2.1	3.1	0	...	3.3	3.6	1.9	1.1	1.6	3.4
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮	⋮	⋮	⋮	⋮	⋮
X23	1.0	1.0	1.0	1.0	1.0	1.1	...	0	2.5	3.2	2.8	2.7	3.8
X24	1.0	1.0	1.0	1.0	1.0	1.0	...	3.8	0	3.7	2.2	2.4	3.6
X25	1.0	1.0	1.0	1.0	1.0	1.0	...	3.7	2.1	0	2.6	2.5	3.3
X26	1.0	1.0	1.0	3.9	1.0	1.6	...	3.5	3.6	1.9	0	4.2	2.7
X27	1.0	1.0	1.0	3.9	1.0	1.4	...	3.3	3.6	1.7	3.9	0	3.3
X28	1.0	1.0	1.0	3.8	1.0	1.1	...	3.3	3.2	2.2	2.7	2.5	0

3) Calculate a total-relation matrix (T) and its sum of rows and columns

Then, the total direct-relation matrix is calculated using Eq. (4), as shown in Table 5. Then, pr_i^+ and pr_i^- is calculated using Eq. (5) and (6). The result and their implication are shown in Table 6.

Table 5 The total direct-relation matrix of twenty-six decision-makers

	X1	X2	X3	X3	X5	X6	...	X23	X24	X25	X26	X27	X28
X1	0.0232	0.0351	0.0397	0.0807	0.0702	0.0835	...	0.1136	0.1044	0.0746	0.0701	0.0893	0.1031
X2	0.0315	0.0230	0.0439	0.0737	0.0653	0.0773	...	0.1012	0.0903	0.0718	0.0638	0.0791	0.1015
X3	0.0292	0.0446	0.0213	0.0731	0.0470	0.0539	...	0.0981	0.0748	0.0651	0.0593	0.0814	0.0859
X4	0.0306	0.0355	0.0427	0.0367	0.0606	0.0715	...	0.1030	0.0842	0.0692	0.0621	0.0771	0.0958
X5	0.0336	0.0376	0.0402	0.0734	0.0354	0.0838	...	0.1182	0.0961	0.0792	0.0707	0.0803	0.1128
X6	0.0311	0.0330	0.0355	0.0567	0.0610	0.0367	...	0.1044	0.0936	0.0715	0.0595	0.0677	0.1003
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮	⋮	⋮	⋮	⋮	⋮
X23	0.0297	0.0305	0.0310	0.0441	0.0381	0.0438	...	0.0681	0.0786	0.0804	0.0733	0.0755	0.0996
X24	0.0304	0.0312	0.0317	0.0448	0.0390	0.0439	...	0.1066	0.0566	0.0871	0.0694	0.0744	0.1001
X25	0.0295	0.0303	0.0307	0.0432	0.0374	0.0422	...	0.1020	0.0745	0.0493	0.0709	0.0728	0.0942
X26	0.0306	0.0316	0.0322	0.0730	0.0401	0.0509	...	0.1047	0.0922	0.0703	0.0484	0.0916	0.0924
X27	0.0303	0.0313	0.0319	0.0726	0.0395	0.0483	...	0.1016	0.0911	0.0678	0.0847	0.0514	0.0969
X28	0.0300	0.0309	0.0315	0.0705	0.0388	0.0447	...	0.1001	0.0858	0.0716	0.0726	0.0742	0.0644

Table 6 Identification of cause-and-effect factors

	R	C	pr_i^+	pr_i^-	Identify		R	C	pr_i^+	pr_i^-	Identify
X1	2.3903	0.8177	3.2080	1.5726	Cause	X15	1.7883	3.0339	4.8222	-1.2456	Effect
X2	2.2446	0.8654	3.1100	1.3792	Cause	X16	1.9356	2.4178	4.3534	-0.4823	Effect
X3	2.0130	0.8906	2.9036	1.1224	Cause	X17	2.0692	2.6454	4.7146	-0.5762	Effect
X4	2.1507	1.4611	3.6118	0.6897	Cause	X18	2.0335	2.0425	4.0759	-0.0090	Effect
X5	2.4586	1.2240	3.6826	1.2345	Cause	X19	2.1127	2.0105	4.1233	0.1022	Cause
X6	2.2008	1.4377	3.6385	0.7630	Cause	X20	2.4275	2.1869	4.6144	0.2406	Cause
X7	1.8076	1.9203	3.7278	-0.1127	Effect	X21	1.9039	1.7573	3.6612	0.1466	Cause
X8	1.9209	1.4745	3.3953	0.4464	Cause	X22	2.1026	2.8096	4.9123	-0.7070	Effect
X9	2.2264	2.3336	4.5599	-0.1072	Effect	X23	2.0622	2.7879	4.8502	-0.7257	Effect
X10	2.1980	2.3609	4.5589	-0.1630	Effect	X24	2.1336	2.2836	4.4171	-0.1500	Effect
X11	1.9430	2.5473	4.4903	-0.6043	Effect	X25	2.0358	2.0096	4.0454	0.0261	Cause
X12	1.7334	2.4696	4.2030	-0.7362	Effect	X26	2.1567	1.8577	4.0145	0.2990	Cause
X13	1.5550	2.5390	4.0940	-0.9840	Effect	X27	2.1253	2.0229	4.1482	0.1024	Cause
X14	1.4413	2.4516	3.8929	-1.0103	Effect	X28	2.0870	2.5982	4.6852	-0.5113	Effect

The pr_i^+ and pr_i^- are the cartesian x and y, respectively. Thus, Fig. 2 illustrates the position of financial risk factors as a diagram, the causal diagram.
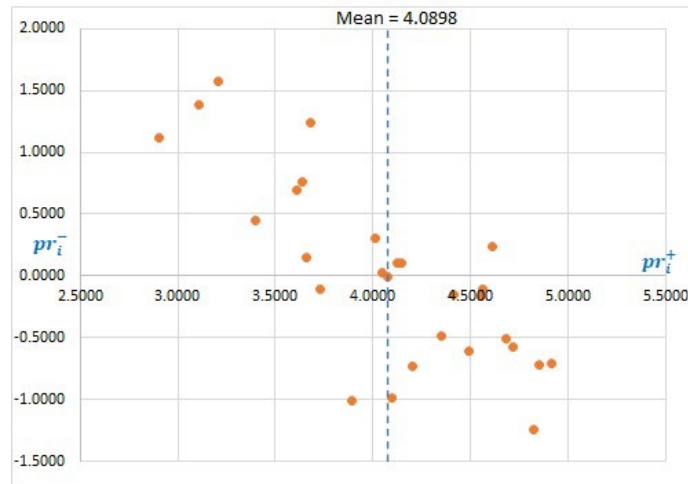
Figure 2 The importance and relationships of the factors

4) Calculate a threshold value (α)

By using Eq. (7), the α is equal to 0.0730. That means some relationships are trivial and can be ignored by risk management team. For example, $t_{6,3} = 0.0355$, which lower than α, see Table 5. It implies that even Inflation rate is a cause of financial risk; however, it does not affect to Political corruption. Another example is $t_{4,7} = 0.0771$. It means Regulation and policy changes affects to Environmental impacts.

6. Conclusion

Twenty-six decision makers decided on twenty-eight financial risk factors on the five-point Likert scale using a pairwise comparison method. Then, the average direct-relation matrix was determined. The total direct-relation matrix was obtained. The cause-and-effect factors can be obtained by calculating pr_i^+ and pr_i^-. It showed that thirteen out of twenty-eight factors, such as Inflation rate, Household debt, Poor financial market, and 'Poor market research' are the causes.

In comparison, fifteen factors are the effects, such as Project's credit risk, Design change, Substandard materials, and Project delay. Additionally, the DEMATEL also provides a threshold value equal to 0.0730 to eliminate the trivial relationship between cause-and-effect factors. This tool facilitates the financial risk management team's ability to effectively focus on critical risk factors. In future studies, we want to modify the DEMATEL to boost it from the perspective of risk ordering. This will help the risk management team manage their limited resources to mitigate the most priority risk factors.

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Development of Systems and Mechanisms for Enhancing Academic, Research, and Innovation Collaboration with International Partners at Rajamangala University of Technology Lanna

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ABSTRACT

This study provides an in-depth review of Rajamangala University of Technology Lanna (RMUTL) international collaborations over the past twenty years. RMUTL has partnered with 57 institutions across 16 countries in Asia, Australia, and Europe, with a notable emphasis on Asian partnerships. Collaborations primarily focus on short-term exchanges, training programs, and joint projects. Despite the extensive network, the study highlights the need for RMUTL to strengthen its network and develop better mechanisms to support academic, research, and innovation activities. Current efforts are largely limited to short-term exchanges and faculty interactions. For sustainable development and enhanced internationalization, RMUTL must adopt comprehensive strategies to expand collaborations, increase visibility, and invest in capacity building. The proposed research framework identifies four key factors for improving collaboration: people, partners, products, and processes. Strategies recommended include identifying strategic partners, enhancing communication, and developing flexible collaboration programs. By implementing these strategies and refining its organizational structure, RMUTL can bolster its international partnerships and advance its mission of global academic and research excellence. RMUTL's policies are set by the President and managed by a primary unit responsible for international research collaboration. This unit, under executive oversight, formulates and monitors policies and manages funding through a centralized research system, including the Research and Development Institute (RDI) and various faculties. University committees facilitate progress, supported by mechanisms for funding, personnel exchanges, and continuous investment in research and training.

KEYWORDS: Educational, Cooperation Exchange Programs, Strategic Partnerships, Global Partnerships

1. Introduction

In an era of rapid technological advancement, the world has experienced swift transformations in communication, society, economy, and culture, along with the emergence of international networks. Technological progress and the widespread dissemination of information across various fields have significantly impacted the global landscape in a short time. As a result, it has become essential to cultivate global citizens, strengthen connections within the international community, and promote internationalization in a world without borders. This requires a collaborative effort to build national capacity and contribute to collective global development.

The role of a university encompasses any chartered or statutory operations or activities, including instruction, research, study, administration, residential life, social engagement, innovation, and other directly related functions. Universities play a vital role in connecting people worldwide and preparing a global workforce. Moreover, Thailand's strategic development is guided by the National Strategic Framework and the Sustainable Development Goals (SDGs) for 2017-2036, which emphasize the appropriate development of people, society, and the economy in response to global changes. Human resource development is pivotal to national progress, and it is essential to prepare individuals to engage with the global community with a clear, holistic perspective, while remaining adaptable to global shifts and evolving social contexts. This necessity is reflected in research focused on international relations development, service model transformation, and network building, as demonstrated by the works of Wanna Sermsuk and Banjung Chaiyarinkham (2023), Thiwat Manichoti and Songyot Saroj (2017, 2022) and Anchalee Worathavornwiwat (2022)

The role of educational institutions is crucial in developing human resources, particularly in equipping students with knowledge and skills aligned with technological advancements. Rajamangala University of Technology, as outlined in the Rajamangala University of Technology Act B.E. 2548 (2005), is tasked with being a leading institution in professional and technological education. Its mission includes promoting academic and professional excellence with a strong emphasis on practical experience, providing academic services in science and technology, and creating pathways for vocational education graduates to further their studies (Chutima Sutcharya Teenthong, Kaew Pornpat Intarawattana, and Suwicha Niamson, 2020). Therefore, it is essential for Rajamangala University of Technology to continuously advance in professional and technological fields to produce graduates who meet international standards. This includes fostering collaborations with overseas educational institutions.

Rajamangala University of Technology Lanna (RMUTL) has a mission aligned with the strategic needs of the northern region, particularly its border areas with Mekong River Basin countries, including Thailand, Myanmar, Laos, Cambodia, Vietnam, and Southern China. The university also focuses on building foreign relations within the Eastern and Western Economic Corridors, encompassing Myanmar, Thailand, Laos, Cambodia, and Vientiane. To enhance international cooperation, RMUTL engages in various projects that offer assistance, coordination, and services related to scholarships, training, seminars, job visits, and foreign affairs. These initiatives aim to develop the potential of both students and staff while advancing the academic work of RMUTL towards internationalization.

Research on collaborative mechanisms between foreign universities and local institutions reveals diverse impacts and strategies. Collaboration between foreign subsidiaries and local universities can enhance knowledge absorption and spillovers（Guimón and Salazar‑Elena, 2015）. In Chinese‑foreign cooperative education, resource sharing and quality assurance are crucial for improving educational quality and promoting cultural exchange（Xuxun and Tham, 2024）. Multinational companies often bypass local Research and development（R&D）units in favor of distant collaboration with foreign universities, depending on knowledge capabilities, research domain characteristics, and local knowledge leakage risks（Belderbos et al., 2021）. For Chinese manufacturing firms, collaboration with universities in developing countries, particularly NIEs and emerging economies, enhances ground‑breaking innovations, while partnerships with US/EU/Japan universities benefit foreign‑invested firms. Domestic university collaborations play a significant role in diffusing advanced technology within China (Fu and Li, 2016).

Research universities play a crucial role in developing countries' participation in the global knowledge economy (Altbach, 2013). Collaborative mechanisms between universities in developing and developed countries have gained importance over the past decades (Parker, 1992). These collaborations can help developing countries address financial constraints and capacity shortages in higher education (Guimón and Narula, 2019). International branch campuses of foreign universities can be beneficial if they complement and strengthen weak areas in the host country's education system (Guimón and Narula, 2019). However, the impact of international collaboration may not always surpass that of institutional collaboration. A case study in a developing country found that while internationally co‑authored papers were published in slightly higher‑ranked journals, their citation counts were comparable to institutionally collaborated articles (Al-Abbas and Saab, 2020). To maximize benefits, developing countries should carefully consider their readiness for collaboration and implement policies that align foreign universities with their national goals (Parker, 1992; Guimón and Narula, 2019).

This paper compiles data, processes, and analyzes the policy guidelines for international relations and foreign affairs at RMUTL. The findings aim to inform the development of cooperation strategies and policy formulation, as well as to enhance systems and mechanisms for academic, research, and innovation collaboration with international partners. The ultimate goal is to advance the university's education and elevate it to an international standard in the future.

2. Objective

Here is the English translation:

2.1 To develop systems and mechanisms for academic, research, and innovation collaboration between RMUTL and global network partners.

2.2 To create sustainable approaches for supporting and promoting the development of personnel, research outputs, and innovations through academic, research, and innovation collaboration mechanisms with global network partners.

2.3 To develop strategies for producing students and graduates through international collaboration mechanisms, enabling them to pursue employment opportunities and further education abroad.

3. Methodology

The purpose of this research study is to study and collect data on the cooperation that has been carried out by Rajamangala University of Technology Lanna. To see the future development of cooperation and international relations and to develop the system and mechanism for academic, research and innovation cooperation of the University of Thailand with global network partners. The method of operation is to study and collect data from the analysis of data results of cooperation in international cooperation. RMUTL has started to sign a cooperation agreement in 2019. The results of the survey were conducted from 2005 to the present in 2023 for a period of 19 years, and the amount of data was clarified by area group and important issues in cooperation between various educational institutions to see the direction of development of cooperation that occurred

For this research, the research concept framework is shown in Figure 1 from the development guidelines for cooperation in foreign affairs, which consists of 4 related areas: 1) People, i.e. faculty, staff, and students of Lanna University, 2) Partners, which is a group of overseas cooperation networks through academic cooperation between institutions, namely the ASEAN region. 3) Product is the result of cooperation, which consists of academic cooperation (Co-Research), cooperation in writing academic articles (Co-Publication), and cooperation in innovation production (Co-Innovation). The research process is as follows

1. Collecting relevant research data and research documents.

2. Collecting basic quantitative information such as the number of academic cooperation (MOUs), countries, cooperation patterns, and activities that occur.

3. Collecting information from internal departments such as the international relations agency representatives of relevant parties and faculties related to foreign affairs Research and Innovation

4. Development of university strategies and mechanisms to enhance academic research and innovation with global partners.

4. Results

4.1 RMUTL's Data on MOUs with International Institutions

Over the past two decades, an analysis of RMUTL cooperation agreements with overseas educational institutions, starting from 2005, reveals partnerships with a total of 57 institutions across 16 countries in Asia, Australia, and Europe. Of these, 11 countries are in Asia, including China, Taiwan (R.O.C), Japan, Malaysia, South Korea, Indonesia, Vietnam, Cambodia, Myanmar, Laos, and Singapore. The analysis also shows partnerships with 51 educational institutions in Australia, 2 in New Zealand, and 3 in Germany. The data highlights that the majority of RMUTL's collaborations are with institutions in Asian countries as shown in Fig.1 and Fig.2.

In the past, to develop joint academic cooperation between educational institutions and agencies that had signed agreements, the researcher categorized the key aspects of these collaborations. The summary highlights the proportion and content of these agreements. These activities included short-term student and faculty exchanges, scholarships for studying abroad, collaborative projects with faculty members holding master's and doctoral degrees, joint research projects, language and culture camps, language training courses, and the donation of a laboratory and training center as part of a project to establish a joint laboratory at RMUTL. Additionally, the cooperation extended to short training courses and participation in the Vocational Education and Training Network. For roles other than international cooperation. Teaching and learning in universities to become international Lanna University has opened an international program in the Faculty of Business Administration and Liberal Arts. The Bachelor of Business Administration Program in International Business Management (International Program) and foreign students in the Royal Scholarship Program with students from Cambodia. Studied at the undergraduate level in engineering and business administration, etc.

Overall, RMUTL collaboration with foreign institutions has consistently expanded during the past operational period. The establishment of a network with 57 institutions reflects sustained efforts to develop and maintain these partnerships. However, there is a need to further enhance this network to mutually benefit academic work and promote sustainable development. Currently, the activities with partner institutions are primarily centered on short-term student exchanges and training, which constitute the majority of collaborations, as well as faculty exchanges as outlined in the MOUs. However, efforts toward sustainable development, internationalization, and enhancing academic, research, and innovation collaboration with international partners have yet to be fully realized. Developing effective mechanisms to achieve these goals should be a priority.

4.2 Systems and Mechanisms for Enhancing Academic, Research, and Innovation Collaboration with International Partners

Figure 3 presents a research framework designed to enhance academic, research, and innovation collaboration with international partners. This framework includes four key factors: people, partners, products, and processes. The details of these factors are outlined below.
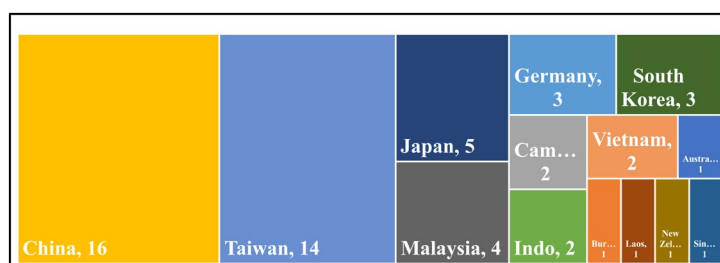
Fig. 1 The number of cooperation agreements between foreign educational institutions and agencies and RMUTL. (Phantachang et al, 2023)
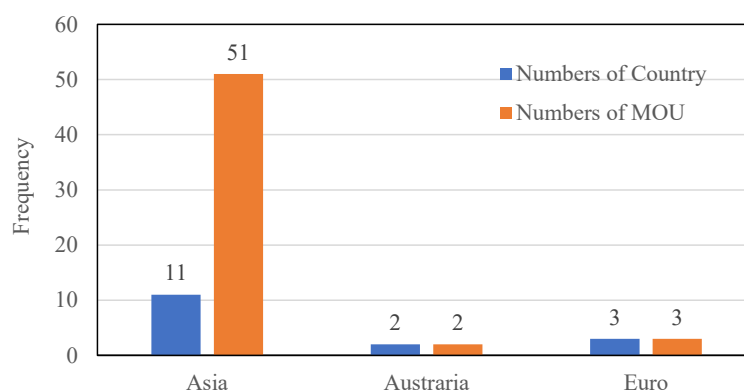
Fig. 2 Number of cooperation agreements between foreign educational institutions and agencies and RMUTL

by continent (Phantachang et al, 2023)

1. Partners: RMUTL currently partners with institutions across ASEAN (e.g., Singapore, Malaysia, Vietnam), Asia (e.g., China, Taiwan, India, Japan), Europe (e.g., Germany, France), as well as the USA, Australia, and New Zealand. To expand its network and enhance collaborations, RMUTL might consider the following strategies:

1.1 Identify Strategic Partners

Focus on Mutual Interests: Identify institutions with shared academic and research interests.

Expand Geographic Reach: Target regions and countries where RMUTL has less representation, such as Africa or South America.

Leverage Existing Networks: Use current partnerships to explore new connections through conferences, academic networks, and alumni.

1.2 Enhance Visibility and Reputation

Publish Joint Research: Collaborate on high-impact publications with international partners.

Host International Conferences and Workshops: Invite global institutions to participate in academic events organized by RMUTL.

Participate in Global Rankings: Improve RMUTL's presence in international rankings to attract more partners.

Fig.3. Research Framework

1.3 Strengthen Communication and Relationship Management

Regular Communication: Maintain regular contact with existing partners through virtual meetings, newsletters, and updates.

Create a Dedicated International Office: Establish an office or team specifically focused on managing and expanding international collaborations.

Celebrate Successes: Publicize successful collaborations and achievements to motivate continued engagement.

1.4 Develop Comprehensive Collaboration Programs

Create Flexible MOUs: Develop Memoranda of Understanding (MOUs) that allow for diverse types of collaboration, including research, student exchanges, and joint degree programs.

Introduce Dual-Degree and Joint Programs: Establish dual-degree programs that can draw students and faculty from partner institutions.

Offer Collaborative Research Grants: Provide funding opportunities specifically for collaborative research with international partners.

1.5 Invest in Capacity Building

Language and Cultural Training: Offer language and cultural exchange programs to both faculty and students to facilitate better international collaboration.

Support Faculty and Student Exchanges: Increase the number and scope of exchange programs to build deeper connections with partner institutions.

Enhance Digital Collaboration Tools: Invest in digital platforms that allow for seamless collaboration, especially for research and joint projects.

1.6 Continuous Evaluation and Adaptation

Monitor and Evaluate Collaborations: Regularly assess the effectiveness of ongoing collaborations and make adjustments as needed.

Adapt to Changing Global Trends: Stay informed about global academic trends and adapt RMUTL's collaboration strategies accordingly.

Solicit Feedback: Seek feedback from partners on how to improve the collaboration process and implement their suggestions.

2. Products: For enhancing collaboration in the areas of co-research, co-publication, and co-innovation, RMUTL could consider the following strategies:

2.1 Co-Research Initiatives

Joint Research Programs: Establish joint research programs with international partners that align with both institutions' strengths and interests.

Collaborative Grants: Apply for international research grants and funding opportunities that require or encourage collaborative efforts.

Research Exchanges: Facilitate researcher exchanges and visiting scholar programs to foster collaboration and share expertise.

Shared Research Facilities: Create opportunities for shared use of research facilities and resources to support joint research activities.

2.2 Co-Publication Efforts

Co-Authorship Agreements: Develop formal agreements that outline co-authorship roles and responsibilities for publications resulting from joint research.

International Conferences: Co-organize or participate in international conferences and workshops to present collaborative research findings.

Joint Special Issues: Publish special issues in academic journals that feature research from collaborative projects.

Research Networks: Join or create research networks that facilitate collaboration and co-publication among international researchers.

2.3 Co-Innovation Projects

Innovation Incubators: Set up innovation incubators or labs that bring together teams from RMUTL and international partners to work on joint projects.

Technology Transfer Partnerships: Develop partnerships for technology transfer and commercialization of jointly developed innovations.

Startup Collaborations: Collaborate on startup ventures and spin‑offs that stem from co‑innovation projects.

Cross‑Disciplinary Teams: Form cross‑disciplinary teams with international partners to address complex problems and develop innovative solutions.

3. People: to enhance collaboration in the areas of academic resources such as professors, lectures, students, and staff, RMUTL could consider the following strategies:

3.1 Professors and Lecturers

Guest Lectures and Seminars: Invite international professors and lecturers to deliver guest lectures and seminars, and send RMUTL faculty to do the same at partner institutions.

Collaborative Research Projects: Encourage faculty members to collaborate on research projects with international colleagues, leading to joint publications and innovations.

Academic Workshops: Organize workshops and training sessions involving international experts to enhance faculty skills and knowledge in specialized areas.

Visiting Professorships: Establish visiting professorships to allow international scholars to spend time at RMUTL, enriching the academic environment.

3.2 Students

International Study Tours: Arrange study tours and field trips abroad for students to gain international exposure and experience different academic and cultural environments.

Joint Academic Projects: Facilitate joint academic projects and case studies with students from partner institutions to enhance collaborative learning.

Global Competitions: Participate in or host international academic competitions and conferences to provide students with opportunities to showcase their work and network globally.

Exchange Programs: Expand student exchange programs to enable students to study at partner institutions and benefit from diverse educational experiences.

3.3 Staff

Cross‑Cultural Training: Provide training for staff on working in cross‑cultural environments to improve collaboration with international colleagues.

Staff Exchange Programs: Implement staff exchange programs to foster professional development and enhance relationships with international institutions.

Collaborative Initiatives: Encourage staff to participate in collaborative initiatives and projects with their counterparts at partner institutions.

Networking Events: Organize networking events and forums where staff can connect with international peers to explore potential collaborations and share best practices.

4. Processes: To enhance collaboration in the areas of process at RMUTL, including change agents, systems and mechanisms, types of collaboration, activities, internationalization, and MOU and research funding, RMUTL could consider the following strategies:

Change Agents: Individuals or groups driving the collaboration efforts.

Create Systems and Mechanisms: Establishing the necessary frameworks, agreements (MOUs), and platforms to support collaboration.

Develop Types of Collaboration: Identifying and establishing various forms of partnership, such as academic exchanges, joint research, and innovation projects.

Activities: Implementing specific collaborative activities like exchange programs, short- term training, and cultural exchanges.

Internationalization: Strategies for preparing RMUTL for global engagement, including enhancing language skills and adapting the admissions process for international students.

MOU and Research Funding: Securing formal agreements and financial support for collaborative initiatives.

4.3 Mechanism of Admirative University Committees

To develop systems and mechanisms for enhancing academic, research, and innovation collaboration with international partners, two primary areas need attention: improving RMUTL's organizational structure and refining mechanisms for collaboration. The details of these areas are outlined below.

4.3.1 Organizational Structure

4.3.1.1 Policies are set at the university's executive level by the President.

4.3.1.2 A primary unit is responsible for promoting international research collaboration, overseen by university executives who formulate, manage, and monitor policies, assess performance against these policies, and provide recommendations to the administration.

4.3.1.3 A centralized research system is in place through units like the Research and Development Institute (RDI) and various faculties, each with clearly defined responsibilities.

4.3.1.4 There is a unit dedicated to identifying and securing funding and budgets that align with the university's research needs and development direction.

4.3.1.5 Research units are clearly designated, such as those focused on technological development aligned with international development policies, as well as basic and applied research.

4.3.2 Mechanisms

4.3.2.1 Progress is driven through university committees, with clearly defined roles and responsibilities.

4.3.2.2 Strategies and tactics are developed to promote international research collaboration, aiming to enhance knowledge, innovation, and the economy, support the pursuit of excellence, and enable the future development of research into commercial applications.

4.3.2.3 The university should have mechanisms to allocate funding to create research and innovation networks with international partners, including both academic institutions and private sectors. This includes developing mechanisms to prioritize funding, such as promoting international collaboration, funding joint research with foreign institutions, and supporting the publication of joint academic works with international universities.

4.3.2.4 are mechanisms for exchanging personnel, both from abroad and within the country, to enhance the capabilities of RMUTL faculty by providing opportunities for development in collaboration with countries that have strong research potential.

4.3.2.5 Financial and budgetary regulations should facilitate the promotion of both domestic and international research collaboration.

4.3.2.6 Continuous investment is made in study visits, training, and research development.

4.3.2.7 The university supports and encourages the publication of joint academic research with international partners to advance both research quality and academic career development.

5. Conclusion

5.1 This study provides a comprehensive overview of RMUTL's international collaborations over the past two decades, revealing partnerships with 57 institutions across 16 countries in Asia, Australia, and Europe. The analysis highlights the predominance of collaborations with Asian institutions and identifies the primary focus areas, including short-term exchanges, training programs, and collaborative projects.

5.2 Despite the growth and continuity of these partnerships, there is a clear need for RMUTL to enhance its network and develop mechanisms that more effectively support academic, research, and innovation collaborations. The current activities, while significant, are primarily centered on short-term exchanges and faculty interactions. To achieve sustainable development and internationalization, RMUTL must prioritize developing comprehensive strategies that include expanding collaborations, enhancing visibility, and investing in capacity building.

5.3 The research framework presented outlines key factors for enhancing collaboration: people, partners, products, and processes. Strategies include identifying strategic partners, strengthening communication, and creating flexible collaboration programs. By implementing these strategies and refining its organizational structure, RMUTL can improve its international partnerships and advance its mission of fostering global academic and research excellence.

5.4 The university's policies are established by the President, with a primary unit responsible for managing and promoting international research collaboration. This unit, overseen by executives, formulates policies, monitors performance, and provides recommendations. The centralized research system includes the Research and Development Institute (RDI) and various faculties with defined roles. Additionally, a specific unit manages funding and budgets aligned with research needs.

5.5 University committees drive progress through clearly defined roles. Strategies are developed to enhance international research collaboration, focusing on knowledge, innovation, and economic development. Mechanisms include funding allocation for research networks, joint projects, and academic publications. Personnel exchange programs and continuous investment in study visits, training, and research development are also key. Financial regulations support both domestic and international collaboration, while the university encourages joint research publication to improve research quality and academic careers.

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Financial Risk Assessment for A Construction Project

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ABSTRACT

This article demonstrates an application of a multi‑criteria decision analysis tool, named Decision‑making Trial and Evaluation Laboratory (DEMATEL). Since the financial risk factors of a construction project are complicated and one factors may affect to other factors with different degree, a conventional decision analysis tool which ignore relationship among risk factor will fail to identify critical risk systematically. This study chose a sample construction project in China and twenty‑six staff members are the decision makers. There are twenty‑eight risk factors in nine groups from literature be considered. The result shows that DEMATEL can identify cause‑and‑effect factors evidently. Furthermore, the threshold value of this technique helps us to ignore trivial effects and focus on significant relationship between independent and dependent factors. This decision tool can be applied to the case experiment effectively.

KEYWORDS: Safety management, construction industry, multi-criteria decision making, DEMATEL

1. Introduction

The construction business is a multifaceted, efficient, and highly demanding sector in the expanding global economy. Successfully achieving the key aims and objectives of the industry demands careful attention to resource management, labor requirements, equipment, processes, contract management, and expert advice (Kumar, 2018). In addition to the multitude of intricate duties inherent in construction, the presence of risks and uncertainties throughout multiple processes is an anticipated aspect of this expansive and essential business. The economic development is contingent upon expanding the construction industry while effectively addressing risks (Srinivasan and others, 2022).

The risk that harms the project is considered from the beginning of the investment process, namely when the contract is awarded after winning the bidding (Gad and others, 2022). The risk level associated with a specific construction contract is a significant determinant in deciding whether to accept or decline the contract. The primary concern revolves around accurately identifying contract risk. The risk factors that substantially influence the project's success and are commonly encountered are further examined. The verification method is contingent upon the company's level of expertise in the construction sector (Singh and others, 2019).

In the last years, China has been suffering from a severe economic crisis, which has affected a large number of businesses and industries, specifically the construction industry (Jiao, 2021). Inevitably, the construction industy is suffering from this factor. Nevertheless, the industry must continue to lead the economic and must be conducted cautiously. To do so, we need to identify, classify, and analyze the most significant risks inherent in a construction project; specifically, on the financial and economic risk category.

This study aims to mitigate financial risk by identifying and analyzing the factors that influence the financing of a construction project. The study contributes to mitigating the financial risk associated with a project and enhancing operational efficiency in the future. It examines the traditional way of evaluating project financing risks and its application to a current building project. The DEMATEL-ISM approach is employed to conduct data analysis to produce project finance risk and evaluate the index system. The rest of the article is organized as follows: Section 2 illustrates the objective of this study; section 3 reviews related theory and their state-of-the-art risk assessment methods. The DEMATEL is described briefly. Section 3 explains the research method and shows the research procedure. Section 4 shows the results and rigorously discusses them. Finally, the conclusion and recommendations for future study are portrayed in section 5.

2. Research Objective

To identify and classify financial risk factor of a sample construction project in Kunming.

3. Literature Review

3.1 Construction Industry

The construction industry constituted around 6.8 percent of China's total domestic GDP in 2023. A substantial portion of the nation's economy is dependent on the real estate sector and the construction of infrastructure. During periods of economic decline, authorities often rely on infrastructure improvements as a means to stimulate economic growth (Zhang, 2024).

In 2023, the China construction industry was worth USD 2,734.90 Billion. It is expected to grow at a Compound Annual Growth Rate (CAGR) of 5.4% from 2024 to 2030, reaching USD 4,107.20 Billion by 2030. The construction market, often known as the infrastructure sector, plays a crucial role in the economy by managing the whole lifespan of various physical assets, such as infrastructure, buildings, and amenities. This sector comprises a broad spectrum of projects, including residential, commercial, and industrial developments, as well as civil engineering and institutional real estate activities.

The operation relies on the collaboration of various parties, including architects, engineers, contractors, suppliers, developers, investors, and government authorities. The business is set to expand due to a growing focus on environmentally sustainable practices, such as incorporating green construction materials and energy-efficient designs. Moreover, the increasing per capita income in emerging economies and the low interest rates in established nations are expected to boost the growth of the infrastructure industry (Next MSC., 2024).

The infrastructure sector in China is seeing significant expansion, fueled by increasing investments in infrastructure projects throughout the region. According to data from the Global Infrastructure Hub, investments in the infrastructure sector reached a significant amount of USD 942 billion in 2023. The road transport sector receives a substantial amount of investment, at $ 356 billion, with the energy sector closely following at USD 281 billion. The current trend of investment is projected to persist, promoting consistent expansion and progress in the building industry.

In addition, the decrease in inflation rates strengthens consumer preference and purchasing power, potentially increasing demand for new projects, such as residential and commercial constructions. China's inflation rate in 2024 was 0.97%, which is considerably lower than that of other countries like India and Japan. This positive economic indicator contributes to the growth of the infrastructure sector, attracting more investment and promoting overall economic development in the country.

Figure 1 China's construction industry growth forecasting

3.2 Financial Risk Analysis in Construction Projects

3.2.1 Construction project risk management

Risk management refers to the collective mindset, methods, and systems employed to generate advantages while mitigating adverse outcomes proactively. Befrouei and Taghipour (2015) defined risk management in the context of construction project management as a thorough approach to recognizing, evaluating, and dealing with risks in order to accomplish the project's goals and objectives. As to the British Standards BS31100 (2011), risk management is making decisions to address known or quantified risk and taking actions to reduce the impact or likelihood of its occurrence.

Risk management is a crucial responsibility for project managers. Neglecting this job can lead to a range of problems and financial setbacks. Effective dynamic risk management necessitates a meticulous approach and the acquisition of pertinent information, extensive knowledge, and practical experience. The primary rationale behind risk management in construction projects is to provide a secure work environment for the labor force and enhance the achievement of objectives. According to Mihoci and others (2020), risk management is a thorough procedure involving identifying and evaluating risks to determine the necessary measures for effective risk mitigation.

Moreover, it enables a system to effectively manage the typical risks in its daily operations and maintain its processes in a comprehensive and suitable environment, facilitating cost-effective outcomes. Risk

management involves proactively preparing for future incidents for the same reason. Nevertheless, the neglect of risk management in the building industry has resulted in unfavorable consequences and substandard workmanship. For instance, the lack of effectiveness in managing and the inaccurate assessment of two essential project factors, namely cost and time, which are difficult to measure accurately, can result in project delays and increased expenses.

3.2.2 Financial risk analysis

Financial risk analysis involves evaluating the probability of a potential danger occurring and its potential consequences. Therefore, it is significant in the field of risk management. Financial risk management involves assessing the probable impact and level of exposure to a risk (Mashrur and others., 2020).

Performing this estimate is a complex endeavor, as a particular risk has the potential to initiate numerous consequences. For instance, malfunctioning equipment causes mechanical harm that necessitates repair, disrupts production, incurs financial losses, causes delivery delays, and tarnishes the company's reputation.

The assessment of a company's financial risk begins with the identification of all potential risk occurrences. This article explains the process of identifying them. The analysis not only estimates potential losses but also proactively prevents them. For instance, credit risk analysis, a prominent form of financial risk assessment, evaluates the likelihood that a borrower may be unable to meet their obligations. Armed with this information, the bank proactively takes measures to prevent such incidents or minimize their consequences. Therefore, it is imperative for financial risk management to consider both the internal and external elements that give birth to potential hazards.

Internal factors refer to the factors generated as a result of the company's business operations. Inadequate cash management or production issues pose hazards that can negatively influence a company's financial accounts and market valuation. External variables are political, economic, or social situations that impact a company's performance. These influences can include economic crises, fluctuations in exchange rates, industry changes, or government policy shifts. An efficient approach to performing a financial risk analysis at a company involves integrating the likelihood of a risk event with the potential economic damages it may induce. After identifying the risks and selecting the most suitable instrument to manage them, the organization can determine whether to avoid or accept them based on risk appetite and tolerance level. Risk exposure is quantitatively measured. To evaluate the possible impact of an incident that affects only a specific organization region, we can calculate it by multiplying the chance of the risk occurring by the approximate financial loss. The outcome can provide a graphical representation of functions indicating acceptable and hazardous risks.

Undoubtedly, while making decisions, it is imperative to take into account market trends as well as macroeconomic and financial elements. The financial risk manager can utilize real-time risk detection techniques to effectively manage and proactively address various conditions, hence minimizing potential financial risks. Risk management software is a specific technology used for managing and mitigating risks. Risk management software minimizes the need for manual transaction duties and, as a result, reduces the subjective

nature of analysis. Consequently, it serves as a proficient and user‑friendly instrument in the realm of financial risk management.

3.3 Decision-making Trial and Evaluation Laboratory (DEMATEL)

The DEMATEL technique possesses the capacity to address intricate and arduous issues in real‑life scenarios. The DEMATEL approach employs graph theory and matrix operations. By examining a system's logical links and direct cause‑and‑effect relationships, we can classify its components into two distinct groups: the group that is influenced and the group that exerts influence. The primary advantage of this technique lies in its ability to incorporate the viewpoints of multiple experts on a particular subject and analyze complex relationships among various parts using a graphical structural model (Ha and Yang, 2018).

The DEMATEL technique can efficiently transform the relationships among the identified components into a tangible structural model of the studied system. This strategy can be executed by classifying the components into cause‑and‑effect categories. Concerning this issue, the identified criteria can be organized in a hierarchical order, and the resulting priority can be utilized for formulating long‑term strategic decisions and devising enhancement initiatives. In essence, DEMATEL cannot address decision‑making issues; its primary purpose is to assess the interconnectedness of cause-and-effect factors.

4. Research Methodology

This section presents the research procedure and details, including the sample construction projects in Kunming, China. However, the participants are only at middle‑ to upper‑management levels. Thus, 26 staff members participated in this study. The details of the participants are described in section 4.1.

4.1 Population and Sample

The sample construction project is in Kunming, China. The project size, value, and number of staff are confidential, so we are not allowed to show them to the public. Furthermore, other quantitative data, such as plot size, project location, and construction equipment, are closed. Table 1. Shows the research respondents and their facts.

Table 1 Research participants

No.	Position	Number	Experience (Years)
1	Project manager	1	15
2	Vice project managers	1	13
3	Financial manager	1	7
4	Marketing manager	1	10
5	Personal manager	1	5
6	Supplier manager	1	7
7	Construction engineers	12	3 - 7
8	Supervisors	8	5 - 10
	Total	26	3 - 15

4.2 Research Instrument

The risk factors were retrieved from the literature and reviewed by three managers from three departments of the sample construction company with at least five years of experience. The risk factors are shown in Table 2.

Table 2 Key risk factors

Class	Elemental description	Code
Pandemic, R_1	Pandemic outbreak	x_1
Political, R_2	War and geopolitical conflict	x_2
	Political corruption	x_3
	Regulation and policy changes	x_4
Economy, R_3	Fluctuation of currency exchange rate	x_5
	Inflation rate	x_6
	Interest rate	x_7
	Household debt	x_8
Credit, R_4	Project's credit risk	x_9
	Equity holder's credit risk	x_{10}
Engineering, R_5	Design change	x_{11}
	Lack of material and qualified suppliers	x_{12}
	Substandard materials	x_{13}
	Substandard equipment	x_{14}
	Project delay	x_{15}
Operation, R_6	Counterparty risk	x_{16}
	Rating risk	x_{17}
	Tax risk	x_{18}
Market, R_7	Client's financial stability	x_{19}
	Poor financial market	x_{20}
	Poor market research	x_{21}
Liquidity, R_8	Lack of cash flow	x_{22}
	Project's liquidity	x_{23}
	Delay payment by client	x_{24}
Others, R_9	Lack of competent staff	x_{25}
	Environmental impacts	x_{26}
	Public impacts	x_{27}
	Poor construction supply chain management	x_{28}

The questionnaire was validated using the index of item-objective congruence (IOC) by three university professors who studied risk analysis, financial management, and construction management over ten years in China. The IOC equals 1.00; that means the questionnaire is congruent with the objective.

4.3 Data Analysis

1) Pairwise comparisons: obtain an initial direct-relation matrix (Z)

The initial direct-relation matrix Z is an average $n \times n$ matrix constructed by pairwise comparisons of m decision-makers. Equation (1) is $Z = [z_{ij}]_{n \times n}$ where Z_{ij} is denoted as an average direct-relation value of x_{ij} and all principal diagonal $z_{ij}(i=j)$ equals to zero, $X^k = [x_{ij}^k]$ is a judgement on causal relationship between x_{ij} by the kth decision maker.

$$Z = [z_{ij}]_{n \times n} = \frac{1}{m} \sum_{k=1}^{m} z_{ij}^k, \quad \forall i, j = 1, 2, \dots, n \tag{1}$$

2) Direct-relation matrix normalization (D)

The normalized direct-relation matrix $D = [d_{ij}]_{n \times n}$ where the value of each factor in matrix D is $0 \leq d \leq 1$, can be obtained through Eq. (2) and (3). The maximum value of the sums of each row and column is used to calculate a coefficient s.

$$s = \min \left[\frac{1}{\max\limits_{1 \leq i \leq n} \sum_{j=1}^{n} |z_{ij}|}, \frac{1}{\max\limits_{1 \leq j \leq n} \sum_{i=1}^{n} |z_{ij}|} \right] \quad i, j = 1, 2, \dots, n \tag{2}$$

$$D = s \times Z \text{ or } [d_{ij}]_{n \times n} = s \times [z_{ij}]_{n \times n}, s > 0 \tag{3}$$

3) Calculate a total-relation matrix (T) and its sum of rows and columns

The total-relation matrix T is calculated by Eq. (4) as matrix operations on D.

$$T = \lim_{m \to \infty} (D^1 + D^2 + \dots + D^m) = \sum_{m=1}^{\infty} D^i = D(I - D)^{-1} \tag{4}$$

where I is an $n \times n$ identity matrix. R_i and C_j in Eq. (5) are the sums of rows and columns in the matrix T, respectively, in which t_{ij} denotes the interdependent value of each pair of the investigated factors. Additionally, in Eq. (6), the horizontal axis value pr_i^+ denotes how crucial the ith factor is, whilst the vertical axis value pr_i^- classifies the factors into the cause-and-effect group. If the value of pr_i^- is positive, the factor is classified into the cause group. Alternatively, when the value of pr_i^- is negative, the factor is grouped into the effect group.

$$R_i = \sum_{j=1}^{n} t_{ij} \quad, \quad C_j = \sum_{i=1}^{n} t_{ij} \quad (i, j = 1, 2, \dots, n) \tag{5}$$

$$pr_i^+ = R_i + C_i \quad, \quad pr_i^- = R_i - C_i \tag{6}$$

4) Calculate a threshold value (α)

The threshold value α tends to filter and remove the factors that have trivial relation on others in the matrix T. The threshold value is calculated by the average value of t_{ij}, where N denotes the total number of element ($i \times j$), see Eq. (7). Only the factors whose relation values of t_{ij} are higher than the threshold value can be considered interdependency among the risk factors.

$$\alpha = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} t_{ij}}{N} \tag{7}$$

5. Results and Analysis

There were 100% return rate with 26 decision makers. The followings show some important results of the study.

1) Pairwise comparisons: obtain an initial direct-relation matrix (Z),

The direct‑relation matrix is calculated using Eq. （1）as shown in Table 3. Please note that due to the limited space of this manuscript, the matrix is shown in shrink type.

Table 3 Direct-relation matrix of twenty-six decision-makers

	X1	X2	X3	X3	X5	X6	...	X23	X24	X25	X26	X27	X28
X1	0	1.1	1.5	4.2	3.7	4.5	...	3.6	4.1	1.8	1.8	3.4	3.1
X2	1.0	0	2.1	3.7	3.4	4.1	...	2.8	3.1	1.9	1.5	2.7	3.4
X3	1.0	2.5	0	4.1	1.9	2.1	...	3.4	2.2	1.8	1.5	3.5	2.5
X5	1.0	1.4	2.1	0	3.1	3.7	...	3.3	2.7	1.8	1.5	2.7	3.1
X5	1.0	1.3	1.5	3.4	0	4.5	...	3.9	3.1	2.1	1.7	2.3	3.9
X6	1.0	1.1	1.3	2.1	3.1	0	...	3.3	3.6	1.9	1.1	1.6	3.4
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮	⋮	⋮	⋮	⋮	⋮
X23	1.0	1.0	1.0	1.0	1.0	1.1	...	0	2.5	3.2	2.8	2.7	3.8
X24	1.0	1.0	1.0	1.0	1.0	1.0	...	3.8	0	3.7	2.2	2.4	3.6
X25	1.0	1.0	1.0	1.0	1.0	1.0	...	3.7	2.1	0	2.6	2.5	3.3
X26	1.0	1.0	1.0	3.9	1.0	1.6	...	3.5	3.6	1.9	0	4.2	2.7
X27	1.0	1.0	1.0	3.9	1.0	1.4	...	3.3	3.6	1.7	3.9	0	3.3
X28	1.0	1.0	1.0	3.8	1.0	1.1	...	3.3	3.2	2.2	2.7	2.5	0

2) Direct-relation matrix normalization (D).

The normalized direct‑relation matrix is determined using Eq. （2）and（3）. Table 4 shows information of the normalized direct‑relation matrix.

Table 4 The normalized direct-relation matrix of twenty-six decision-makers

	X1	X2	X3	X3	X5	X6	...	X23	X24	X25	X26	X27	X28
X1	0	1.1	1.5	4.2	3.7	4.5	...	3.6	4.1	1.8	1.8	3.4	3.1
X2	1.0	0	2.1	3.7	3.4	4.1	...	2.8	3.1	1.9	1.5	2.7	3.4
X3	1.0	2.5	0	4.1	1.9	2.1	...	3.4	2.2	1.8	1.5	3.5	2.5
X5	1.0	1.4	2.1	0	3.1	3.7	...	3.3	2.7	1.8	1.5	2.7	3.1
X5	1.0	1.3	1.5	3.4	0	4.5	...	3.9	3.1	2.1	1.7	2.3	3.9
X6	1.0	1.1	1.3	2.1	3.1	0	...	3.3	3.6	1.9	1.1	1.6	3.4
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮	⋮	⋮	⋮	⋮	⋮
X23	1.0	1.0	1.0	1.0	1.0	1.1	...	0	2.5	3.2	2.8	2.7	3.8
X24	1.0	1.0	1.0	1.0	1.0	1.0	...	3.8	0	3.7	2.2	2.4	3.6
X25	1.0	1.0	1.0	1.0	1.0	1.0	...	3.7	2.1	0	2.6	2.5	3.3
X26	1.0	1.0	1.0	3.9	1.0	1.6	...	3.5	3.6	1.9	0	4.2	2.7
X27	1.0	1.0	1.0	3.9	1.0	1.4	...	3.3	3.6	1.7	3.9	0	3.3
X28	1.0	1.0	1.0	3.8	1.0	1.1	...	3.3	3.2	2.2	2.7	2.5	0

3) Calculate a total-relation matrix (T) and its sum of rows and columns

Then, the total direct-relation matrix is calculated using Eq. (4), as shown in Table 5. Then, pr_i^+ and pr_i^- is calculated using Eq. (5) and (6). The result and their implication are shown in Table 6.

Table 5 The total direct-relation matrix of twenty-six decision-makers

	X1	X2	X3	X3	X5	X6	...	X23	X24	X25	X26	X27	X28
X1	0.0232	0.0351	0.0397	0.0807	0.0702	0.0835	...	0.1136	0.1044	0.0746	0.0701	0.0893	0.1031
X2	0.0315	0.0230	0.0439	0.0737	0.0653	0.0773	...	0.1012	0.0903	0.0718	0.0638	0.0791	0.1015
X3	0.0292	0.0446	0.0213	0.0731	0.0470	0.0539	...	0.0981	0.0748	0.0651	0.0593	0.0814	0.0859
X4	0.0306	0.0355	0.0427	0.0367	0.0606	0.0715	...	0.1030	0.0842	0.0692	0.0621	0.0771	0.0958
X5	0.0336	0.0376	0.0402	0.0734	0.0354	0.0838	...	0.1182	0.0961	0.0792	0.0707	0.0803	0.1128
X6	0.0311	0.0330	0.0355	0.0567	0.0610	0.0367	...	0.1044	0.0936	0.0715	0.0595	0.0677	0.1003
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋱	⋮	⋮	⋮	⋮	⋮	⋮
X23	0.0297	0.0305	0.0310	0.0441	0.0381	0.0438	...	0.0681	0.0786	0.0804	0.0733	0.0755	0.0996
X24	0.0304	0.0312	0.0317	0.0448	0.0390	0.0439	...	0.1066	0.0566	0.0871	0.0694	0.0744	0.1001
X25	0.0295	0.0303	0.0307	0.0432	0.0374	0.0422	...	0.1020	0.0745	0.0493	0.0709	0.0728	0.0942
X26	0.0306	0.0316	0.0322	0.0730	0.0401	0.0509	...	0.1047	0.0922	0.0703	0.0484	0.0916	0.0924
X27	0.0303	0.0313	0.0319	0.0726	0.0395	0.0483	...	0.1016	0.0911	0.0678	0.0847	0.0514	0.0969
X28	0.0300	0.0309	0.0315	0.0705	0.0388	0.0447	...	0.1001	0.0858	0.0716	0.0726	0.0742	0.0644

Table 6 Identification of cause-and-effect factors

	R	C	pr_i^+	pr_i^-	Identify		R	C	pr_i^+	pr_i^-	Identify
X1	2.3903	0.8177	3.2080	1.5726	Cause	X15	1.7883	3.0339	4.8222	-1.2456	Effect
X2	2.2446	0.8654	3.1100	1.3792	Cause	X16	1.9356	2.4178	4.3534	-0.4823	Effect
X3	2.0130	0.8906	2.9036	1.1224	Cause	X17	2.0692	2.6454	4.7146	-0.5762	Effect
X4	2.1507	1.4611	3.6118	0.6897	Cause	X18	2.0335	2.0425	4.0759	-0.0090	Effect
X5	2.4586	1.2240	3.6826	1.2345	Cause	X19	2.1127	2.0105	4.1233	0.1022	Cause
X6	2.2008	1.4377	3.6385	0.7630	Cause	X20	2.4275	2.1869	4.6144	0.2406	Cause
X7	1.8076	1.9203	3.7278	-0.1127	Effect	X21	1.9039	1.7573	3.6612	0.1466	Cause
X8	1.9209	1.4745	3.3953	0.4464	Cause	X22	2.1026	2.8096	4.9123	-0.7070	Effect
X9	2.2264	2.3336	4.5599	-0.1072	Effect	X23	2.0622	2.7879	4.8502	-0.7257	Effect
X10	2.1980	2.3609	4.5589	-0.1630	Effect	X24	2.1336	2.2836	4.4171	-0.1500	Effect
X11	1.9430	2.5473	4.4903	-0.6043	Effect	X25	2.0358	2.0096	4.0454	0.0261	Cause
X12	1.7334	2.4696	4.2030	-0.7362	Effect	X26	2.1567	1.8577	4.0145	0.2990	Cause
X13	1.5550	2.5390	4.0940	-0.9840	Effect	X27	2.1253	2.0229	4.1482	0.1024	Cause
X14	1.4413	2.4516	3.8929	-1.0103	Effect	X28	2.0870	2.5982	4.6852	-0.5113	Effect

The pr_i^+ and pr_i^- are the cartesian x and y, respectively. Thus, Fig. 2 illustrates the position of financial risk factors as a diagram, the causal diagram.
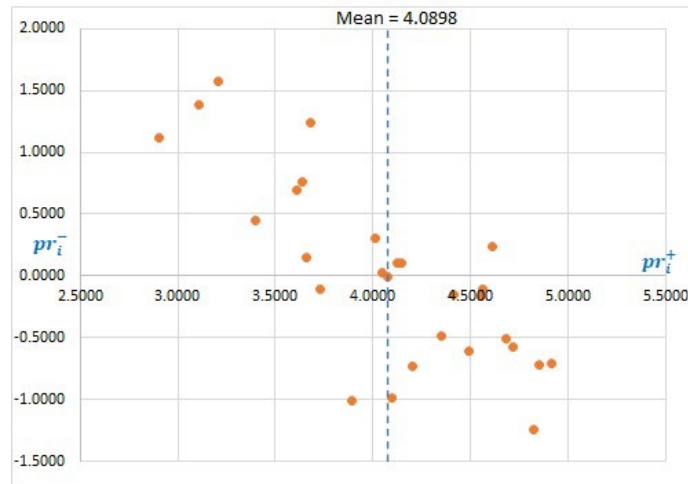
Figure 2 The importance and relationships of the factors

4) Calculate a threshold value (α)

By using Eq. (7), the α is equal to 0.0730. That means some relationships are trivial and can be ignored by risk management team. For example, $t_{6,3} = 0.0355$, which lower than α, see Table 5. It implies that even Inflation rate is a cause of financial risk; however, it does not affect to Political corruption. Another example is $t_{4,7} = 0.0771$. It means Regulation and policy changes affects to Environmental impacts.

6. Conclusion

Twenty‑six decision makers decided on twenty‑eight financial risk factors on the five‑point Likert scale using a pairwise comparison method. Then, the average direct‑relation matrix was determined. The total direct‑relation matrix was obtained. The cause‑and‑effect factors can be obtained by calculating pr_i^+ and pr_i^-. It showed that thirteen out of twenty‑eight factors, such as Inflation rate, Household debt, Poor financial market, and 'Poor market research' are the causes.

In comparison, fifteen factors are the effects, such as Project's credit risk, Design change, Substandard materials, and Project delay. Additionally, the DEMATEL also provides a threshold value equal to 0.0730 to eliminate the trivial relationship between cause‑and‑effect factors. This tool facilitates the financial risk management team's ability to effectively focus on critical risk factors. In future studies, we want to modify the DEMATEL to boost it from the perspective of risk ordering. This will help the risk management team manage their limited resources to mitigate the most priority risk factors.

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