SCSR
Supply chain and Sustainability Research

ISSN 2822-0412 (ONLINE)

SCSR SUPPLY CHAIN AND SUSTAINABILITY RESEARCH

Vol.4 No.1; Jan - Jun; 2025

SOUTHEAST BANGKOK UNIVERSITY
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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR

VOL.4, NO.1; Jan – Jun ; 2025

ISSN 2822-0412 (Online)

Supply Chain and Sustainability Research (SCSR) is an independently run non-profit journal dedicated to serve the worldwide scientific community through periodical of high-quality and high-impact scholarly, multi, and inter-disciplinary research that broadly resides in the arenas of supply chain and sustainability research. SCSR is committed to provide a platform that disseminates academic work, findings, and knowledge promptly, openly, and freely to all, and thus promote practical and public conversation and communication. By this, SCSR strives to be one of the important supply chain and sustainability journals in the world.

The Purpose: To support and encourage the writing of academic works. Disseminate academic works of faculty, academics and students both internally and externally as well as being a medium for education, research and dissemination of academic knowledge.

The goal is to serve as a hub for scholarly support, knowledge transfer, and dissemination. along with quality research The SCSR strives to publish insightful, innovative, and pertinent research that describes or may have an impact on management and/or innovation within the SCSR framework. Benefits to society, the community, and the country as a whole are frequently published in electronic journals by the SCSR. is diverse and interdisciplinary in character. The magazine accepts essays on all topics related to management as well as those relevant to innovation, regardless of discipline or subject area.

SCSR uses a “double-blind peer review system,” meaning that the authors do not know who the reviewers are, and the reviewers do not know who the authors are. All submitted manuscripts are to be reviewed by three expert reviewers per paper. Reviewers are chosen because of their expertise in the topic area and/or methodology used in the paper. Each article is judged based solely on its contribution, merits, and alignment with the journal’s mission. Should any revision be required, our instructions to authors are designed to move authors towards a successfully published article.

This journal is a semiannual publication, issued twice a year:

- Issue 1: January to June
- Issue 2: July to December

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ISSN 2822-0412 (Online)

Greetings from Editor-in-Chief: Supply Chain and Sustainability Review (SCSR)

The application of sustainability issues to supply chain management, logistics, transportation, and various optimization methods has been increasingly popular in recent years. One of the numerous issues that supply chain management encounters on an ongoing basis is operating in a sustainable manner. The goal of the SCSR is to investigate the use of sustainability in supply chain management, operation management, logistics, transportation, healthcare management, and fuzzy sets theory. The first issue of SCSR is to serve this purpose as how sustainable development must go hand in hand with logistics and supply chain management.

We invite academics from a variety of management-related disciplines to submit original, high-quality research papers that primarily address sustainability-management-related challenges and contribute to the SCSR's mission. The articles in the SCSR will emphasize both theoretical and empirical research. Literature reviews, conceptual theory development, qualitative survey research, such as case studies, and quantitative empirical methodologies may all be included in academic papers. SCSR rules must be adhered to by all submitted papers.

In view of current disruptions in global supply chains (e.g., chip crisis), the implications of supply chains for the climate and biodiversity discourse, new supply chain laws to increase social responsibility, and technological innovations (e.g., blockchain), supply chain management has become an imperative for global business.

In this issue, 9 research papers are presented.

1) The guiding role of the Internet economic supply chain management model based on management psychology on the negative emotions and behavioral mechanisms of interested audiences

2) Enhancing Data Privacy Compliance Through Logistics Service Quality: A Strategic Framework for Thailand's Logistics SMEs

3) Intersecting Inequalities in Kenyan Education: A Bordieuan Lens on Economic, Social, and Cultural Capital

4) Youth Climate Action in Thailand: Participation, Strategies, International Linkages, and Policy Reform

5) Co-Creation for Sustainable Development: A Community-Driven Innovation Model in Bang Nam Phueng, Thailand

6) Development of an Instructional Package on Sustainable Supply Chain Innovation Management through the Carbon Heroes Board Game for Undergraduate Students in Logistics and Supply Chain Management

7) Closing the Device: A Comprehensive Analysis of AI-Driven Intelligent Learning Platforms to Meet Varied Student Educational Requirements

The current issue and full text archive of this journal is available on Supply Chain and Sustainability Research at:
https://so08.tci-thaijo.org/index.php/SCSR/index

8) Empowering digital futures: youth-led initiatives for inclusive digital transformation in Bangkok

9) A Study on the Sustainable Development of the Human Resource Supply Chain in China's Domestic Service Education Industry — From the Perspective of Artificial Intelligence

In addition, we would like to inform you about our next issues (Volume 2) in 2025. Recent announcement of the call for papers is accessible on the SCSR website. This issue marks the debut of the SCSR and its birth. It is my pleasure to address you on this occasion. I would like to express a warm welcome to the SCSR readership on behalf of the SCSR Editorial Team. I would like to thank our authors, editors, and anonymous reviewers, who have all voluntarily contributed to the journal's success. Without your participation, this initial issue would not exist.

We look forward to receiving your contributions.

Jirasek Trimetsoothorn

Editor-in-Chief

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Editors

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VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

The guiding role of the Internet economic supply chain management model based on management psychology on the negative emotions and behavioral mechanisms of interested audiences

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Abstract

This study investigates the guiding role of an innovative Internet economic supply chain management (IE-SCM) model, grounded in management psychology, in mitigating negative emotions and influencing the behavioral mechanisms of interested audiences, specifically supply chain enterprise leaders. The current Internet economy landscape, characterized by an imperfect market and legal environment, often fosters mutual distrust, anxiety, unease, and tension among stakeholders due to fear of virtual supply chain risks, talent mobility issues, and social responsibility conflicts. The primary objective was to understand these existing challenges, analyze the root causes of negative emotions, and then innovate the IE-SCM model using principles of management psychology. The aim was to achieve rapid response, flexible management, and zero-time-lag information transmission to meet customer requirements, enhance market competitiveness, and ultimately alleviate negative emotions and guide beneficial behaviors of stakeholders. The research employed an experimental design involving 54 randomly selected supply chain leaders, categorized into young, young and middle-aged, and middle-aged groups. Their psychological states (anxiety, unease, tension) and views on the IE-SCM model were assessed before and after the implementation of the innovative management approach. Data were processed using SPSS software, utilizing a 1-5 scoring scale where lower scores indicated reduced negative emotions.

Results demonstrated a significant improvement in the negative emotional states of all participant groups following the intervention. Before the model innovation, subjects exhibited higher scores across anxiety, unease, and tension dimensions. Post-intervention, negative emotions were alleviated to varying degrees, with a maximum score change of 26 points, showing significant statistical differences ($P<0.05$) compared to pre-experiment data. Mental health scores across ten dimensions also markedly improved ($P<0.05$) after the optimized management model was applied In conclusion, the innovative IE-SCM model, informed by management psychology, effectively reduces negative emotions such as anxiety and tension among stakeholders, substantially enhancing their mental well-being. This model facilitates seamless information flow and improved customer satisfaction, underscoring the critical importance for future enterprise operators to leverage management psychology in optimizing supply chain management for sustainable development and improved stakeholder well-being.

The current issue and full text archive of this journal is available on Supply Chain and Sustainability Research at: https://so08.tci-thaijo.org/index.php/SCSR/index

Keywords: Management psychology, Internet economy, Supply chain management model, Benefit audience, Negative emotions

Introduction

The research content of management psychology is the law of people's psychological activities in organization and management. Its main task is to explore the psychological basis for improving business activities, find various ways to motivate employees' psychology and behavior, and maximize employees' enthusiasm, creativity and productivity. Its research mainly focuses on the specific social psychological phenomena in organizational management, as well as the specific psychological activity laws of individuals, groups, organizations and leaders (Rafferty Alannah E& Griffin Mark A,2006).

Management psychology belongs to a marginal discipline, which integrates the research contents of multiple disciplines, such as psychology, sociology, etc. This psychology can also become behavior management, which can be applied in human resource management. It can also understand the behavior and psychological changes of the research object through the knowledge of this psychology, so as to promote the normal development of research. With the continuous development of network technology and economy, the Internet economy has been formed. Its technical basis is modern information technology, and its carrier is the electronic Internet. The development of the Internet economy promotes the rapid development of e-commerce and the change of enterprise management mode. Supply chain is the carrier of enterprise logistics and other related components. The supply chain is composed of internal and external supply chains. Enterprises can carry out effective integrated management of the supply chain to achieve the goals of high quality and low cost (LI Chun-You， SD Shan,2008).

However, there are still some problems in the current Internet economy supply chain management. Due to the imperfect market and legal environment, the supply chain benefit audience is prone to mutual distrust, and there will be anxiety and other negative emotions due to the fear of the dangers of the virtual supply chain. Moreover, some enterprises may even do harm to other benefit audiences under the trend of interests. Being worried about this phenomenon will aggravate the negative emotions of benefit audiences. What's more，there are still some problems in the human resource management of supply chain enterprises. Under the influence of the Internet economy, the application of information technology, artificial intelligence, AI technology and other technologies has improved work efficiency, changing the attitude of enterprises towards employment, and enhancing the capacity of enterprises to accommodate personnel. On the other hand, the application of these information technologies will help the enterprise employees quickly collect more employment information, enabling them to obtain more job opportunities, thereby enhancing employee mobility. Therefore, under the influence of the internet economy, talent is easily lost, and the loss of core talents in enterprises will reduce their competitiveness. This is also the reason for the negative emotions of the benefit audience, who fear that their own interests will be affected. This negative emotion will be directly reflected in their behavior, hoping to cultivate and retain more core talents. In addition, while the supply chain of the Internet economy develops, it also needs to assume corresponding

social responsibilities. This process is supervised by the public, so that each interest audience in the supply chain will restrict their own behavior. When it conflicts with interests, these interest audiences will also have negative emotions such as irritability and tension.

To sum up, the development of Internet information technology has made the economic development model no longer limited to a single traditional form, and the flow of resources and talents has made the current economic development form and model gradually show a trend of diversification and rejuvenation. The development momentum of commercial enterprises is good, and the enterprise management mode under the operation mode of the Internet economy has also undergone great changes accordingly. As an important carrier of enterprise logistics and other related components, the supply chain can effectively realize the sharing of information resources among enterprises and resist external market sharing (Guo Y, et al., 2001; Bhasin M K.,2018). Therefore, the quality of the supply chain management model has an intuitive and obvious impact on the development of enterprises under the Internet economic situation. However, under the current management status, the benefit audiences involved in the supply chain management model are unaware of risks and interests. Consideration of exclusivity, irregularity of management, unpredictability of resource flow and other concerns make the business trust mechanism between enterprises limited, which makes it difficult to promote the reasonable flow of resources and talents, which has caused great difficulties for the development of enterprises. Obstacles also make the corresponding supply chain and economic entities have negative emotions and negative psychology, which is not conducive to the long-term development of their individuals and the whole enterprise (Kurbanova N.,2019; Yang C, et al., 2019; Aripova N., 2020). Based on the relevant theories of management psychology, the research explores the guiding role of the Internet economic supply chain management model on the negative emotions and behavioral mechanisms of the benefit audiences, in order to help the relevant benefit audiences relieve their negative emotions and improve their mental health.

1. Analysis of the Influence Mechanism of the Internet Economy Supply Chain Management Model on the Benefit Audience from the Perspective of Management Psychology.

1.1 The guiding role of the supply chain management model of the Internet economy on the emotions and behaviors of interested audiences

The Internet economy based on modern information technology has been formed and developed rapidly, which has greatly changed people's way of life. At the same time, it has also promoted the rapid development of e-commerce and the reform of enterprise management models , so that it is no longer limited to a single and traditional model for development (Mekonen EG., et al, 2021) Supply chain management mode refers to a management mode that is composed of internal and external supply chains , and it is a management mode that reasonably handles logistics and resource scheduling and allocation. The quality of its management mode reflects its overall coordination and scheduling of resources to a certain extent. Capability is also one of the important contents of the overall development of an enterprise. However, the relative laxity of the market economy and the short development time of the Internet economy make it easier for various economic audiences under the supply

chain model to have conflicts and conflicts of interest. The reason is that the Internet economy is promoting the rational flow of talents and resources. While providing channels and methods, it also increases the difficulty of resource integration, which affects the trust mechanism between various economic interested audiences (Mimiaga M, et al, 2019). At the same time, the legal system in the market environment is not sound enough. Most of the interested audiences are in the maintenance of their own interests, the competition for market share and the uncontrollability of risks, so they are more likely to show irritability, nervousness, tension, etc. in the form of Internet economic development. Negative emotions and problems such as anxiety (Rezayat M R,et al 2020). While the supply chain of the Internet economy is developing, it also needs to undertake corresponding social responsibilities and is subject to the supervision of the public. Correspondingly, this also invisibly increases the restriction and legitimacy of the economic entities of enterprises on their own behavior. The setting of the degree of interest framework makes it also produce emotional fluctuations and related behavioral mechanisms when faced with conflicts of interest and contradictions (Riyadi I, 2020). Figure 1 shows the guiding role of the supply chain management model of the Internet economy on the emotions and behaviors of interested audiences.

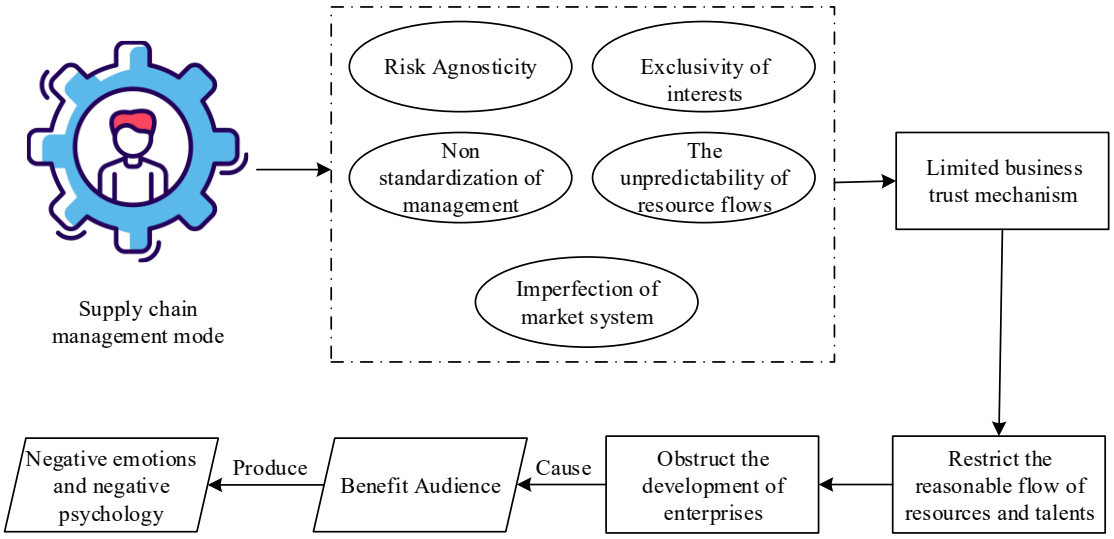

Fig.1 The guiding role of the Internet economy supply chain management model in the interest audience's emotion and behavior

1.2 Optimization of the internet economy supply chain management model from the perspective of management psychology

The research content of management psychology is the psychological activity patterns of people in organization and management. It mainly stimulates employees' psychology and behavior by exploring the psychological basis of improving business activities to maximize employees' enthusiasm, creativity and productivity. The psychological theory of realizing the overall development plan of the enterprise. The research scope of management psychology is not to study the whole of individuals, but to explore the specific psychological activities of individuals, groups, organizations and leaders by limiting the scope of research to organizational management activities. We better understand the psychological characteristics behind the management work, in order to improve

the quality and efficiency of enterprise management (Karamchandani K, et al,2020). Under management psychology, the subject behavior in organizational management activities has certain rules, and behind these rules, people's psychological activity mechanism is hidden, that is, it believes that the subject behavior in the social organization is very closely related to psychology Therefore, the psychological laws and conditions of management subjects in organizational activities have a more important relationship with the development of the overall enterprise (Mansiroglu A K, et al, 2020)

The negative emotions displayed by the audience in the supply chain management mode are the negative emotional experience of their current performance or unknown things, including short-term suddenness and long-term continuity. There are many reasons for negative emotions, such as market environment, Factors such as individual affordability and economic ability will trigger the generation of negative emotions (Keilman L J,et al, 2021; Kensbock J M, et al, 2022). To improve the management model of the Internet economy supply chain with the help of management psychology, it is necessary to innovate its management model, realize zero-time-lag information transmission through rapid response and flexible management, meet customer needs, improve market competitiveness, and win more for the benefit audience. And actively guide the behavior of the benefit audience, realize a flexible and agile operation mechanism, improve the trust between the benefit audience, and then achieve the application effect of alleviating their negative emotions. Figure 2 is a schematic diagram of the optimization idea of the Internet economy supply chain management model from the perspective of management psychology.

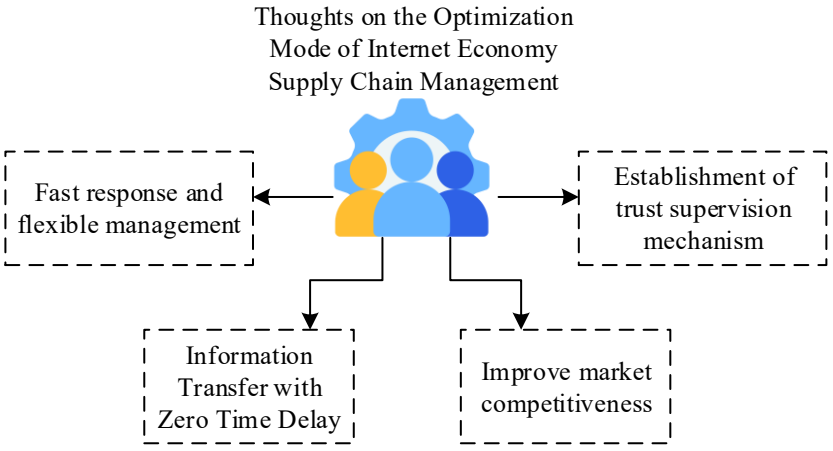

Fig.2 The thought pattern of optimizing the Internet economy supply chain management mode from the perspective of management psychology

1.3 Experimental design and data processing

Enterprises can carry out effective integrated management of the supply chain to achieve high-quality and low-cost goals, and guide the behavior of the audience and stakeholders by setting a reasonable and effective management model, regulate their commercial behavior, and establish a trust mechanism at the same time, reduce the occurrence of psychological problems. This research is based on the current situation and problems of the supply chain management model of the Internet economy, randomly selects 54 supply chain leaders as the research objects, analyzes the reasons for their negative emotions, and uses the theoretical knowledge of management

psychology to innovate the supply chain management model, and multiple improvements were made from aspects such as information transmission, resource flow, and the construction of trust mechanisms, as well as psychological intervention for benefit audiences.

54 randomly selected suppliers were divided into three groups: young, middle-aged, and middle-aged. The age distribution of the youth group is between 20 and 30 years old, the age distribution of middle-aged and young people is between 31 and 44 years old, and the age distribution of the middle-aged group is between 45 and 59 years old.

In the course of the experiment, with the help of relevant psychological scale tools, data collection and relevant effective records are carried out to collect data on the changes of leaders' negative emotions and behavioral mechanisms under the management innovation model. At the same time, SPSS software was used for data processing during the experiment. When analyzing the data, the scores were replicated by weights on a scale of 1-5, with lower scores indicating less impact. At the same time, in order to facilitate the expression of the research results, the research uses the mean ± standard error as the result, and the test method is repeated variance test. The formula for calculating the standard error is formula (1)

$$S=\sqrt{\frac{\sum_{i=1}^{n}\left(X_i-\bar{X}\right)^2}{n-1}} \quad (1)$$

In formula (1), the standard error is S, the number of samples is, the mean of n the i sample is X_i, and the mean is $\bar{X}$.

2. Analysis of the Guiding Role of the Innovative Internet Economy Supply Chain Management Model on the Negative Emotions and Behavioral Mechanisms of Interest Audiences

The Internet economy supply chain management model involves a wide range of subjects, and the economic interests involved are relatively complex. Therefore, the emotional changes caused by the differences and inappropriateness of management methods and methods will have a greater impact on economic development. This research collected data on the negative emotions exhibited by the subjects during the experiment, and the results are shown in Table 1.

Table 1 Changes in negative psychological emotions of the subjects during the experiment

Age group	Anxious		Uneasy		Nervous	
	Before the reform	After the reform	Before the reform	After the reform	Before the reform	After the reform
Young people	55.17±3.62	29.76±3.34	56.36±3.55	38.45±3.21	55.41±3.39	40.37±2.74
Young and middle-aged groups	56.34±2.12	34.23±3.41	58.74±4.42	39.37±4.15	57.51±2.04	38.48±2.87
Middle aged group	56.55±3.53	37.45±3.39	57.23±3.57	37.44±3.42	56.34±3.24	26.64±1.29
t	0.154	2.431	0.326	2.636	0.152	2.869
P	0.738	0.012	0.639	0.002	0.057	0.000

The results in Table 1 show that before the innovation of the supply chain management model, the research subjects of the three age groups showed higher scores in the three dimensions of anxiety, restlessness and tension, and the score difference was small. The negative emotions displayed by the subjects were improved in different degrees, and the maximum change in the score was 26 points, and the data had significant statistical differences compared with those before the experiment ($P < 0.05$). The mental health status scores of the subjects during the experiment were counted, and the results are shown in Table 2.

Table 2 Mental health score of subjects during the experiment

/	Before model improvement	After model improvement	*P*
Depression	2.42	1.90	<0.05
Anxiety	2.01	1.55	<0.05
Paranoid	1.99	1.77	<0.05
Somatization	2.14	1.79	<0.05
Obsessive-compulsive symptoms	1.89	1.38	<0.05
Interpersonal relationship	2.47	1.52	<0.05
Hostility	2.52	1.77	<0.05
Fear	2.33	1.22	<0.05
Psychotic	2.44	1.61	<0.05
Other	2.26	1.89	<0.05

The results in Table 2 show that before the improvement of the supply chain model, the scores of the 10 dimensions of the mental health scale of the research subjects were all above 1.5 points, which were higher than

the scores after the improvement. The data changes before and after the experiment were quite different. There was a significant statistical difference ($P < 0.05$).

Objective

Understand the current situation of the supply chain management mode of the Internet economy, the negative emotions and behavior of the benefit audience, and analyze the reasons for the negative emotions of the benefit audience. Based on the knowledge of management psychology, the supply chain management model of Internet economy is innovated. Through rapid response and flexible management, information transmission with zero time lag can be realized, customer requirements can be met, market competitiveness can be improved, and more benefits can be earned for the benefit audience, which helps to alleviate the negative emotions of the benefit audience. Under the careful management mode, it guides the behavior of the interest audience, realizes the flexible and agile operation mechanism, improves the trust among the interest audiences, and improves their sense of security.

Methods

The research object is the leaders of supply chain enterprises. Fifty-four leaders of a supply chain were randomly selected to understand their basic personal information, their psychological status and their views on the supply chain management model of Internet economy, and to analyze the reasons for their negative emotions. Innovate the Internet economy supply chain management mode, study the changes of negative emotions and behaviors of leaders under the Internet economy supply chain management innovation mode, and record relevant data. In the processing and analysis of relevant data, SPSS software is used for data processing. Grade 1-5 is adopted, and the lower the score, the lighter the degree.

Result

The results showed that before implementing the innovative supply chain management model, participants across all three age groups—young adults, middle-aged adults, and older adults—had high scores in anxiety, unease, and tension, with only minor differences in scores between groups. This indicated that, prior to the intervention, all groups experienced similar levels of stress and worry. After the application of the developed supply chain management model, these negative emotions improved to varying degrees across the groups. For example, in some groups, the reduction in scores reached up to 26 points. A comparison of pre- and post-intervention data revealed statistically significant differences ($P<0.05$). These findings indicate that the supply chain management model effectively alleviated participants' anxiety, unease, and tension, clearly demonstrating its efficacy and suitability in improving participants' mental state and overall well-being in practical contexts.

Conclusion

The rapid development of the Internet economy has provided more convenient conditions for the development of enterprises, and it has also had a greater impact on its management model. When resources are in normal flow, it is very important for enterprises to give full play to their advantages and seize development opportunities. In view of the problems existing in the current supply chain management model and its influence on the negative emotions and behavioral mechanisms of the beneficiaries, this research is based on the relevant theories of management psychology to innovate the management model. The experimental results show that the optimized management model can achieve. The zero-delay information transmission meets the needs of customers, effective relieves the negative emotions such as anxiety and anxiety of the interested audience and greatly improves their mental health level. The data changes before and after the experimental intervention are quite different. Therefore, in the future enterprise management, operators should be good at using management psychology to optimize the management mode.

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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR
VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

Enhancing Data Privacy Compliance Through Logistics Service Quality: A Strategic Framework for Thailand's Logistics SMEs

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Abstract

This study investigates the causal relationships among logistics service quality (LSQ), customer confidence (CFD), and the intention to comply with the Personal Data Protection Act (PDPA) within small and medium-sized enterprises (SMEs) in Thailand's logistics sector. It hypothesizes that customer confidence functions as a mediating variable linking LSQ and compliance intention. A mixed-methods research design was adopted. The quantitative phase involved data collection from 400 participants using a five-point Likert scale questionnaire. Data were analyzed through structural equation modeling (SEM). The qualitative phase comprised in-depth interviews with 30 executives and subject-matter experts, with data analyzed using thematic analysis.

Quantitative findings reveal that LSQ has a statistically significant positive influence on CFD, which, in turn, significantly affects the intention to comply with the PDPA. CFD is confirmed as a full mediator between LSQ and compliance intention. The model demonstrates excellent fit indices (CFI = 1.000, RMSEA = 0.000, GFI = 0.993). Qualitative results highlight key organizational development strategies, including PDPA training, data governance practices, cybersecurity integration, and the implementation of ISO/IEC 27001 standards. Based on the empirical evidence, this study proposes a three-step strategic framework to enhance PDPA compliance among SMEs: (1) optimizing logistics processes, (2) promoting transparency in data management, and (3) developing standardized procedures aligned with the law. This framework aims to foster customer trust and encourage sustained compliance, while supporting the United Nations Sustainable Development Goals (SDGs 9, 12, and 16).

Keywords: Logistics Service Quality, PDPA, Legal Compliance, Customer Confidence, Strategic Framework, SMEs in Thailand

Introduction

In the data-driven digital economy, Thailand's logistics sector faces increasing pressures from technological innovation, operational transformation, and evolving regulatory requirements. A key legislative milestone is the enactment of the Personal Data Protection Act B.E. 2562 (PDPA), which establishes new standards for the collection, use, and protection of personal data. This has compelled logistics enterprises-particularly small and medium-sized enterprises (SMEs)-to urgently adapt in order to ensure effective legal compliance. Concurrently, as a member of the United Nations, Thailand is committed to advancing the Sustainable Development Goals (SDGs), notably SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 16 (Peace, Justice, and Strong Institutions), all of which emphasize transparent, resilient, and accountable systems (United Nations, 2015).

While large enterprises often have adequate resources to implement data governance systems aligned with PDPA standards, SMEs frequently face significant constraints in terms of financial capacity, regulatory knowledge, and skilled personnel. In response, this study proposes a strategic framework that emphasizes enhancing PDPA compliance through the improvement of logistics service quality (LSQ). The study argues that LSQ—comprising key dimensions such as accuracy, responsiveness, reliability, and transparency—plays a critical role in building customer confidence in an organization's data management practices, which , in turn influences their intention to comply with data protection standards in a sustainable manner.

Research Objectives

1. To examine the effects of logistics service quality on customer confidence and its impact on the intention to comply with the Personal Data Protection Act (PDPA) among logistics SMEs in Thailand.
2. To develop a strategic framework for enhancing PDPA compliance by leveraging logistics service quality and customer confidence as key driving mechanisms.

Literature Review, Conceptual Framework

This literature review focuses on key theoretical foundations related to logistics service quality (LSQ), customer confidence (CFD), and the intention to comply with the Personal Data Protection Act (PDPA). The central emphasis lies in the role of LSQ in fostering trust in organizations and promoting acceptance of personal data protection practices.

The concept of LSQ was developed by Parasuraman, Zeithaml, and Berry (1988) under the SERVQUAL model, which consists of five core dimensions: reliability, responsiveness, assurance, empathy, and tangibles. These dimensions have been adapted to the logistics context to evaluate customer service experiences (Maltz, 1998; Lin et al., 2023). Meanwhile, customer confidence has been proposed as a critical mechanism linking perceived service quality with behavioral acceptance and adherence to data handling practices (Bart et al., 2005; Mukherjee & Nath, 2007). This proposition aligns with the work of DeLone and McLean (2008) and Petter et al.

(2013), who identified confidence as a key mediator in information systems that influences natural system adoption, especially in contexts where transparency is paramount—such as in personal data management systems.

In terms of legal compliance, the PDPA is a regulatory framework that drives organizational transformation. Cornish (2020) and Siti Seli'ah et al. (2021) suggest that organizations fostering transparency and data literacy are more likely to reduce resistance to new compliance mandates. This is particularly effective when technologies such as artificial intelligence (AI) and data visualization are employed to support internal learning and governance within SMEs.

The notion of a compliance roadmap is thus centered on designing actionable strategies tailored to the limitations and realities of small logistics businesses in Thailand (Nimnu, 2022; Deskaug, 2022). Ultimately, aligning LSQ development with customer confidence—and subsequently promoting sustainable PDPA compliance—forms a conceptual framework that addresses academic, business, and policy dimensions in advancing Thailand's logistics sector in the digital age.

Research Methodology

This study employed a quantitative research design with the objective of investigating the causal relationships among three primary latent variables: Logistics Service Quality (LSQ), Customer Confidence (CFD), and the Intention to Comply with the Personal Data Protection Act (PDPA) (INT). Structural Equation Modeling (SEM) was applied to analyze the structural relationships between these variables and to construct a strategic framework that can be practically applied in the logistics business sector.

Sample and Sampling Method

The sample consisted of 400 executives or business owners from small and medium-sized enterprises (SMEs) operating in the logistics sector in Thailand. A multistage sampling technique was employed, based on enterprise classification criteria defined by the Office of Small and Medium Enterprises Promotion (OSMEP).

Research Instrument

Data were collected using a structured questionnaire employing a five-point Likert scale. The questionnaire comprised three sections: (1) general business information, (2) indicators measuring LSQ, CFD, and INT, and (3) opinions regarding PDPA compliance. The content validity of the instrument was verified by five experts. Instrument reliability was assessed using Cronbach's alpha coefficient, yielding high reliability across constructs. LSQ = 0.913, CFD = 0.915, INT = 0.912, overall reliability = 0.928

Data Analysis

Both descriptive and inferential statistical analyses were conducted using intermediate and advanced statistical software. Descriptive statistics included frequency, mean, and standard deviation. SEM was used to evaluate the goodness-of-fit between the proposed model and the empirical data. Model fit indices were as Chi-square/df = 0.707, p-value = 0.838, GFI = 0.993, CFI = 1.000, RMR = 0.003, RMSEA = 0.000

These results, illustrated in Figure 2 (Structural Equation Model - SEM), indicate a strong fit between the model and the empirical data, supporting the hypothesis that LSQ has a significant positive influence on CFD, which in turn significantly affects INT. The findings suggest that enhancing logistics service quality can serve as a strategic mechanism to foster customer confidence and encourage sustainable compliance with PDPA among logistics SMEs in Thailand.

Research Findings and Discussion

The study investigated the effects of logistics service quality (LSQ) on customer confidence (CFD) and its impact on the intention to comply with the Personal Data Protection Act (PDPA) among logistics SMEs in Thailand. The structural equation modeling (SEM) results indicated that LSQ had a statistically significant positive direct effect on CFD ($p < 0.01$). Furthermore, CFD played a significant mediating role in influencing the intention to comply with the PDPA. Notably, no direct effect was found between LSQ and the intention to comply (INT), confirming that customer confidence serves as a key mechanism driving sustainable behavioral acceptance of personal data management practices. The model demonstrated excellent goodness-of-fit indices, including Chi-square/df = 0.707, p-value = 0.838, CFI = 1.000, RMSEA = 0.000, GFI = 0.993, and RMR = 0.003. These indicators confirmed the model's robustness in explaining the structural relationships among latent variables. The findings affirm that enhancing LSQ can strategically foster customer trust, which in turn supports voluntary and sustained compliance with the PDPA within Thailand's SME logistics sector.

These findings are consistent with prior research by DeLone and McLean (2008) and Petter et al. (2013), which emphasized the importance of service quality in building trust and satisfaction within information systems, leading to behavioral acceptance. Similarly, Bart et al. (2005) and Mukherjee and Nath (2007) found that customer confidence plays a critical role in shaping positive attitudes toward digital systems and personal data practices. The development of a strategic compliance framework was another key outcome of this study. It emphasizes that the PDPA should not be perceived solely as a regulatory burden but as an opportunity to enhance service quality standards—particularly in SMEs, which often face limitations in resources, legal knowledge, and operational capacity. The proposed framework encourages SMEs to begin by improving LSQ elements such as accuracy, transparency, responsiveness, and accessible communication, which, in turn foster customer trust and support the acceptance of PDPA principles.

Furthermore, the use of enabling technologies such as artificial intelligence (AI) and data visualization is proposed to improve operational understanding and employee engagement. These strategies align with organizational governance principles and the United Nations Sustainable Development Goals (SDGs 9, 12, and 16), helping Thai logistics businesses comply effectively with the PDPA while advancing toward sustainable growth in the digital economy.

This discussion reinforces the position that LSQ is a critical entry point for building trust in personal data systems—particularly for SMEs with structural limitations. Supported by well-established theories such as Bandura's (1986) social cognitive theory and Ajzen's (1991) theory of planned behavior, the findings highlight the

role of positive attitudes and trust in influencing compliance behavior. Cornish (2020) further argues that organizations emphasizing trust and transparency in data governance are more likely to achieve sustainable compliance. Similarly, Siti Seli'ah et al. (2021) demonstrated that technology tools such as AI and data visualization can enhance understanding of data policies and reduce resistance to organizational change.

In summary, the study confirms that strengthening LSQ is a foundational strategy for cultivating customer confidence, which plays a pivotal role in enabling sustainable PDPA compliance, especially within resource-constrained SME environments. These findings provide an evidence-based roadmap for designing data governance policies and ethical service systems that are transparent, secure, and socially accountable.

Recommendations

Practical Implications

The study revealed that logistics service quality (LSQ) has a significant direct influence on customer confidence (CFD), which in turn plays a mediating role in shaping the intention to comply with the Personal Data Protection Act (PDPA) among logistics SMEs. No direct effect was found between LSQ and compliance intention, highlighting the pivotal role of CFD as a behavioral driver of sustainable data protection practices. This finding supports the conceptual models of DeLone and McLean (2008), Petter et al. (2013), and Bart et al. (2005), which emphasize the influence of service quality in fostering trust and behavioral acceptance toward new systems or practices. It also aligns with the theoretical frameworks of Bandura (1986) and Ajzen (1991), which propose that confidence and positive attitudes lead to sustained behavioral outcomes.

The study proposes a strategic approach in which SMEs reframe the PDPA not as a regulatory burden, but as an opportunity to elevate service quality standards. Starting with the development of LSQ-particularly focusing on accuracy, transparency, responsiveness, and clear communication—can help build customer trust and facilitate voluntary legal compliance. Moreover, the adoption of enabling technologies such as artificial intelligence (AI) and data visualization can enhance internal communication and data understanding. These insights resonate with the work of Cornish (2020) and Siti Seli'ah et al. (2021), who argue that transparency and emphasis on personal data governance significantly contribute to sustainable policy adherence at the behavioral level.

Suggestions for Future Research

1. Explore the application of digital technologies in enhancing PDPA compliance among logistics SMEs in Thailand.
2. Investigate the role of organizational culture and data awareness in shaping PDPA compliance behavior among SME operators in the logistics sector.

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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR
VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

Intersecting Inequalities in Kenyan Education: A Bordieuan Lens on Economic, Social, and Cultural Capital

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Abstract

This paper investigates how Pierre Bourdieu's forms of capital-economic, social, and cultural-interact to influence educational outcomes among students in Kenya. Despite significant reforms like Free Primary Education (FPE) and the Competency-Based Curriculum (CBC) aimed at improving access and quality, structural inequalities persist due to social class, geography, and cultural background. Traditional metrics often fail to capture these systemic challenges. Drawing from qualitative fieldwork conducted in both urban (Nairobi) and rural (Turkana/Bungoma) contexts, the study employs a comparative case analysis to examine how the unequal distribution of these capitals shapes academic trajectories. Utilizing semi-structured interviews, classroom observations, and document analysis, this research reveals that disparities in economic, social, and cultural capital reinforce cycles of privilege and disadvantage within the Kenyan education system.

Findings indicate that urban students generally benefit from a synergistic accumulation of economic resources (e.g., private tuition, consistent meals, digital access), robust social networks (e.g., high parental involvement, alumni mentorships), and alignment with dominant cultural norms (e.g., confidence in academic English, participation in discussions). Conversely, learners in rural contexts face multi-dimensional disadvantages, often lacking basic material resources, parental involvement, and cultural familiarity with institutional norms, leading to a compounding effect of disadvantage. The study highlights that teachers and administrators, despite their commitment, operate within systems that inadvertently perpetuate these disparities. The interaction between different forms of capital creates a compounding effect, where access in one domain often enhances access in another, underscoring the need for multidimensional interventions beyond traditional infrastructure-based approaches. Recommendations include promoting culturally responsive pedagogy, targeted resource allocation for rural schools, strengthening community-school partnerships, institutionalizing multi-level capital support programs, and designing capital-inclusive education policies. This research contributes to policy and scholarly discourse on education equity in Sub-Saharan Africa by offering a nuanced understanding of how intangible yet critical resources influence educational outcome.

Keywords : Bourdieu, social capital, cultural capital, economic capital, educational inequality, Kenya

Introduction

In Kenya, significant educational reforms such as Free Primary Education (FPE) and the Competency-Based Curriculum (CBC) have been initiated with the aim of reducing deeply rooted disparities in educational access and quality. The FPE policy, introduced in 2003, abolished tuition fees in public primary schools, resulting in a dramatic surge in enrollment from 5.9 million to 7.2 million students within the first year alone. This landmark initiative sought to eliminate financial barriers that had historically excluded children from poor families, particularly in marginalized communities. Similarly, the CBC, launched in 2017 to replace the 8-4-4 system, represents a paradigm shift from exam-oriented learning to a more holistic approach that emphasizes competencies, skills development, and practical application of knowledge. The curriculum reform aims to nurture every learner's potential by recognizing diverse talents and abilities beyond academic performance.

However, despite these well-intentioned efforts, structural inequalities deeply embedded in dimensions of social class, geography, and cultural background continue to serve as crucial barriers preventing the achievement of fair and equitable educational outcomes (Wambugu & Muthama, 2021). Children from affluent families still enjoy significant advantages through access to private tutoring, educational technology, and well-resourced schools, while their counterparts from low-income households struggle with inadequate learning materials, overcrowded classrooms, and poorly maintained infrastructure. Geographic disparities are particularly pronounced, with urban schools typically having better-qualified teachers, superior facilities, and more consistent electricity and internet connectivity compared to rural institutions. In remote areas such as Turkana, Marsabit, and parts of the North Eastern region, students often walk several kilometers to school, face teacher shortages, and learn in dilapidated structures that lack basic amenities like clean water and sanitation facilities. Cultural factors further complicate the educational landscape, as certain communities maintain traditional practices that prioritize early marriage, livestock herding, or other economic activities over formal schooling, particularly for girls.

Traditional indicators of educational progress, such as standardized test scores and student attendance rates, often fail to comprehensively and profoundly reflect the complex systemic challenges that students face within the education system. While these metrics may show improvements in enrollment numbers or average performance, they mask the nuanced realities of educational inequality. For instance, a child may be physically present in school (thus counted in attendance statistics) but unable to concentrate due to hunger, having walked to school on an empty stomach. Similarly, standardized test scores do not capture the disadvantages faced by students who lack electricity at home for evening studies, have no access to supplementary learning materials, or come from non-English speaking households where parents cannot assist with homework. These conventional measurements also overlook crucial factors such as the quality of teaching, the psychological impact of poverty-related stress, the hidden costs of "free" education (such as uniforms, books, and examination fees), and the profound influence of peer effects and community expectations on educational aspirations and outcomes.

Pierre Bourdieu's theory of capital (1986) presents a powerful and particularly useful sociological lens for understanding the dynamics of these overlapping inequalities. According to Bourdieu's concept, individuals possess not only economic capital in the form of money and assets, but also hold cultural capital (such as knowledge, skills, education, and artistic appreciation) and social capital (networks of relationships and social connections) at varying levels, all of which have profound and complex influences on their educational experiences and life opportunities.

This study therefore focuses on carefully exploring how these forms of capital function and impact within the context of Kenyan schools, particularly presenting a comparative analysis between the educational experiences of students living in affluent urban environments and students in rural areas that typically lack resources (Mutua & Kimani, 2022).

This research was directly initiated in response to observations regarding the persistent gaps between academic achievement and school retention rates across different regions and income levels throughout Kenya. The primary objective of the research is to meticulously analyze both tangible resources (such as learning materials and the physical environment of schools) and intangible resources (such as family support, social networks, and cultural values aligned with schooling) that individual students bring to the classroom, as well as to deeply understand how these resources significantly influence and determine their learning outcomes and overall educational trajectories.

Objectives

1. To examine the roles of economic, social, and cultural capital in shaping students' educational outcomes in Kenya.
2. To assess how these capitals intersect to reinforce or alleviate educational inequalities.
3. To compare the effects of these capitals in rural versus urban educational contexts.
4. To propose equity-based policy recommendations grounded in empirical data.

Research Questions

1. In what ways do students' access to economic, social, and cultural capital influence their educational journeys?
2. How do these capitals interact to perpetuate or challenge systemic inequality?
3. What are the key similarities and differences between urban and rural school contexts regarding access to capital?
4. What actionable interventions can address these disparities?

Significance of the Study

Academically, the study contributes to the growing literature on education and inequality in the Global South, particularly in postcolonial African contexts. Practically, it informs policymakers, educators, and development agencies about the hidden factors perpetuating inequality in Kenyan schools. The recommendations serve as a foundation for designing inclusive education reforms sensitive to the socio-cultural realities of diverse learners.

Literature Review

Bourdieu's Forms of Capital

Pierre Bourdieu's (1986) theory of capital offers a multidimensional lens for understanding how power and privilege are transmitted and reproduced within educational systems. Bourdieu (1986) argued that beyond economic capital, individuals also possess cultural and social capital, which significantly influence their life opportunities, including academic success. These forms of capital are not merely resources but mechanisms through which social inequalities persist across generations.

Economic Capital

Economic capital refers to material wealth and financial assets. In the educational context, this includes the ability to pay tuition fees, purchase textbooks, hire private tutors, or access technology and stable housing. Students from affluent families gain exposure to academic environments that promote learning, better infrastructure, and learning aids, which directly impact their academic performance and educational trajectories.

Cultural Capital

Bourdieu (1986) classified cultural capital into three types:

1. Embodied State. Enduring mental and physical dispositions such as language expertise, manners, or confidence in academic spaces.

2. Objectified State. Cultural properties such as books, musical instruments, or digital resources.

3. Institutionalized State. Academic qualifications and recognized educational credentials.

In Kenyan schools, children from families that emphasize reading, communicate in English or Kiswahili at home, or participate in intellectually stimulating activities often have advantages, as the school system rewards these characteristics (Mutua & Kimani, 2022). Conversely, students whose home cultures differ from mainstream school norms may struggle to adapt or be perceived as "less capable," even when this is not the case.

Social Capital

Social capital involves networks of relationships and connections that provide access to information, support, or opportunities (Coleman, 1988). This may include parental connections to school authorities, peer support groups, alumni networks, or access to educational NGOs. For example, families in urban Kenya often have stronger institutional ties and are more likely to participate in school governance or leverage support systems that enhance their children's learning experiences.

The Interaction of Different Forms of Capital

These forms of capital rarely operate in isolation. Economic capital can be converted into cultural capital (e.g., paying for elocution lessons or international curriculum schools), while social capital often mediates access to both educational opportunities and material support. Bourdieu (1986) described this interaction as habitus, a system of durable and transferable dispositions that determine how individuals perceive the world and act within it. Students' habitus influences how they relate to teachers, engage with curriculum content, and imagine their academic futures.

By applying Bourdieu's framework to this study, we can move beyond surface-level explanations of inequality (such as lack of desks or books) and examine the "hidden curriculum" – the unspoken social expectations and cultural codes embedded in school systems. This enables a deeper understanding of how educational systems, even with equal infrastructure, can produce unequal outcomes based on students' access to intangible yet crucial resources.

Educational Inequality in Kenya

Despite various educational reforms and investments, educational inequality in Kenya remains deeply entrenched, reflecting broader socioeconomic disparities and regional differences (Wambugu & Muthama, 2021). While national programs such as Free Primary Education (FPE), Free Day Secondary Education (FDSE), and the implementation of the Competency-Based Curriculum (CBC) have improved access, they have not resulted in uniform quality learning experiences or outcomes for all learners. These disparities are not merely infrastructural but are deeply linked to systematic neglect and inadequate investment in marginalized communities. The result is a persistent urban-rural performance gap, particularly evident in national examinations such as KCPE and KCSE.

Social Capital and Learning Environments

In Kenya, access to social capital significantly influences the quality of students' learning environments and their ability to navigate the education system. In urban areas, families often maintain strong relationships with school communities, including participation in parent associations, access to alumni networks, and relationships with education-focused organizations. These connections open opportunities for accessing additional resources such as academic counseling, scholarship information, and extracurricular opportunities that enhance students' educational trajectories. Teachers in such environments are more likely to be held accountable through engagement with informed and empowered parents.

In contrast, students in rural areas often attend schools where parental involvement is minimal due to factors such as geographical distance, limited formal education among parents, or prioritization of labor over learning. Without the benefit of strong school-community relationships, these students may lack both encouragement and support. The absence of peer support systems and role models further isolates students, reducing exposure to academic or professional development opportunities. Teachers in such contexts may face challenges in motivating students who receive limited encouragement at home, and their efforts are often constrained by resource scarcity and administrative neglect.

Furthermore, rural schools often operate in isolation, with limited engagement from external partners who might bring resources or training programs. This lack of connection to such institutions exacerbates existing disparities, making it harder for students in disadvantaged areas to compete with their urban counterparts who are embedded in diverse, opportunity-rich networks. Addressing these imbalances requires not only infrastructure investment but also targeted strategies to strengthen community-school partnerships, facilitate peer mentoring, and connect marginalized schools to broader support networks.

Economic Capital and Access to Resources

Economic capital plays a crucial role in determining educational experiences in Kenya. Families with better financial standing can afford school-related expenses such as uniforms, books, transportation, private tuition, and digital devices. Many also send their children to private schools with better facilities, lower teacher-student ratios,

and more individualized attention. These investments not only enhance academic achievement but also increase opportunities for advancement to higher education levels.

In contrast, economically disadvantaged families, particularly in rural areas and slums, often struggle to meet even basic educational expenses despite government subsidies. Students from such backgrounds face frequent learning disruptions due to unpaid fees, lack of learning materials, or the need to earn income to support households. These material constraints affect attendance, concentration, and overall academic performance. Additionally, the inability to access technological tools such as computers or stable internet creates a growing digital divide, especially as digital literacy becomes increasingly important in 21st-century curricula.

Ultimately, disparities in economic capital result in a cycle where the poor are systematically excluded from quality education, limiting their future earning potential and reinforcing intergenerational poverty.

Cultural Capital and Academic Success

Cultural capital has subtle but significant effects on how students engage with and are perceived within the education system. In Kenya, students from urban middle-class backgrounds often come to school already acculturated to the dominant cultural norms valued by the system, such as fluency in English or Kiswahili, confidence in public speaking, and familiarity with academic routines. These students tend to participate actively in class, express themselves clearly, and navigate formal assessments with ease, all of which align with teacher expectations and reinforce positive feedback loops.

Conversely, learners from rural or marginalized communities may face challenges when home cultures and communication styles differ from what schools prioritize. For example, children whose mother tongue is neither English nor Kiswahili may struggle to understand classroom instructions or hesitate to participate, not due to lack of intelligence but because of unfamiliarity with the school's cultural expectations. Teachers may misinterpret such silence or hesitation as lack of ability or motivation, potentially resulting in lowered expectations and limited support. This misalignment often disadvantages students from disadvantaged backgrounds, even when curricula are technically identical. Unless educators consciously adapt their practices to recognize and accommodate diverse cultural backgrounds, these patterns of exclusion, though unintentional, continue to create inequalities within classrooms.

Gaps in Literature

While there is substantial research on educational inequality in Kenya, most studies tend to focus on quantifiable aspects such as infrastructure deficits, exam results, teacher shortages, and dropout rates. These studies often emphasize material indicators without examining the hidden sociocultural mechanisms that perpetuate inequalities. Consequently, important but invisible factors such as the influence of family networks, linguistic familiarity, and social behaviors valued in educational institutions remain inadequately explored.

Specifically, few studies in the Kenyan context have systematically applied Bourdieu's theory of capital to analyze how economic, social, and cultural resources interact to determine student outcomes. Research that references Bourdieu often considers different forms of capital in isolation rather than as intersecting influences. Additionally, there is limited comparative analysis that juxtaposes rural and urban learning experiences through this sociological

lens, creating a gap in understanding how educational advantages are reproduced across different geographical and socioeconomic environments.

Another significant gap is the lack of empirical data on how students' actual experiences of capital affect their engagement, identity formation, and long-term aspirations. These dimensions are crucial for formulating comprehensive policies and teacher training programs that go beyond infrastructure and curriculum reforms. This study thus addresses these gaps by applying Bourdieu's framework to explore how different forms of capital interact to influence educational access and achievement in both rural and urban Kenyan schools. In doing so, this study contributes a nuanced perspective that bridges sociological and educational dimensions of inequality.

Research Methodology

Research Design

This study adopts a qualitative comparative case study design, grounded in the interpretivist paradigm, to explore how economic, social, and cultural capital influence educational outcomes in Kenya. A case study approach is appropriate because it allows for an in-depth, contextualized examination of complex social phenomena within real-life settings—something particularly valuable when studying hidden dimensions of inequality like cultural and social capital.

The choice of two contrasting environments—urban (Nairobi) and rural (Turkana or Bungoma)-enables a comparative perspective that highlights variations in capital access and educational experience across geographic and socioeconomic contexts. By focusing on multiple embedded units (students, parents, teachers, and administrators) within each school, the design captures different stakeholder viewpoints and uncovers layered dynamics that affect student success.

The qualitative nature of the study allows the researcher to engage with participants' lived experiences, interpret their meanings, and uncover the subtle, often invisible ways that advantage or disadvantage is transmitted. This is particularly crucial for studying Bourdieu's concept of capital, which includes intangible dimensions such as confidence, values, and relational networks that do not lend themselves easily to quantification.

Additionally, the comparative element ensures that the study does not treat educational inequality as a uniform experience but instead reveals how it manifests differently depending on the distribution and interaction of capital across settings. By analyzing similarities and differences between the rural and urban cases, the research design facilitates a holistic understanding of how structural and cultural factors contribute to inequality, and how policy responses must be localized rather than one-size-fits-all.

Finally, the design is intentionally flexible, allowing the researcher to adapt data collection strategies as themes emerge, consistent with qualitative inquiry. This adaptability is critical when working in diverse school environments where unforeseen barriers or opportunities may arise.

Participants and Sampling

This study targets a diverse group of participants from both urban and rural school settings in Kenya to ensure a comprehensive understanding of how different forms of capital shape educational experiences. The key participant groups include students, parents or guardians, teachers, and school administrators, each providing unique perspectives on the influence of economic, social, and cultural capital within the schooling ecosystem.

Target Participants

A. Students (aged 12–17): To share firsthand experiences related to classroom learning, school culture, peer dynamics, and family support structures.

B. Parents/Guardians: To provide insights on household socioeconomic conditions, parental involvement, and intergenerational transmission of values or expectations.

C. Teachers: To reflect on pedagogical approaches, perceptions of student capability, and how they interpret and respond to diverse forms of student capital.

D. Administrators: To comment on school resource distribution, community engagement strategies, and broader policy implementation at the school level.

Sampling Strategy

The study employs a purposive sampling technique, selecting participants based on their relevance to the research objectives and their ability to provide rich, meaningful data. Schools will be chosen to represent contrasting contexts: Two urban schools in Nairobi (one public, one private or mission-based). Two rural schools in Turkana or Bungoma (public, with one in a highly marginalized community). Within each school, participants will be selected to ensure variation in gender, socioeconomic background, academic performance, and roles within the institution. This maximum variation sampling approach helps capture the breadth of experiences and avoids over-representation of any single narrative.

Sample Size

A projected sample size includes:

1. 8–12 students per site
2. 4–6 parents per site
3. 3–5 teachers per site
4. 1–2 school administrators per site

This will result in approximately 64–100 participants in total, depending on data saturation the point at which no new themes emerge from additional interviews.

Inclusion and Exclusion Criteria

Inclusion: Participants must be currently enrolled in or working at the selected schools, and for minors, both student assent and parental consent will be required. Exclusion: Individuals who are not directly affiliated with the school or who decline to participate voluntarily will be excluded. This carefully structured participant pool and sampling approach ensures that the study captures nuanced and layered perspectives, enriching the understanding of how access to capital plays out in Kenyan schools.

Data Collection Methods

To capture the complex, context-dependent nature of how economic, social, and cultural capital influence educational outcomes, the study employs multiple qualitative data collection methods. These methods are designed to generate rich, triangulated insights across different participant groups and school settings.

Semi-Structured Interviews

Semi-structured interviews will be conducted with students, parents, teachers, and school administrators. This format provides a balance between consistency and flexibility, allowing the researcher to explore key themes while also following up on participant-specific experiences and perspectives.

1. Students will be asked about their daily school experiences, access to learning materials, family expectations, and peer support.

2. Parents/Guardians will be interviewed regarding their socioeconomic status, involvement in school activities, and perceptions of educational success.

3. Teachers will be asked about classroom dynamics, differentiation strategies, and how they perceive and respond to variations in student behavior or ability.

4. Administrators will provide insights into school policies, resourcing, and external partnerships that influence the broader learning environment.

Each interview will last between 30 to 60 minutes and will be audio-recorded (with consent) for accurate transcription and analysis.

Focus Group Discussions (FGDs)

Focus groups will be conducted with teachers and, where appropriate, students to facilitate dialogue around shared experiences and collective perceptions. FGDs allow participants to interact and reflect on each other's views, which can surface additional insights not easily captured in one-on-one interviews.

1. Each focus group will include 5 to 8 participants and will be moderated by the researcher using a pre-tested guide with open-ended questions.

2. Sessions will explore themes such as the role of family support, cultural identity in the classroom, peer influence, and equity challenges in school policies.

Classroom Observations

To complement self-reported data, non-intrusive classroom observations will be conducted using a structured observation checklist informed by Bourdieu's framework. These observations will focus on:

1. Student-teacher interactions.

2. Patterns of participation and confidence among students.

3. Use of learning materials and technology.

4. Language use and teacher expectations.

Each classroom will be observed over a full 40–60-minute lesson across different subjects to capture varied dynamics.

Document Review

Relevant documents will be reviewed to understand institutional and policy contexts. These include.

1. School admission records and fee structures.
2. Performance reports (KCPE/KCSE results).
3. Parental engagement logs (e.g., PTA attendance lists).
4. Government or NGO support programs received by the school.

This method provides background context and helps validate data gathered through interviews and observations. By using interviews, focus groups, observations, and document analysis, the study achieves methodological triangulation, which enhances the credibility, depth, and richness of findings. This approach also aligns with understanding how different forms of capital interact within and beyond the classroom setting.

Data Analysis

The data analysis process for this study will follow a thematic analysis approach, guided by Bourdieu's theoretical framework of economic, social, and cultural capital. The goal is to identify patterns that explain how these forms of capital shape educational opportunities and outcomes in urban and rural Kenyan schools. The analysis will be iterative, involving multiple rounds of coding, reflection, and refinement to ensure the trustworthiness and depth of interpretation.

Transcription and Familiarization

All interviews and focus group recordings will be transcribed verbatim. Observation notes and reflective memos will also be compiled and reviewed. The researcher will immerse themselves in the data to develop an initial understanding of participants' perspectives, with attention to recurring terms, metaphors, and experiences that suggest links to various forms of capital.

Open Coding

An open coding process will be used to break the data into discrete units of meaning. Initial codes may include concepts like "parental involvement," "language barrier," "access to books," "peer support," or "school favoritism." These will not be pre-determined but will emerge organically from the data. Coding will be done using NVivo software to manage large volumes of qualitative data efficiently.

Axial Coding

Axial coding will then be used to group the open codes into broader thematic categories, specifically aligned with the study's objectives:

1. Codes related to economic conditions and material access will be categorized under economic capital.
2. Responses describing relationships, community engagement, or school networks will form the basis of social capital.
3. Patterns linked to language use, school values, student confidence, or academic behavior will be organized under *cultural capital*.

Each category will be examined across different participant groups (students, parents, teachers, administrators) and school settings (urban vs. rural) to identify contrasts and connections.

Thematic Mapping and Interpretation

1. The themes will be mapped against the research objectives and questions, ensuring alignment with the study's analytical goals. This includes:

2. Understanding how each form of capital influences educational outcomes.
3. Exploring the intersection and interaction of capitals.
4. Comparing urban and rural differences in capital distribution.
5. Generating evidence-based insights for policy and practice.
6. The interpretation will be theory-driven but also grounded in participants' voices, preserving the authenticity of their experiences while situating them within a sociological framework.

Cross-Case Comparison

A comparative analysis will be conducted between the urban and rural case study sites. This cross-case approach will identify patterns of inequality, resilience, and variation in how capital operates across settings. Differences in access, recognition, and conversion of capital into educational success will be explored. Through this systematic and theory-informed analysis process, the study will generate context-sensitive and objective-aligned findings that directly inform the research questions and contribute to the practical and theoretical advancement of equitable education policy in Kenya.

Ethical Considerations

Ethical integrity is central to the design and implementation of this research, particularly because it involves minors, vulnerable communities, and sensitive discussions related to inequality. The study will adhere strictly to ethical guidelines for qualitative research involving human participants and will obtain approval from a recognized Institutional Review Board (IRB) prior to data collection.

Informed Consent and Assent

All participants will be fully informed about the study's purpose, procedures, potential risks, and benefits. Informed consent will be obtained from all adult participants, including parents, teachers, and school administrators. For student participants, informed assent will be obtained from the students themselves, alongside parental or guardian consent**.** Consent and assent forms will be provided in both English and Kiswahili (or other relevant local languages) to ensure clarity and accessibility.

Voluntary Participation and Right to Withdraw

Participation in the study will be entirely voluntary. Participants will be explicitly informed that they have the right to decline participation or withdraw from the study at any stage without facing any penalties or consequences. This assurance will help foster an open and pressure-free environment for honest sharing.

Confidentiality and Anonymity

All data collected will be treated with strict confidentiality. Participants' real names, school names, and identifiable characteristics will be replaced with pseudonyms during transcription and reporting. Audio recordings and written data will be stored securely on password-protected devices, accessible only to the researcher and approved supervisors.

Minimizing Harm and Promoting Respect

Care will be taken to ensure that participants do not experience psychological or social discomfort during interviews or focus groups. Questions will be phrased sensitively, especially when addressing potentially

stigmatizing issues like poverty, performance gaps, or school discipline. In classroom observations, the researcher will remain as unobtrusive as possible to avoid disrupting learning environments.

Cultural Sensitivity

The study will respect the diverse cultural norms, languages, and values of the communities involved. Local facilitators or translators will be engaged where needed to ensure effective communication and to foster trust. The researcher will also reflect regularly on their positionality and biases to avoid misinterpretation or imposition of external values.

Feedback and Reciprocity

To ensure ethical reciprocity, a summary of key findings will be shared with participating schools and communities in an accessible format. Where feasible, feedback workshops or brief presentations will be organized to highlight practical insights and policy implications arising from the study. This will support local ownership of the findings and promote community engagement in solution-building.

Results and Discussion

Influence of Economic Capital on Educational Outcomes

Access to economic resources directly influenced students' ability to participate fully in schooling. Urban students had access to private tuition, educational apps, consistent meals, and transport. In contrast, rural students often walked long distances to school and lacked basic learning materials.

"I missed classes when my mother couldn't pay for my test booklet," said a rural student.

Table 1: Comparative Access to Economic Capital

Indicator	Urban Students (%)	Rural Students (%)
Regular meals before school	88%	52%
Access to textbooks	91%	49%
Attends extra tuition	77%	26%
Access to internet/digital devices	83%	32%

Influence of Social Capital in the Learning Environment

Urban learners reported high parental involvement, alumni mentorships, and structured peer groups. Conversely, rural students often lacked adult supervision, and school-community engagement was low.

"My mother can't read or write, so she never attends meetings," a rural student shared.

Table 2: Parental and Community Involvement Indicators

Social Capital Element	Urban (%)	Rural (%)
Parents attend PTA meetings	85%	39%
Parent-teacher communication (monthly)	78%	33%
School has active alumni network	67%	12%
Student has non-family mentor	59%	15%

Role of Cultural Capital in Academic Identity

Urban students often displayed school-valued behaviors confidence in speaking, academic vocabulary, and familiarity with classroom norms giving them a perceived academic edge. Teachers favored students who matched theses petitions.

Observations showed teachers praising urban students for volunteering answers while rural students remained quiet despite knowing the content.

Table 3: Expression of Cultural Capital Traits

Trait Observed in Classrooms	Urban (%)	Rural (%)
Students initiate discussions	74%	29%
Confident use of academic English	83%	34%
Participates in group presentations	68%	37%
Brings learning resources from home	71%	28%

Intersectionality of Capital Forms and Regional Disparities

The combined impact of limited economic, social, and cultural capital results in a compounding effect of disadvantage in rural schools. Students with support in only one area struggled more than those with suppor tacross multipledimensions.

A rural teacher noted: “It’s not just poverty. Some kids don’t speak Kiswahili, don’t have confidence, and don’t get encouragement from home.”

Table 4: Composite Capital Access Scores (Urban vs. Rural)

Capital Type	Urban Average Score (/100)	Rural Average Score (/100)
Economic Capital	85	45
Social Capital	80	50
Cultural Capital	90	55

Implications for Policy and Local Practice

The findings underscore the need for region-specific solutions: Rural schools need targeted investments not just in infrastructure but in mentorship programs, teacher capacity building, and language-inclusive pedagogy.

Urban policies must regulate the privatization gap and ensure that resource advantages are not the sole determinant of student success.

The data above affirms the necessity of multidimensional and contextual interventions. Addressing just one capital domain without acknowledging its links to others would likely result in superficial or unsustainable change.

Conclusion and Recommendation

This study set out to examine how social, economic, and cultural capital intersect to influence educational outcomes in Kenya, particularly by comparing urban and rural school contexts. Using Pierre Bourdieu's theory of capital as a conceptual lens, the research found that inequality in Kenya's education system is not solely a result of infrastructural or curricular differences but is deeply embedded in broadersocial structures and access to intangible resources.

Students in urban schools generally benefit from a synergistic accumulation of economic means, supportive social networks, and alignment with the dominant cultural values of the education system. In contrast, learners in rural contexts face multi-dimensional disadvantage, often lacking basic material resources, parental involvement, and cultural familiarity with institutional norms. Teachers and school administrators, while committed, often operate within systems that inadvertently reinforce these disparities.

Moreover, the interaction between different forms of capital creates a compounding effect, whereby access in one domain often enhances access in another. This finding confirms the need for multidimensional interventions that go beyond traditional infrastructure-based approaches to educational reform.

By highlighting the nuanced ways in which capital operates within classrooms and communities, this study contributes to a more holistic understanding of educational inequality and points toward more context-sensitive, equity-oriented policy strategies.

Based on the findings, the following recommendations are proposed for policymakers, educators, and development partners:

Promote Culturally Responsive Pedagogy

Train teachers to recognize, value, and incorporate the cultural backgrounds of students into lesson delivery and assessment. Develop inclusive teaching strategies that accommodate language diversity, especially in rural and pastoralist communities.

Targeted Resource Allocation for Rural Schools

Government funding should prioritize schools in underserved areas with high multidimensional deprivation. Establish monitoring frameworks that evaluate schools not only by infrastructure but also by access to learning materials, digital tools, and teacher retention.

Strengthen Community-School Partnerships

Mobilize local leaders, faith-based groups, and NGOs to facilitate parental involvement in education, even where literacy is low. Develop mentorship programs that connect students with role models from similar backgrounds.

Institutionalize Multi-Level Capital Support Programs

Introduce bundled interventions that address more than one form of capital for instance, digital literacy training (economic/cultural) paired with community discussion forums (social). Encourage school-based initiatives like alumni clubs, peer mentoring, and student-led leadership programs to boost social capital.

Design Capital-Inclusive Education Policies

Embed equity metrics into national education policies, ensuring that planning and evaluation capture disparities in capital access. Include qualitative assessments of school culture, student well-being, and household engagement in policy audits.

Areas for Future Research

While this study provides valuable insights, it was limited to a relatively small number of schools in selected counties. Future research could: Conduct **longitudinal studies** to explore how capital accumulation or deprivation affects educational and life outcomes over time. Explore intersectionality across gender, disability, and ethnicity**,** especially how girls and marginalized ethnic groups experience capital disparities. Compare findings regionally across East Africa to develop scalable, culturally grounded policy frameworks for equitable education.

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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR
VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

Youth Climate Action in Thailand: Participation, Strategies, International Linkages, and Policy Reform

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Abstract

This study investigates the pivotal role of Thai yoth in climate action, focusing on their participation strategies, international linkages, and contributions to sustainable supply chain management (SSCM), with a comparative analysis of Taiwan's youth climate initiatives. Utilizing secondary data from policy documents and authoritative reports, the research examines how Thai youth, through movements like Fridays For Future Thailand (organizing 50+ climate strikes since 2019, mobilizing 3,000+ youth), drive sustainable practices in tourism and agriculture supply chains, such as local sourcing that reduces transport emissions (United Nations Economic and Social Commission for Asia and the Pacific [ESCAP], 2024). Yet, limited policy access (only 5% of Thailand's NDC consultations include youth) restricts their influence (UNFCCC, 2022). Conversely, Taiwan's Youth Climate Coalition (TWYCC) has trained 15,000 students since 2020, shaping renewable energy policies through curriculum-based advocacy and virtual COP simulations engaging 10,000+ youth annually, despite UNFCCC exclusion (Kuo, 2021; Huang, 2025). Taiwan's structured model offers scalable strategies for Thailand, while Thailand's community resilience informs Taiwan's rural engagement. Grounded in environmental justice (Schlosberg, 2004) and SSCM frameworks (Carter & Rogers, 2008), the study underscores youth-driven innovations aligning with SDGs 8, 12, and 13. Findings advocate for Thailand to adopt Taiwan's education model to amplify youth policy influence, while Taiwan can leverage Thailand's grassroots approaches. Policy recommendations include establishing a National Youth Climate Council, funding green startups, and enhancing Thailand's YOUNGO participation using Taiwan's digital diplomacy. This research enriches environmental justice and SSCM literature, providing actionable insights for policymakers and businesses to foster youth-led climate-resilient supply chains in Thailand and beyond.Youth climate action.

Keywords: Sustainable supply chain management, Environmental justice, Thailand-Taiwan comparison Climate, policy reform

Introduction

Climate change poses an existential threat to global ecosystems, economies, and societies, with its impacts disproportionately affecting vulnerable regions and populations. In Thailand, a country highly susceptible to climate risks, the urgency to address these challenges is compounded by the need to integrate diverse stakeholders, particularly youth, into effective climate governance. This study examines the role of Thai youth in climate action, focusing on their participation strategies, international linkages, and contributions to

sustainable supply chain management (SSCM). By comparing Thailand's grassroots-driven youth initiatives with Taiwan's structured advocacy model, the research seeks to identify transferable practices and propose policy reforms to enhance youth-driven climate resilience. This introduction outlines the background and context, articulates the research problem, specifies the objectives, and highlights the study's academic and practical significance.

Background and Context

Thailand faces severe climate risks that threaten its socioeconomic stability and environmental sustainability. The Intergovernmental Panel on Climate Change (IPCC) projects that rising sea levels could inundate 10% of Bangkok's land area by 2050, endangering millions of residents and critical infrastructure (IPCC, 2022). Concurrently, recurrent floods and droughts disrupt Thailand's agriculture and tourism sectors, which account for 8.5% and 18% of GDP, respectively (World Bank, 2023). These disruptions ripple through supply chains, increasing costs and undermining resilience in food production and tourism services (Thailand Ministry of Agriculture and Cooperatives, 2023).

Thailand's climate policies, articulated in its Second Nationally Determined Contribution (NDC), commit to a 30% reduction in greenhouse gas emissions by 2030 and carbon neutrality by 2050 (UNFCCC, 2022). However, these policies have been criticized for their limited inclusion of youth perspectives, despite youth comprising 20% of Thailand's population (United Nations Population Fund, 2023). The absence of structured mechanisms for youth engagement contrasts with the global rise of youth-led climate movements, such as Fridays For Future and the Youth NGOs (YOUNGO) constituency of the United Nations Framework Convention on Climate Change (UNFCCC), which have mobilized millions to demand urgent climate action (Thew et al., 2020).

Thai youth are inspired by these global movements but face local barriers, including centralized governance and restricted civic spaces, which limit their policy influence (Amnesty International, 2023). For instance, Thailand's hybrid political regime, characterized by military-backed governance, imposes constraints on public protests and advocacy, hindering youth-led initiatives like Fridays For Future Thailand (Human Rights Watch, 2024). Despite these challenges, Thai youth have initiated grassroots efforts, such as community-based waste management and eco-tourism projects, to promote sustainable supply chains (UNICEF Thailand, 2022).

To contextualize Thai youth's efforts, this study compares them with Taiwan, a region with similar climate vulnerabilities but distinct governance and advocacy structures. Like Thailand, Taiwan faces typhoons and heat waves that disrupt agriculture and tourism (Taiwan Environmental Protection Administration, 2024). However, Taiwan's democratic governance fosters structured youth advocacy through organizations like the Taiwan Youth Climate Coalition (TWYCC), which has influenced national renewable energy policies (Chen & Wu, 2023). This Thailand-Taiwan comparison highlights how governance structures shape youth climate action and their contributions to SSCM, offering insights into scalable strategies for Thailand.

Research Problem

Thai youth possess significant potential to drive climate-resilient supply chains, particularly in eco-tourism and sustainable agriculture, yet their contributions remain underutilized due to limited access to policy-making processes. Only 5% of Thailand's NDC consultation processes included youth representatives, reflecting a systemic gap in inclusive governance (UNFCCC, 2022). This exclusion not only marginalizes a key

stakeholder group but also restricts the integration of innovative, youth-led solutions into national climate strategies.

Furthermore, there is a paucity of comparative studies examining youth climate action in Thailand and Taiwan, particularly through the lens of SSCM. While Thailand's grassroots approach emphasizes community resilience, Taiwan's curriculum-based advocacy model leverages education and digital diplomacy to influence policy (Kuo, 2021). The lack of comparative analysis hinders the identification of transferable practices that could enhance Thailand's youth climate action and its alignment with sustainable supply chains.

Additionally, the potential for Thai youth to engage with international climate frameworks, such as YOUNGO or the UNFCCC's Conference of the Parties (COP), remains underexplored. Given Thailand's limited representation in global climate negotiations (e.g., only 10 youth delegates at COP29), there is a critical need to investigate how Thai youth can leverage international platforms to amplify their impact (ESCAP, 2024). Addressing these gaps is essential to unlocking youth-driven innovations in climate governance and supply chain sustainability.

Objectives

This study pursues the following objectives:

1. To analyse Thai youth's climate action strategies and participation mechanisms, focusing on their contributions to sustainable supply chains in tourism and agriculture.

2. To examine Thai youth's engagement with international climate frameworks, such as YOUNGO and UNFCCC processes.

3. To compare Thai and Taiwanese youth climate action models, with a 40% focus on Taiwan's structured advocacy, to identify transferable practices.

4. To propose policy reforms that integrate youth perspectives into Thailand's climate governance and enhance SSCM.

Significance

Academic Significance: This study advances the literature on environmental justice and SSCM by offering a novel comparative analysis of youth climate action in Thailand and Taiwan. By applying Schlosberg's (2004) environmental justice framework, it highlights the youth's demand for procedural and recognition justice in climate governance. Additionally, it contributes to SSCM scholarship by integrating youth-led innovations, such as local sourcing and waste reduction, into supply chain frameworks (Carter & Rogers, 2008). The Thailand-Taiwan comparison fills a gap in regional studies, providing a model for examining youth agency in climate-vulnerable contexts.

Practical Significance: The study offers actionable recommendations for policymakers, businesses, and NGOs to harness youth-driven climate resilience in supply chains. By proposing mechanisms like a National Youth Climate Council and public-private partnerships, it addresses Thailand's policy gaps and aligns with Sustainable Development Goals (SDGs) 8 (Decent Work and Economic Growth), 12 (Responsible Consumption and Production), and 13 (Climate Action). For businesses, the findings underscore opportunities to support youth-led green startups in eco-tourism and agriculture, enhancing supply chain sustainability. Internationally,

the study advocates for strengthening Thai youth's participation in global climate frameworks, drawing on Taiwan's digital diplomacy model.

Literature Review

The intensifying impacts of climate change demand innovative and inclusive governance models that prioritize the voices of youth, who are both future stewards and active contributors to climate resilience. As Thailand grapples with rising sea levels, floods, and droughts, and Taiwan faces similar climate vulnerabilities, youth-led initiatives offer transformative potential for sustainable development, particularly in supply chain management. This literature review synthesizes scholarship on youth climate activism, environmental justice, Thailand's climate governance, Taiwan's youth advocacy, and sustainable supply chain management (SSCM) to provide a robust foundation for analysing Thai youth climate action and its comparison with Taiwan's structured model. By identifying critical gaps—namely, the lack of comparative studies on youth-driven SSCM innovations in Thailand and Taiwan—this chapter positions the study to advance environmental justice and SSCM literature while offering practical insights for policymakers and businesses.

Youth Climate Activism and Environmental Justice

Youth climate activism has emerged as a global phenomenon, redefining the landscape of climate governance and advocacy. Since 2018, Fridays For Future, initiated by Greta Thunberg, has mobilized over 14 million youth across 150 countries, organizing thousands of climate strikes to demand urgent policy action (Fridays For Future, 2023). Similarly, the Youth NGOs (YOUNGO) constituency within the United Nations Framework Convention on Climate Change (UNFCCC) has empowered young advocates since 2009, securing observer status and submitting policy proposals at Conferences of the Parties (COP) (Thew et al., 2020). These movements underscore the youth's role as legitimate stakeholders, challenging traditional top-down governance models that often marginalize younger generations.

Environmental justice provides a critical theoretical framework for understanding youth activism. Schlosberg (2004) articulates environmental justice through three interconnected dimensions: distributive justice, which seeks equitable allocation of environmental benefits and burdens; procedural justice, which emphasizes inclusive decision-making processes; and recognition justice, which demands acknowledgment of marginalized groups' identities and contributions. Youth activists prioritize procedural and recognition justice, advocating for their inclusion in policy forums and recognition as key actors in climate solutions (Thew et al., 2020). For example, YOUNGO's submissions to COP26 and COP27 called for youth advisory councils and dedicated funding for youth-led projects, highlighting the need for structural changes in global climate governance (Bulkeley et al., 2013).

Despite their momentum, youth movements face significant barriers. Age-based discrimination often dismisses youth as inexperienced, while limited access to financial resources and decision-making spaces restricts their influence (Walker, 2020). In hybrid or authoritarian regimes, these challenges are amplified by restrictions on civic freedoms, such as protest bans or surveillance, which deter youth activism (Amnesty International, 2023). To circumvent these barriers, youth leverage digital platforms—such as social media campaigns and virtual summits—to amplify their voices and build transnational alliances (O'Brien et al., 2018). For instance, the Global Youth Climate Network uses online platforms to coordinate advocacy across 120

countries, demonstrating youth's adaptability (Global Youth Climate Network, 2023).

The environmental justice framework also intersects with power dynamics in climate governance. Lukes' (2005) three-dimensional power model—decision-making power, agenda-setting power, and ideological power—reveals how youth are often excluded from shaping climate agendas due to entrenched institutional structures. Youth activism disrupts these power dynamics by demanding transparency and accountability, as seen in their critiques of fossil fuel subsidies and greenwashing (Fisher, 2019). This global context is critical for analyzing Thai youth, who face governance constraints, and Taiwanese youth, who operate within a democratic system conducive to structured advocacy.

Thailand's Climate Governance and Youth Engagement

Thailand's climate governance reflects a complex interplay of ambitious commitments and systemic challenges. The country's Second Nationally Determined Contribution (NDC) outlines a 30% reduction in greenhouse gas emissions by 2030, carbon neutrality by 2050, and a transition to 20% renewable energy by 2037 (UNFCCC, 2022; Thailand Ministry of Energy, 2023). These targets are supported by policies like the Power Development Plan 2023–2037, which promotes solar and wind energy, and the National Adaptation Plan, which addresses climate risks in agriculture and tourism (Thailand Ministry of Natural Resources and Environment, 2023). However, Thailand's energy mix remains heavily reliant on fossil fuels (70% of total energy consumption), with coal and natural gas dominating electricity production (International Energy Agency, 2023). This reliance undermines climate goals and exacerbates vulnerabilities in agriculture and tourism, which contribute 8.5% and 18% to GDP, respectively, but face disruptions from floods, droughts, and heatwaves (World Bank, 2023).

Youth engagement in Thailand's climate governance is conspicuously limited, reflecting structural barriers within its hybrid political regime. Only 5% of NDC consultation processes included youth representatives, a stark contrast to global calls for inclusive governance (UNFCCC, 2022). Thailand's centralized governance, shaped by military-backed rule since the 2014 coup, imposes restrictions on civic participation, including youth-led protests (Human Rights Watch, 2024). For example, climate strikes organized by Fridays For Future Thailand have faced police oversight and permit denials, discouraging widespread participation (Amnesty International, 2023). These constraints highlight the tension between Thailand's climate ambitions and its political environment, which stifles youth agency.

Despite these challenges, Thai youth have demonstrated remarkable resilience through grassroots initiatives. Fridays For Future Thailand, launched in 2019, has organized over 50 climate strikes, mobilizing approximately 3,000 youth across Bangkok, Chiang Mai, and rural provinces (UNICEF Thailand, 2022). These strikes raise awareness of climate impacts and advocate for policy reforms, such as increased renewable energy investments. Similarly, UNICEF's #CountMeIn campaign, active since 2020, has engaged over 5,000 youth in climate education workshops and community projects, including waste recycling and eco-tourism initiatives in northern Thailand (UNICEF Thailand, 2024). For instance, youth-led projects in Chiang Mai promote local sourcing for tourism markets, reducing transport-related emissions and supporting smallholder farmers (United Nations Economic and Social Commission for Asia and the Pacific [ESCAP], 2024).

These initiatives align with SSCM principles, particularly circular economy practices that minimize waste and enhance supply chain resilience (Seuring & Müller, 2008). However, the lack of formal policy

channels limits their scalability. Youth proposals for integrating climate education into national curricula or establishing youth advisory councils have been largely ignored, reflecting a gap in procedural justice (Sarkki et al., 2019). This exclusion underscores the need for governance reforms to harness Thai youth's potential in climate-resilient supply chains, a focus of this study's comparative analysis with Taiwan.

Taiwan's Youth Climate Action

Taiwan provides a contrasting model of youth climate action, shaped by its democratic governance, robust civil society, and innovative advocacy strategies. The Taiwan Youth Climate Coalition (TWYCC), established in 2018, has emerged as a leading force, training over 15,000 students through its "Climate Leader for Future" program since 2020 (Kuo, 2021). This curriculum-based initiative integrates climate education into high schools and universities, equipping youth with policy literacy, scientific knowledge, and advocacy skills. TWYCC's efforts have directly influenced Taiwan's 2022 Renewable Energy Development Act, which increased renewable energy targets to 27% by 2030, reflecting the youth's ability to shape national policy (Taiwan Environmental Protection Administration, 2024). The coalition's success stems from its structured approach, which combines educational outreach with targeted lobbying, engaging policymakers through petitions, public forums, and policy briefs (Chen & Wu, 2023).

A defining feature of Taiwanese youth activism is digital diplomacy, necessitated by Taiwan's exclusion from UNFCCC processes due to geopolitical constraints. TWYCC's virtual Conference of the Parties (COP) simulations, launched in 2020, engage over 10,000 youth annually, enabling them to participate in mock global climate negotiations and advocate for Taiwan's climate commitments (Huang, 2025). These simulations foster critical skills, such as drafting policy proposals and building coalitions, and have facilitated regional alliances, such as the Asia-Pacific Youth Climate Summit, which connects Taiwanese youth with counterparts in Japan, South Korea, and Southeast Asia (Chen & Wu, 2023). By leveraging digital platforms, TWYCC bypasses traditional barriers, amplifying Taiwan's voice in global climate dialogues despite its non-member status in the UNFCCC.

Taiwanese youth also make significant contributions to SSCM, particularly in agriculture and logistics. TWYCC's advocacy for green logistics has led to pilot projects reducing packaging waste by 20% in agricultural supply chains, aligning with Taiwan's circular economy goals (Taiwan Environmental Protection Administration, 2024). For example, youth-led campaigns have promoted biodegradable packaging and local sourcing in Taiwan's fruit export industry, enhancing supply chain sustainability (Lin, 2022). These initiatives demonstrate how youth can bridge grassroots innovation and policy advocacy, a model with potential applicability to Thailand.

However, Taiwanese youth face challenges, including limited funding and urban-rural disparities. Most TWYCC activities are concentrated in Taipei and Kaohsiung, leaving rural youth underrepresented (Lin, 2022). Additionally, the high cost of digital infrastructure for virtual COP simulations poses scalability issues, requiring external support from NGOs and government agencies (Chen & Wu, 2023). Despite these constraints, Taiwan's structured advocacy model offers valuable lessons for Thailand, where youth lack similar educational platforms and policy access. The comparison highlights how governance structures—democratic in Taiwan versus hybrid in Thailand—shape youth climate action and SSCM contributions, a central focus of this study.

Sustainable Supply Chains and Youth

Sustainable supply chain management (SSCM) integrates environmental, social, and economic considerations to enhance supply chain resilience and sustainability (Carter & Rogers, 2008). SSCM emphasizes practices such as local sourcing, waste reduction, and green logistics, which align with global sustainability goals (Seuring & Müller, 2008). Youth play an increasingly critical role in SSCM by advocating for and implementing innovative solutions in sectors like agriculture and tourism, which are vital to both Thailand and Taiwan's economies (Pagell & Wu, 2009). Globally, youth-led initiatives have driven circular economy practices, such as zero-waste supply chains and renewable energy adoption, reducing environmental impacts and fostering economic resilience (Ellen MacArthur Foundation, 2023).

In Thailand, youth contribute to SSCM through community-based projects that address local supply chain challenges. For example, eco-tourism initiatives in northern Thailand, supported by youth groups like Climate Watch Thailand, promote local sourcing of food and materials, reducing transport-related emissions and supporting smallholder farmers (ESCAP, 2024). Similarly, youth-led waste recycling programs in Phuket's tourism sector have diverted 15% of plastic waste from landfills, aligning with circular economy principles (UNICEF Thailand, 2024). These efforts demonstrate Thai youth's ability to innovate within constrained governance contexts, though their impact remains localized due to limited policy support (Sarkki et al., 2019).

In Taiwan, TWYCC's advocacy has driven SSCM innovations, particularly in agricultural supply chains. Youth-led campaigns for green logistics have reduced packaging waste by 20% in pilot projects, promoting biodegradable materials and local sourcing (Taiwan Environmental Protection Administration, 2024). Additionally, TWYCC's partnerships with SMEs have introduced green certification programs, enhancing supply chain transparency and sustainability (Lin, 2022). These initiatives align with Taiwan's National Climate Change Action Plan, which prioritizes circular economy practices and SDG 12 (Responsible Consumption and Production) (Taiwan Environmental Protection Administration, 2024).

Despite these contributions, the literature reveals significant gaps. Few studies examine youth-driven SSCM innovations in Thailand and Taiwan, particularly in comparative contexts (Pagell & Wu, 2009). Existing research focuses primarily on corporate or governmental SSCM practices, overlooking the role of youth as grassroots innovators (Seuring & Müller, 2008). Moreover, there is limited exploration of how youth can leverage international frameworks like YOUNGO to advance supply chain sustainability, a critical gap given the global nature of climate challenges (Bulkeley et al., 2013). This study addresses these gaps by integrating environmental justice and SSCM frameworks to analyze youth climate action in Thailand and Taiwan, offering a novel comparative perspective and actionable policy recommendations.

Research Methodology

Conceptual Framework and Methodology

To analyse the role of Thai youth in climate action and compare it with Taiwan's structured advocacy model, this study requires a robust theoretical and methodological approach. This chapter outlines the conceptual framework and methodology, integrating environmental justice and sustainable supply chain management (SSCM) to examine youth participation, strategies, international linkages, and policy reforms. By employing a qualitative, comparative case study approach based on secondary data, the study ensures

analytical depth while addressing the practical implications for climate-resilient supply chains in Thailand and Taiwan. This framework aligns with the study's objectives, building on the literature review's theoretical foundations and contextual insights from the introduction.

Conceptual Framework

The study adopts a hybrid conceptual framework that integrates environmental justice (Schlosberg, 2004) and SSCM (Carter & Rogers, 2008), providing a multidimensional lens to analyse youth climate action and its contributions to sustainable supply chains. This framework is tailored to capture the interplay between youth agency, governance structures, and supply chain innovations, aligning with Sustainable Development Goals (SDGs) 8 (Decent Work and Economic Growth), 12 (Responsible Consumption and Production), and 13 (Climate Action).

Environmental Justice

Environmental justice, as articulated by Schlosberg (2004), encompasses distributive, procedural, and recognition justice. In the context of youth climate action, procedural justice emphasizes inclusive decision-making, ensuring youth have access to policy forums. Recognition justice demands acknowledgment of youth as legitimate stakeholders, valuing their unique perspectives as future generations. Thai youth, constrained by centralized governance, seek greater participation in climate policy, as evidenced by their limited representation in Thailand's Nationally Determined Contribution (NDC) consultations (UNFCCC, 2022). Taiwanese youth, operating within a democratic system, leverage structured advocacy to influence policy, exemplifying procedural justice (Chen & Wu, 2023). By applying this framework, the study examines how youth in both regions demand recognition and participation, addressing systemic barriers to their agency.

Sustainable Supply Chain Management

SSCM integrates environmental, social, and economic considerations to enhance supply chain sustainability (Carter & Rogers, 2008). Youth-led innovations, such as green logistics and circular economy practices, contribute to SSCM by reducing environmental impacts and promoting resilience in sectors like agriculture and tourism. In Thailand, youth initiatives promote local sourcing in eco-tourism, aligning with circular economy principles (UNICEF Thailand, 2024). In Taiwan, the Taiwan Youth Climate Coalition (TWYCC) advocates for green logistics, reducing packaging waste in agricultural supply chains (Taiwan Environmental Protection Administration, 2024). The SSCM framework analyses how these innovations enhance supply chain sustainability, addressing the study's focus on youth-driven solutions.

SDG Alignment

The hybrid framework aligns with SDGs 8, 12, and 13. SDG 8 is addressed through youth-led green startups that create decent work opportunities in sustainable tourism and agriculture. SDG 12 is reflected in youth initiatives promoting responsible consumption, such as waste reduction and local sourcing. SDG 13 is central, as youth climate action directly contributes to climate mitigation and adaptation (United Nations, 2023). This alignment ensures the study's relevance to global sustainability agendas and SCSR's focus on practical implications.

Research Approach

The study employs a qualitative research approach, utilizing secondary data to analyse youth climate action in Thailand and Taiwan. This approach is suitable given the study's objectives: to examine participation

mechanisms, strategies, international linkages, and policy barriers without requiring primary data collection. A comparative case study design is adopted, focusing on Thailand's grassroots model and Taiwan's structured advocacy, with an emphasis on their contributions to SSCM. This design allows for in-depth exploration of contextual differences—Thailand's hybrid governance versus Taiwan's democratic system—and facilitates the identification of transferable practices (Yin, 2018).

The qualitative approach leverages existing literature, policy documents, and reports, ensuring analytical rigor while accommodating the study's resource constraints. By focusing on secondary data, the study maintains feasibility while addressing the literature review's identified gaps, particularly the lack of comparative SSCM studies in Thailand and Taiwan. The comparative case study method is well-suited to SCSR's interdisciplinary scope, enabling the integration of environmental justice and SSCM perspectives.

Data Sources

The study draws on a diverse range of secondary data sources to ensure comprehensive coverage of youth climate action and supply chain impacts in Thailand and Taiwan. These include policy documents, organizational reports, and media coverage, selected for their relevance and authority.

Thailand

For Thailand, the analysis includes:

- Thailand's Second NDC (UNFCCC, 2022): Provides insights into national climate commitments and youth inclusion levels.
- National Adaptation Plan (Thailand Ministry of Natural Resources and Environment, 2023): Details adaptation strategies in agriculture and tourism, highlighting areas for youth contributions.
- UNICEF Thailand Reports (2022, 2024): Document youth initiatives like Fridays For Future Thailand and the #CountMeIn campaign, detailing participation and supply chain innovations.
- ESCAP Technical Cooperation Highlights (2024): Summarizes youth engagement in climate action, including eco-tourism projects in Chiang Mai.

Taiwan

For Taiwan, the analysis includes:

- TWYCC Reports (Kuo, 2021): Detail the "Climate Leader for Future" program and its policy impacts.
- Taiwan's Renewable Energy Development Act (2022): Reflects youth influence on renewable energy policy (Taiwan Environmental Protection Administration, 2024).
- Taiwan EPA Green Logistics Reports (2024): Document youth-led waste reduction initiatives in agricultural supply chains.
- Media Coverage (Huang, 2025): Provides qualitative insights into TWYCC's digital diplomacy and virtual COP simulations.

Comparative Data

Comparative insights are drawn from

- UNDP Asia-Pacific Youth Reports (2023): Highlight regional youth climate action trends.
- ESCAP Regional Reports (2024): Provide context on Asia-Pacific youth engagement, facilitating Thailand-Taiwan comparisons.
- These sources ensure a robust evidence base, addressing the study's objectives and aligning with

SCSR's emphasis on credible data.

Analysis Method

The study employs thematic analysis to identify key themes: participation mechanisms, supply chain innovations, international linkages, and policy barriers. Thematic analysis, as outlined by Braun and Clarke (2006), involves coding secondary data to uncover patterns and insights. Data from policy documents, reports, and media are systematically reviewed to extract themes relevant to youth climate action and SSCM. For example, participation mechanisms include grassroots campaigns (Thailand) and curriculum-based advocacy (Taiwan), while supply chain innovations encompass local sourcing and green logistics.

A comparative framework contrasts Thailand's grassroots model with Taiwan's structured advocacy, focusing on governance contexts, youth agency, and SSCM outcomes. This framework draws on George and Bennett's (2005) case study methodology, which emphasizes structured comparisons to identify causal mechanisms and transferable practices. By analysing differences (e.g., Thailand's centralized governance vs. Taiwan's democracy) and similarities (e.g., shared climate vulnerabilities), the study elucidates how youth contribute to climate-resilient supply chains.

Thematic and comparative analyses are conducted iteratively, ensuring themes are grounded in data and aligned with the conceptual framework. This approach facilitates a nuanced understanding of youth climate action, addressing the literature review's gaps and informing policy recommendations.

Analysis

The escalating climate crisis demands innovative governance models that harness the agency of youth, who are pivotal in driving climate resilience and sustainable supply chain management (SSCM). This chapter provides an in-depth analysis of youth climate action in Thailand and Taiwan, employing a comparative case study approach grounded in the hybrid framework of environmental justice (Schlosberg, 2004) and SSCM (Carter & Rogers, 2008). Building on the Introduction's problem statement, the Literature Review's theoretical synthesis, and the Conceptual Framework's methodological approach, this analysis examines strategies, participation mechanisms, international linkages, and supply chain impacts. By addressing the study's objectives—analysing Thai youth's climate action, comparing it with Taiwan's model (~40% focus on Taiwan), and identifying transferable practices—this chapter elucidates how youth contribute to climate-resilient supply chains, aligning with Sustainable Development Goals (SDGs) 8, 12, and 13. The findings inform policy recommendations to enhance youth inclusion in Thailand's climate governance and SSCM.

Thai Youth Climate Action: Strategies and Participation

Thai youth have emerged as resilient and innovative actors in climate action, navigating a challenging governance landscape to implement grassroots strategies that address local environmental and supply chain challenges. Since 2019, Fridays For Future Thailand has organized over 50 climate strikes across urban centers like Bangkok and Chiang Mai, as well as rural provinces such as Khon Kaen and Surat Thani, mobilizing approximately 3,000 youth (UNICEF Thailand, 2022). These strikes, often synchronized with global Fridays For Future campaigns, raise public awareness of Thailand's acute climate vulnerabilities, including rising sea levels projected to inundate 10% of Bangkok's land area by 2050 and recurrent floods disrupting agriculture and tourism supply chains (IPCC, 2022). The strikes employ creative tactics, such as art installations and public rallies, to engage diverse audiences and demand policy reforms, including increased renewable energy

investments and stricter emissions regulations.

Complementing these high-visibility campaigns, Climate Watch Thailand, a youth-led non-governmental organization, focuses on practical interventions in tourism supply chains. Operating in high-tourism areas like Phuket and Krabi, Climate Watch promotes waste recycling programs that divert plastic waste from landfills and beaches, integrating circular economy principles into local supply chains (UNICEF Thailand, 2024). For instance, their “Recycle for Resilience” initiative collaborates with hotels and restaurants to implement waste segregation, engaging local youth in environmental education and community clean-up drives. Additionally, youth groups in northern Thailand, such as the Chiang Mai Youth Climate Network, organize workshops to train rural youth in sustainable farming practices, reducing reliance on chemical inputs and enhancing agricultural resilience (ESCAP, 2024). These strategies reflect a bottom-up approach, prioritizing local knowledge and community engagement to address climate impacts.

Participation in Thai youth climate action is notably inclusive, spanning urban and rural contexts and fostering procedural justice by creating spaces for diverse voices (Schlosberg, 2004). UNICEF’s #CountMeIn campaign, launched in 2020, has engaged over 5,000 youth through climate education workshops, hackathons, and community projects, reaching students in Bangkok universities and farmers’ children in rural Isaan (UNICEF Thailand, 2024). The campaign’s participatory model empowers youth to co-design projects, such as community gardens in flood-prone areas, which enhance food security and local supply chains. Rural youth, often marginalized in policy discourses, play a critical role in these initiatives, leveraging traditional knowledge to adapt agricultural practices to climate variability (Thailand Ministry of Agriculture and Cooperatives, 2023).

However, systemic barriers significantly constrain youth participation. Only 5% of Thailand’s Nationally Determined Contribution (NDC) consultation processes included youth representatives, reflecting a profound gap in policy access (UNFCCC, 2022). Thailand’s centralized, military-backed governance, in place since the 2014 coup, imposes strict regulations on public protests, with climate strikes frequently facing police oversight, permit denials, or arrests of organizers (Amnesty International, 2023). These restrictions limit youth’s ability to influence national climate policies, such as the 30% emissions reduction target by 2030 or the National Adaptation Plan’s focus on agriculture and tourism (Thailand Ministry of Natural Resources and Environment, 2023). The lack of formal platforms, such as youth advisory councils, further marginalizes young voices, undermining recognition justice and hindering the integration of their innovative solutions into governance frameworks.

The supply chain impact of Thai youth initiatives is substantial, particularly in eco-tourism and agriculture, aligning with SSCM principles (Carter & Rogers, 2008). In Chiang Mai, youth-led eco-tourism initiatives, such as the Green Market, promote local sourcing of organic produce and handmade crafts, reducing transport-related emissions and supporting smallholder farmers (ESCAP, 2024). These markets collaborate with over 200 local vendors, prioritizing sustainable practices like zero-waste packaging and farm-to-table supply chains, which enhance economic resilience and align with SDG 12 (Responsible Consumption and Production) (UNICEF Thailand, 2024). Similarly, in Phuket, youth-driven recycling programs have diverted significant waste from tourism supply chains, fostering partnerships with local businesses to implement sustainable waste management systems (UNICEF Thailand, 2024). While precise emissions reduction data is scarce, ESCAP (2024) highlights that these initiatives contribute to sustainability by minimizing environmental

impacts and strengthening community-based supply chains. However, the absence of national policy support and funding limits their scalability, as youth groups rely on small grants and volunteer efforts. This underscores the need for governance reforms to amplify youth contributions to SSCM, a theme explored further in the comparative analysis.

Taiwanese Youth Climate Action: Strategies and Participation

Taiwanese youth climate action exemplifies a structured, policy-oriented model, leveraging education and digital innovation to achieve significant impact. The Taiwan Youth Climate Coalition (TWYCC), founded in 2018, has trained over 15,000 students through its “Climate Leader for Future” program since 2020, integrating climate education into high school and university curricula across Taipei, Kaohsiung, and Tainan (Kuo, 2021). The program combines scientific training, policy literacy, and advocacy skills, enabling youth to engage policymakers through targeted campaigns, including petitions, public forums, and policy briefs submitted to the Legislative Election and Governance Committee. TWYCC’s advocacy was instrumental in shaping Taiwan’s 2022 Renewable Energy Development Act, which raised renewable energy targets to 27% by 2030, a 7% increase from previous commitments (Taiwan Environmental Protection Administration, 2024). This success highlights how youth can drive systemic change within a democratic governance structure, embodying procedural justice by ensuring access to decision-making processes (Schlosberg, 2004).

Digital diplomacy is a cornerstone of Taiwanese youth action, addressing Taiwan’s exclusion from UNFCCC processes due to geopolitical constraints. Since 2020, TWYCC’s virtual Conference of the Parties (COP) simulations have engaged over 10,000 youth annually in mock global climate negotiations, allowing participants to draft policy proposals, negotiate emissions targets, and build coalitions with regional peers (Huang, 2025). Hosted on platforms like Zoom and supported by interactive tools, these simulations replicate UNFCCC processes, training youth in diplomacy and policy advocacy. The Asia-Pacific Youth Climate Summit, an offshoot of these simulations, connects Taiwanese youth with counterparts in Japan, South Korea, and Southeast Asia, fostering regional alliances that amplify Taiwan’s climate commitments (Chen & Wu, 2023). This digital approach enhances recognition justice by providing a global platform for youth to assert their agency, bypassing traditional barriers and positioning Taiwan as a leader in youth-led climate diplomacy.

Beyond education and diplomacy, TWYCC employs strategic partnerships to advance climate action. Collaborations with environmental NGOs, such as Greenpeace East Asia, and government agencies, like the Taiwan Environmental Protection Administration (EPA), have secured funding for youth-led projects, including renewable energy workshops and urban greening initiatives (Taiwan Environmental Protection Administration, 2024). TWYCC’s “Youth Climate Ambassadors” program trains youth to represent Taiwan at international forums, such as the UN Youth Climate Summit, further extending their global influence (Kuo, 2021). These strategies, rooted in institutional support and educational infrastructure, ensure sustained engagement and policy impact, contrasting sharply with Thailand’s resource-constrained grassroots model.

Participation in Taiwanese youth climate action is structured and widespread, facilitated by Taiwan’s democratic governance and robust civil society. TWYCC’s programs reach urban and suburban youth through school partnerships, with over 500 schools participating in the “Climate Leader for Future” curriculum (Chen & Wu, 2023). Youth are empowered to organize climate marches, engage in policy dialogues, and collaborate with SMEs on sustainability projects, fostering a sense of ownership and agency. However, participation is less

inclusive in rural areas, where limited access to digital infrastructure and urban-centric programming exclude indigenous and farming communities (Lin, 2022). Efforts to address this gap, such as TWYCC's 2023 rural outreach initiative, have trained 2,000 rural youth in sustainable agriculture, but scalability remains a challenge due to funding constraints (Taiwan Environmental Protection Administration, 2024).

The supply chain impact of Taiwanese youth initiatives is profound, particularly in agricultural and logistics sectors, aligning with SSCM frameworks (Carter & Rogers, 2008). TWYCC's advocacy for green logistics has driven pilot projects reducing packaging waste by 20% in Taiwan's fruit export industry, promoting biodegradable materials and local sourcing in markets like Taichung and Pingtung (Taiwan Environmental Protection Administration, 2024). These projects, supported by partnerships with over 100 SMEs, have introduced green certification programs that enhance supply chain transparency and align with SDG 12 (Lin, 2022). Additionally, TWYCC's campaigns for renewable energy adoption in logistics have reduced carbon footprints in transport networks, contributing to SDG 13 (Climate Action) (Chen & Wu, 2023). The policy-driven nature of these initiatives, backed by legislative reforms and institutional funding, ensures scalability, offering a model for Thailand to emulate.

Key strengths of Taiwan's model include its structured advocacy, educational integration, and digital innovation. The democratic governance structure facilitates youth access to policymakers, enabling TWYCC to secure grants and influence legislation (Chen & Wu, 2023). Digital platforms amplify youth voices globally, overcoming geopolitical barriers. However, challenges persist, including urban-rural disparities and the high cost of digital infrastructure, which require sustained investment to maintain inclusivity and impact (Lin, 2022).

Comparative Analysis

The comparative analysis elucidates the strengths, challenges, and complementarities of Thailand's grassroots model and Taiwan's structured advocacy, focusing on participation, strategies, international linkages, and supply chain impacts.

Participation

Thailand's grassroots model excels in community engagement, mobilizing diverse youth through inclusive campaigns like Fridays For Future and #CountMeIn (UNICEF Thailand, 2024). These initiatives reach urban students and rural farmers' children, fostering procedural justice by creating local platforms for participation (Schlosberg, 2004). For example, #CountMeIn's workshops in Isaan empower rural youth to address flood-related agricultural challenges, integrating traditional knowledge into climate solutions (Thailand Ministry of Agriculture and Cooperatives, 2023). However, limited policy access—evidenced by only 5% youth representation in NDC consultations—restricts their influence on national climate strategies, a consequence of Thailand's centralized governance (UNFCCC, 2022). In contrast, Taiwan's curriculum-based approach ensures structured participation, with TWYCC's "Climate Leader for Future" program training youth to engage policymakers through formal channels (Kuo, 2021). Taiwan's democratic system facilitates this access, enabling youth to shape legislation like the 2022 Renewable Energy Act (Taiwan Environmental Protection Administration, 2024). While Thailand's model is inclusive at the community level, Taiwan's structured participation yields greater policy impact, highlighting a trade-off between local engagement and systemic influence.

Strategies

Thailand's strategies prioritize local resilience, focusing on community-based waste management and eco-tourism initiatives that address immediate environmental challenges (ESCAP, 2024). Fridays For Future's climate strikes raise public awareness, often using cultural elements like Thai dance to engage communities, while Climate Watch Thailand's recycling programs in Phuket promote sustainable tourism supply chains (UNICEF Thailand, 2024). These efforts are effective locally but lack national coordination due to governance constraints and limited funding. Taiwan, conversely, emphasizes education and policy influence, with TWYCC's curriculum training youth to advocate for systemic change through policy briefs and legislative lobbying (Kuo, 2021). Taiwan's digital diplomacy, exemplified by virtual COP simulations, extends its reach globally, engaging 10,000 youth annually in international climate dialogues (Huang, 2025). Taiwan's strategies are more scalable, benefiting from institutional support and democratic governance, while Thailand's are constrained by resource and political barriers.

International Linkages

Thai youth face significant barriers in international climate frameworks, with only 10 representatives attending COP29 through YOUNGO, reflecting limited resources and government support (ESCAP, 2024). Initiatives like Fridays For Future Thailand participate in global campaigns, but their international presence is minimal due to funding constraints and visa restrictions for youth delegates (UNICEF Thailand, 2024). In contrast, Taiwan's digital diplomacy engages over 10,000 youth annually in virtual COP simulations, bypassing UNFCCC exclusion and fostering regional alliances through the Asia-Pacific Youth Climate Summit (Huang, 2025). Taiwan's digital platforms, supported by NGOs and government grants, enable youth to influence global climate discourses, offering a scalable model for Thailand to enhance its YOUNGO participation.

Supply Chain Impact

Both regions promote local sourcing, but their approaches and scalability differ. Thai youth's eco-tourism initiatives, such as Chiang Mai's Green Market, reduce transport emissions and support local economies, engaging over 200 vendors in sustainable practices (ESCAP, 2024). These efforts align with SDG 12 but remain localized due to limited policy integration. Taiwan's policy-driven reforms, such as TWYCC's green logistics projects, achieve a broader impact, reducing packaging waste by 20% in agricultural supply chains and introducing green certification programs (Taiwan Environmental Protection Administration, 2024). Taiwan's initiatives, backed by legislative reforms and SME partnerships, are more scalable, aligning with SDGs 12 and 13. Thailand's community-based approach offers resilience, while Taiwan's policy-driven model ensures systemic change.

Synthesis

The comparative analysis reveals significant opportunities for cross-learning between Thailand and Taiwan. Thailand can adopt Taiwan's education model to enhance policy influence, integrating climate education into national curricula to build advocacy skills, as TWYCC has done with its "Climate Leader for Future" program (Kuo, 2021). Establishing a National Youth Climate Council, as proposed by Thai youth at ESCAP workshops, could address the policy access gap, ensuring youth voices are integrated into NDC processes and national climate strategies (ESCAP, 2024). This council could model Taiwan's structured engagement, facilitating youth-policy dialogues and securing funding for youth-led projects. Additionally,

Thailand could leverage digital platforms, inspired by Taiwan's virtual COP simulations, to strengthen YOUNGO participation and amplify its global presence, overcoming resource constraints (Huang, 2025).

Conversely, Taiwan can learn from Thailand's community-based resilience, particularly for engaging rural youth in supply chain initiatives. Thailand's eco-tourism projects, such as Chiang Mai's Green Market, demonstrate how youth can integrate traditional knowledge into sustainable supply chains, offering models for Taiwan to enhance rural SSCM (UNICEF Thailand, 2024). TWYCC's urban-centric programs could expand to rural areas by adopting Thailand's participatory workshops, addressing urban-rural disparities, and aligning with SDG 8 (Decent Work and Economic Growth) (Lin, 2022).

Youth-driven SSCM in both regions significantly advances SDGs 12 and 13. Thailand's local sourcing and waste recycling initiatives reduce environmental impacts in tourism supply chains, while Taiwan's green logistics and certification programs enhance agricultural sustainability (ESCAP, 2024; Taiwan Environmental Protection Administration, 2024). These efforts demonstrate youth's potential to bridge grassroots innovation and policy advocacy, aligning with Carter and Rogers' (2008) SSCM framework. However, Thailand's initiatives require policy support to scale, while Taiwan's benefit from institutional backing. By fostering public-private partnerships and inclusive governance, both regions can amplify youth contributions to climate-resilient supply chains. These findings inform the study's policy recommendations, advocating for structural reforms to harness youth agency in Thailand and beyond.

Results and Discussion

The findings provide the following information and recommendations To analyze Thai youth's climate action strategies and participation mechanisms, focusing on their contributions to sustainable supply chains in tourism and agriculture The research found that Thai youth's grassroots advocacy redefines procedural justice as a contested process of claiming participatory legitimacy within restrictive policy arenas, highlighting the interplay of agency and structural constraints. It is recommended to establish youth-led sustainability incubators within regional universities to empower young entrepreneurs in transforming tourism and agriculture supply chains, including developing digital marketplaces for eco-tourism operators connected with sustainable suppliers, and establishing community-based seed banks to preserve climate-resilient crop varieties. To examine Thai youth's engagement with international climate frameworks, such as YOUNGO and UNFCCC processes: The study suggests that Thailand could establish a Regional Youth Climate Alliance, a virtual platform inspired by Taiwan's digital models, to prepare youth for UNFCCC engagement, supported by ESCAP and UNDP. This alliance would enhance Thai youth's participation in YOUNGO and overcome resource barriers. To compare Thai and Taiwanese youth climate action models, with a 40% focus on Taiwan's structured advocacy, to identify transferable practices. The Thailand-Taiwan comparison reveals how governance contexts mediate the scalability of these initiatives. Thailand could adopt Taiwan's educational model by integrating climate resilience modules into vocational training programs.

Conversely, Taiwan could implement Thailand's participatory community models to engage rural and indigenous youth, addressing urban-centric biases. Taiwan's structured advocacy is evident

in the proposal for a Taiwan-hosted Global Youth Climate Innovation Platform and the pioneering of youth-led bioeconomy cooperatives, which would set a regional benchmark for youth-driven sustainability. To propose policy reforms that integrate youth perspectives into Thailand's climate governance and enhance SSCM. The research suggests that governments must embed youth agency within climate policy frameworks to maximize their sustainability impact. In Thailand, a Youth Climate Policy Commission, an autonomous entity with legislative authority, should be established to ensure youth representation in NDC revisions and adaptation planning. Furthermore, both regions should establish Green Youth Innovation Funds, offering grants for youth-led SSCM projects, such as eco-tourism platforms or sustainable agriculture cooperatives, aligning with SDG 13 by fostering climate-resilient supply chains.

Conclusion and Recommendations

This research study concludes that Thai youth's grassroots advocacy significantly redefines procedural justice within climate action, demonstrating their pivotal role in challenging restrictive policy environments and contributing to sustainable supply chains in tourism and agriculture through initiatives like digital marketplaces and community-based seed banks. The study also identifies the potential for enhanced Thai youth engagement in international climate frameworks, such as UNFCCC processes and YOUNGO, by leveraging collaborative platforms inspired by Taiwanese models. The comparative analysis with Taiwan highlights that while governance contexts mediate the scalability of youth initiatives, valuable transferable practices exist. Taiwan's structured advocacy, including its Global Youth Climate Innovation Platform and youth-led bioeconomy cooperatives, offers a robust benchmark for youth-driven sustainability.

Recommendations

Based on these findings, the study proposes the following recommendations

Policy Reforms for Integrated Youth Perspectives: Governments must actively embed youth agency within climate policy frameworks to maximize their sustainability impact. Specifically, in Thailand, it is recommended to establish a Youth Climate Policy Commission, an autonomous entity with legislative authority, to ensure meaningful youth representation in NDC revisions and adaptation planning, thereby addressing procedural justice deficits. Both Thailand and Taiwan should establish Green Youth Innovation Funds to provide grants for youth-led Sustainable Supply Chain Management (SSCM) projects, such as eco-tourism platforms and sustainable agriculture cooperatives, aligning with SDG 13 by fostering climate-resilient supply chains.

Enhancing International Engagement: To bolster Thai youth's participation in international climate frameworks, the study suggests establishing a Regional Youth Climate Alliance. This virtual platform, drawing inspiration from Taiwan's digital engagement models, would prepare youth for UNFCCC participation and help overcome resource barriers to YOUNGO involvement.

Transferable Practices from Comparative Analysis:

For Thailand: Adopt Taiwan's educational model by integrating climate resilience modules into vocational training programs, thereby channeling grassroots energy into more structured engagement for sustainable supply chain policies.

For Taiwan: Implement Thailand's participatory community models to engage rural and indigenous youth, addressing urban-centric biases, possibly through pilot youth-led agroforestry projects inspired by Thai community initiatives to restore degraded lands and enhance rural supply chains.

Strategic Partnerships for SSCM Enhancement: The research underscores the necessity for businesses to scale youth-led SSCM innovations through strategic alliances. This includes collaborations between Thai hospitality chains and youth for sustainability certification in eco-tourism, and partnerships between agricultural conglomerates and youth for deploying IoT-based irrigation systems. In Taiwan, logistics firms could work with youth cooperatives to mainstream bioplastic packaging. These partnerships, supported by CSR initiatives, will foster economic opportunities for young innovators and promote sustainable consumption (SDGs 8 and 12).

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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR
VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

Co-Creation for Sustainable Development: A Community-Driven Innovation Model in Bang Nam Phueng, Thailand

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Abstract

This study explores a community-driven co-creation model for localizing the Sustainable Development Goals (SDGs) in Bang Nam Phueng, Thailand. Using a participatory action research (PAR) approach, the research engaged 70 international youth participants and local stakeholders across five thematic areas: inclusive tourism, waste management, circular packaging, sustainable mobility, and digital transformation. The study applies the SMCR communication framework to analyze how intercultural collaboration can generate practical, scalable solutions aligned with SDGs 11, 12, and 13. Results demonstrate that youth-led innovation, grounded in local culture and facilitated through stakeholder communication, can effectively enhance sustainability outcomes in community contexts. The research proposes two key outputs: (1) a Co-Learning Framework for youth engagement and (2) a Stakeholder Communication Toolkit adapted from the SMCR model. These models offer a transferable blueprint for participatory SDG implementation through community-based innovation.

Keywords: Youth Empowerment, SDGs, Co-Creation, Transcultural Learning, Participatory Communication

Introduction

Efforts to localize the United Nations Sustainable Development Goals (SDGs) have increasingly recognized the limitations of top-down governance approaches, especially in culturally diverse regions like Southeast Asia. Conventional models often overlook community-specific contexts, resulting in solutions that lack long-term relevance or engagement. In contrast, participatory and youth-led innovations have shown greater potential in aligning global sustainability goals with local realities (Kruger et al., 2018; Rahman & Baddam, 2021; Indrawan & Sofjan, 2021). Community co-creation, where solutions are developed collaboratively by local stakeholders and beneficiaries, offers a compelling framework for deepening grassroots sustainability.

Within this paradigm, youth empowerment plays a vital role. Young people, particularly when positioned as co-designers and co-learners, bring creative insights, intercultural sensitivity, and a strong commitment to action (Voorberg et al., 2015; Marisa, 2019; Zimmerman, 2000). Transcultural learning environments allow youth to engage across boundaries of language, culture, and sector, thus enriching the co-creation process. Such dynamics not only enhance personal transformation but also facilitate social innovation that resonates with both community values and SDG frameworks.

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The present study focuses on the Bang Nam Phueng community in Thailand, which served as a living laboratory for the 2025 UN SDGs Bootcamp. Over 70 youth participants from 30 countries collaborated with local stakeholders to design and prototype community-driven solutions in five thematic areas: inclusive tourism, waste management, circular packaging, sustainable mobility, and digital transformation. Drawing on participatory action research (PAR) and the SMCR communication model, the initiative emphasized inclusive message design, code-sharing, and adaptive stakeholder dialogue (Berlo, 1960; Leesakun, 2017; Borojević et al., 2023). The outputs of this study, namely the SDG Co-Learning Framework and the SMCR-based Stakeholder Communication Toolkit, are offered as transferable models for future youth-led sustainability programs.

Research Objectives

This study aims to explore and synthesize the intercultural co-creation processes of international youth participating in the UN SDGs Bootcamp Forum 2025, with the following specific objectives:

1. To examine how youth-led co-creation contributes to the localization of the Sustainable Development Goals (SDGs) in a Thai community context.

2. To explore the role of participatory communication, particularly the SMCR model, in facilitating stakeholder engagement across cultural boundaries.

3. To develop transferable frameworks for community-driven SDG implementation through youth empowerment and intercultural collaboration.

Literature Review

In the pursuit of localizing the Sustainable Development Goals (SDGs) through youth-driven initiatives, co-creation has emerged as a pivotal paradigm in both educational and community development settings. Kruger et al. (2018) emphasize that co-creation processes must move beyond mere participation to embrace mutuality, where all stakeholders, including, youth contribute equitably to solution design. Particularly in Southeast Asia, co-creation has proven effective when embedded within local cultural systems and traditional knowledge frameworks (Wibeck, Eliasson, & Neset, 2022; Zohar & Newhouse, 2019; Bueno et al., 2023).

A core aspect of this approach lies in intercultural and transcultural learning, which facilitates not only the exchange of knowledge across groups, but also the emergence of shared values. Zohar and Newhouse (2019) propose a transcultural model of education that bridges Indigenous and Western paradigms to promote sustainability mindsets. Similarly, Knoth et al. (2022) highlights the efficacy of virtual exchange and co-teaching in developing students' intercultural competencies. These models are particularly valuable in contexts where international youth collaborate in community-based SDG actions, as demonstrated in the ENG Co-Creation project.

The theoretical backbone of the project rests on Berlo's SMCR model of communication, which conceptualizes message transmission in terms of Source, Message, Channel, and Receiver (Berlo, 1960). This

model has been adapted for participatory contexts in sustainability education, where dialogic communication ensures inclusivity and power balance (Leesakun, 2017; Wang, Aenis, & Siew, 2019). Moreover, participatory communication strategies that enable marginalized voices to be heard, especially those of youth, are critical to the success of SDG localization efforts (Camargo, Flores, & Quijano López, 2025).

In addition, recent research stresses the importance of developing innovation through community-grounded, transdisciplinary collaboration. Van den Berg and Verster (2023) show how the Quintuple Helix Model incorporating academia, industry, government, civil society, and the natural environment enables sustainable-smart innovations rooted in local contexts. When paired with co-learning approaches such as those found in youth-led social labs and hackathons (Andersson et al., 2024), these innovations become replicable and scalable.

In summary, the current literature supports the integration of co-creation, intercultural learning, and participatory communication as synergistic approaches in community driven SDG initiatives. The project builds on these foundations, offering a youth-centric, culturally sensitive, and innovation-oriented framework for sustainable development.

Research Methodology

This study employed a qualitative Participatory Action Research (PAR) approach to explore how international youth engage with local stakeholders in co-creating community-based solutions aligned with the Sustainable Development Goals (SDGs). PAR was selected due to its emphasis on shared learning, empowerment, and iterative action, which aligns with the objectives of youth-centered sustainable development (Kindon, Pain, & Kesby, 2007; MacDonald, 2012). The study was conceptually framed by Berlo's SMCR communication model (Berlo, 1960), which supports the analysis of dialogue, message adaptation, and cultural interpretation across stakeholder groups (Wang, Aenis, & Siew, 2019).

Fieldwork was conducted in Bang Nam Phueng, Thailand, during the 2025 SDGs International Bootcamp, a community-based learning initiative that brought together 70 youth participants from 30 countries. These youth were divided into five thematic project groups focusing on SDG-relevant challenges: inclusive tourism, waste management, circular packaging, sustainable mobility, and digital transformation. Local community stakeholders, including monks, market vendors, educators, and NGOs were integrated into project activities through co-design sessions, workshops, and stakeholder dialogues.

Data collection was based on two primary qualitative methods: participant observation and semi-structured group interviews. The research team engaged in direct field observation during design workshops, site visits, and community co-creation activities. In addition, semi-structured interviews were conducted with youth participants in each of the five project groups, both during and after the Hackathon-style innovation sessions. These sessions provided insight into the learning dynamics, communication challenges, and stakeholder engagement strategies experienced by each group.

The data were analyzed using thematic analysis, following Braun and Clarke's (2006) six-phase process. Coding was carried out manually and inductively, with themes emerging from the documented results of the five

youth groups and transcripts from discussion sessions. The focus of the analysis was to identify patterns of co-creation, communication strategies within intercultural teams, and the contextual nature of community-driven innovation. While no computer-assisted software was used, analytical rigor was maintained through iterative coding cycles and peer review among the research team.

To uphold research ethics and trustworthiness, all participants were informed of the study's purpose and gave verbal consent before participation. Anonymity and confidentiality were maintained in the reporting of findings. Although no formal institutional ethics approval was required for this educational initiative, the study was guided by ethical principles aligned with human-centered, participatory research practices (Lincoln & Guba, 1985; Flick, 2018). Measures to ensure credibility included prolonged engagement, triangulation between observation and interview data, and team debriefing to reduce interpretive bias.

Table 1: Manual Thematic Analysis Procedure

Phase	Description of Process
1. Familiarization	Researchers reviewed data sources, including group presentations, interview summaries, and field notes from participant observations across five project groups.
2. Initial Coding	Recurring words, concepts, and stakeholder interactions were manually highlighted. Notes were written in the margins to capture early impressions and insights.
3. Grouping Ideas	Related codes were clustered together into preliminary categories (e.g., "youth–monk collaboration," "market-driven innovation," and "barriers to communication").
4. Theme Formation	Categories were analyzed across groups to generate broader themes that captured shared patterns or contrasting practices across contexts.
5. Team Validation	The research team collaboratively refined and named final themes through discussion, ensuring consistency, relevance, and alignment with the SDG framework.

Adapted from Braun & Clarke (2006).

Table 1 outlines the manual thematic analysis procedure used in this study, based on Braun and Clarke's framework. The process includes five iterative phases, starting from familiarization with field data to collaborative theme validation by the research team.

Research Limitations

While the participatory and intercultural design of the study enhanced its authenticity and contextual relevance, several limitations must be acknowledged. First, language differences among participants occasionally posed challenges to communication fluency and depth. Although English was the working language, varying levels of proficiency may have limited some participants' ability to articulate nuanced ideas, a limitation commonly observed in intercultural educational settings (Deardorff, 2006; Knoth et al., 2022). Informal peer translation and the use of visual aids were employed to bridge these gaps during fieldwork.

Second, time constraints inherent to the short-term format of the Bootcamp limited opportunities for extended data collection and follow-up interviews. This is a common constraint in action-based, time-bounded

research initiatives (O'Brien, 2021), where the focus on experiential learning and real-time co-creation often requires methodological compromises.

Third, the richness of cultural and disciplinary diversity within the youth groups, while a strength, also created occasional difficulties in reaching group consensus and managing divergent expectations. These dynamics mirror findings from prior research on transdisciplinary co-creation, where collaboration can be both a source of innovation and a site of friction (Bueno et al., 2023).

Finally, the absence of qualitative data analysis software necessitated a fully manual coding process, which increased the risk of oversight and subjectivity. To mitigate this, a structured coding matrix was used, and theme validation was conducted through peer discussion and triangulation of data sources.

Results

The findings from the five project groups revealed shared patterns in how international youth collaborated with local stakeholders to address sustainability challenges in Bang Nam Phueng. Through thematic analysis, five overarching themes emerged: (1) Sustainability Through Local Culture, (2) Transcultural Learning and Empowerment, (3) Communication for Behavioral Change, (4) Systems Thinking and Stakeholder Mapping, and (5) Digital Innovation for SDG Impact. These themes are summarized in Table 2 and discussed below.

Many groups rooted their solutions in local culture, drawing inspiration from temples, traditional products, and community storytelling. This approach helped connect global SDG concepts to everyday community life, reflecting previous studies that advocate for culturally embedded innovation (Ansell et al., 2022; Zulkefli et al., 2022). For example, one group partnered with temple leaders to design sustainable packaging for local products. Participants also engaged in meaningful transcultural learning. Working in international teams enhanced their global perspectives, problem-solving abilities, and intercultural fluency, outcomes consistent with research on youth development through co-creation (Knoth et al., 2022; Dixon & Tahmaz, 2020). This process empowered participants to shift from passive learners to proactive sustainability actors.

Communication strategies were central to each group's initiative. Youth employed gamified content, interactive signage, and social media storytelling to influence behavioral change within the community. These findings support theories of participatory communication, which emphasize message co-design, visual rhetoric, and adaptive feedback (Bennett, 1998; Fischer & Radinger-Peer, 2024). A notable outcome was the emergence of systems thinking. Some teams mapped local challenges using stakeholder frameworks and time-based planning. Their ability to integrate multiple actors—vendors, monks, tourists, and youth into sustainable solutions aligns with current literature on collaborative systems change in SDG contexts (Padthar & Ketkaew, 2024; Bueno et al., 2023).

Finally, digital innovation was used not as a substitute for cultural insight but as an amplifier. Teams employed tools such as QR codes, social media analytics, and mobile apps to enhance impact. These approaches demonstrate the potential of technology-supported youth innovation for SDG localization, as shown in

recent studies (Perello-Marín et al., 2018; Chinapaw et al., 2024). The themes and examples are summarized in the following table:

Table 2: Thematic Summary of Youth Co-Creation Outcomes

Theme	Description	Illustrative Example
Sustainability Through Local Culture	Emphasizing traditional values, rituals, and spaces (e.g., temples) to promote sustainability	Group 1 used temple tourism to promote circular packaging
Transcultural Learning & Empowerment	Gaining global awareness and leadership through intercultural teamwork	Group 5 emphasized cross-cultural storytelling via workshops
Communication for Behavioral Change	Using creative messaging to influence awareness and practices within the community	Group 2 applied social media challenges to promote recycling
Systems Thinking & Stakeholder Mapping	Integrating multiple actors and long-term perspectives in innovation design	Group 3 developed a mobility model linking vendors and youth
Digital Innovation & SDG Impact	Leveraging technology for social change and SDG education	Group 4 created a QR-based platform to trace sustainable use

Table 2 summarizes the five core themes identified through thematic analysis of the Hackathon groups' outputs. Each theme is paired with a description and a practical example from one of the youth teams, illustrating how local and global knowledge were integrated in co-creating sustainability solutions.

Conclusion and Recommendations

This study explored how international youth, working in transcultural teams, co-created community-based solutions aligned with the Sustainable Development Goals (SDGs) in Bang Nam Phueng, Thailand. Using a participatory action research framework and thematic analysis, five key themes emerged: cultural grounding, transcultural learning, strategic communication, systems thinking, and digital innovation. These findings suggest that community-centered co-creation, when facilitated through experiential learning, can serve as a powerful mechanism to localize SDGs in culturally diverse and ecologically sensitive settings.

The integration of intercultural dialogue and local wisdom proved especially effective in generating context-specific innovations that were both socially acceptable and practically implementable. By engaging directly with monks, vendors, educators, and NGOs, youth participants demonstrated not only creative problem-solving but also the ability to negotiate meaning and adapt solutions to local realities. These outcomes align with previous research highlighting the importance of co-design, trust-building, and communication in grassroots sustainability initiatives (Bueno et al., 2023; Zulkefli et al., 2022; Chinapaw et al., 2024).

However, challenges such as language barriers and time constraints limit the depth of engagement in some cases. Therefore, future initiatives should incorporate pre-project intercultural orientation, allocate more time for field-based reflection, and consider multilingual facilitation to enhance participation equity.

Based on the findings, the study offers the following recommendations:

1. Educational institutions should integrate transcultural co-creation experiences into sustainability curricula, particularly through short-term immersive programs and community labs.

2. Community stakeholders are encouraged to view youth not just as visitors, but as active co-developers of solutions. Structured partnerships between local leaders and international youth can yield mutual capacity building.

3. Policy makers and Development Agencies should support platforms that fund and mentor youth-led innovations at the local level, especially those grounded in cultural sustainability and community resilience.

Ultimately, this study reinforces the idea that youth empowerment, when coupled with participatory communication and local collaboration, can act as a transformative force in sustainable rural development.

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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR
VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

Development of an Instructional Package on Sustainable Supply Chain Innovation Management through the Carbon Heroes Board Game for Undergraduate Students in Logistics and Supply Chain Management

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Abstract

This research developed and evaluated an instructional package on "Sustainable Supply Chain Innovation Management" using the Carbon Heroes board game for undergraduate Logistics and Supply Chain Management students. The study employed a five-phase R&D approach: 1) needs assessment through literature review and surveys, 2) curriculum design integrating ESG concepts and experiential learning, 3) expert validation (IOC $\geq$ 0.80), 4) pilot testing with 15 students at Southeast Bangkok University, and 5) data analysis using t-tests, E1/E2 effectiveness criteria, and content analysis. Results showed the instructional package achieved the highest quality level (mean = 4.63, S.D. = 0.30) across all dimensions. Effectiveness scores exceeded the 80/80 criteria with E1 = 84.48% and E2 = 87.33%, demonstrating significant learning enhancement. Student satisfaction was at the highest level ($\bar{x}$ = 4.69, S.D. = 0.32), particularly in knowledge acquisition ($\bar{x}$ = 4.81) and learning activities ($\bar{x}$ = 4.78). The game-based instructional package successfully enhanced both academic achievement and learner motivation, proving suitable for expansion to other educational contexts to strengthen ESG competencies in sustainable supply chain management.

Keywords: Sustainable Supply Chain Management, Game-Based Learning, Educational Innovation, Carbon Heroes Board Game, Experiential Learning, Curriculum Development, Learning Effectiveness, Learner Satisfaction.

Introduction

In an era of increasingly complex environmental, economic, and technological changes, Sustainable Supply Chain Innovation Management has become a critically essential skill for modern logistics and supply chain professionals. This is particularly important as organizations worldwide are emphasizing business operations based on ESG (Environmental, Social, and Governance) principles, which encompass reducing environmental impact,

caring for society and stakeholders, and maintaining good governance (Elkington, 1997; PwC, 2021; World Economic Forum, 2023). However, transferring the necessary knowledge and skills to integrate ESG factors with supply chain innovation management at the undergraduate level remains challenging, as traditional teaching methods such as lectures, PowerPoint presentations, or rote memorization cannot effectively create deep understanding of the holistic connections and complex dynamics between supply chain decision-making and impacts across all three dimensions. This is especially true in the Thai context, where there is still a lack of learning media design that can connect environmental issues with economic systems at local and national levels (Phipma, 2021; UNDP Thailand, 2022).

Therefore, this research aims to develop a training curriculum to enhance such knowledge and skills using the "Carbon Heroes" board game, which is an innovative experiential learning tool specifically designed to simulate the challenges of creating balance between economic goals (production, trade, investment), social objectives (population satisfaction, employment), and environmental concerns (carbon management, resource utilization) in the context of city management and interconnected supply chains.

This game allows players to assume the roles of five types of city leaders who must strategize development, manage resources, negotiate trade deals, invest in projects ("Investing Cards"), and respond to unexpected "situation cards," where every decision impacts CO2 emissions, population satisfaction, and economic stability of their own and other cities. Learning through real-situation simulation, data analysis, and reflection from playing Carbon Heroes aligns perfectly with Active Learning, Problem-Based Learning, and Collaborative Learning approaches (Prince, 2004; Kolb, 1984; Hmelo-Silver, 2004), which will help prepare students to effectively apply knowledge in managing sustainable supply chain innovation in the real working world.

Research Objectives

1. To develop an instructional package on Sustainable Supply Chain Innovation Management using the Carbon Heroes board game for undergraduate students majoring in Logistics and Supply Chain Management.
2. To test the effectiveness of the instructional package to meet the established criteria of 80/80.
3. To determine learner satisfaction with the developed instructional package.

Research Methodology

This research is applied research that aims to develop and test the effectiveness of a training curriculum on Sustainable Supply Chain Innovation Management using the "Carbon Heroes" board game as an experiential learning tool. The study applies the Research and Development (R&D) approach based on Borg & Gall's (1983) methodology, which consists of five main phases.

Phase 1 Problem and Needs Assessment

The researchers conducted a literature review related to Sustainable Supply Chain Innovation concepts, ESG (Environmental, Social, and Governance) principles, and Game-Based Learning to analyze contemporary trends and practices relevant to training curriculum development. Additionally, a needs assessment survey was

conducted among students and faculty in the Logistics and Supply Chain Management field to identify learning gaps and learner engagement behaviors in the current context (Kolb, 1984; Phipma, 2021).

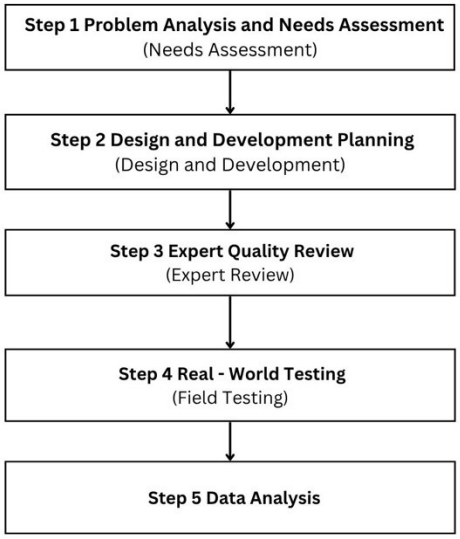

Figure 1 Research Process Steps

Phase 2 Curriculum Design and Development

The "Carbon Heroes" board game was designed based on Experiential Learning principles that emphasize role-playing and decision-making in simulated situations, enabling learners to understand economic, social, and environmental management systems under ESG concepts through game mechanisms such as production, investment, carbon emissions, and trading (Lin et al., 2015). This was coupled with the design of training activities comprising lectures, full-scale game play, and reflection according to the principles of McGuire (1969) and Jonassen (1991).

Phase 3 Quality Validation

The researchers presented the curriculum draft, game prototype, and assessment tools to three experts in curriculum design, logistics management, and game design to evaluate Content Validity using the Index of Item-Objective Congruence (IOC). The evaluation results showed that the index was at an appropriate level (IOC $\geq$ 0.80).

Phase 4 Pilot Implementation

The curriculum and Carbon Heroes game were tested with a sample group of 15 fourth-year undergraduate and graduate students majoring in Logistics and Supply Chain Management at Southeast Bangkok University. Data were collected before and after training through academic achievement tests, the ECCI-I creativity assessment (adapted from Torrance Tests), satisfaction evaluation forms, and focus group interviews to analyze in-depth learning experiences.

Phase 5 Data Analysis and Conclusion

The researchers analyzed quantitative data using paired t-test statistics to compare pre- and post-training scores and analyzed curriculum effectiveness using the E1/E2 index. Descriptive statistics such as mean and standard deviation were also used to assess learner creativity and satisfaction. Additionally, qualitative data from behavioral observations and group discussions were analyzed using Content Analysis to synthesize findings and recommendations for curriculum improvement (Patton, 2002).

Table 1: "Universal Basic Needs & Overall Interdependence Table" (Per Round, for CPL=5)

Universal Basic Needs Categories	Required Resources/Services (Per Round for CPL=5)		Service Provider Cities (Diversifying Dependencies)	Impact If Not Received (Linked L0-L3 Satisfaction)							
				L0 Crisis		L1 Shortage		L2 Sufficient		L3 Abundant	
				Units	Score	Units	Score	Units	Score	Units	Score
1. Sustenance	Food	5-6 units	Agriculture (D1)	< 3	-4	3-4	0	5-6	+2	> 7	+3
2. Utilities Pillar	Standard Energy	5-6 units	Energy (E1) / Industry (A4)	< 3	-2	3-4	0	5-6	+2	> 7	+3
	Basic Construction Parts	1-2 units	Industry (A1)	0	-1	-	-	1	+1	2	+2
3. Well-being & Happiness	Consumer Goods	2-3 units	Industry (A2)	< 2	0	-	-	2-3	+1	> 3	+2
	Recreation Services	1-2 packages	Tourism (B1)	-	-	0	0	1	+1	2	+2
	Communication Networks	1 system	Technology (C1)	-	-	0	0	1	+1	> 1	+1

Table 3: "Specialized Needs & Inter-City Interdependence" (Specialized Needs & Interdependence)

(Needing City)	[illegible]	[illegible]	[illegible] (Supplying City)
Industrial City (A)	- Create new/eco-friendly products - Increase factory efficiency	D2 (Bio-Materials) C2 (Tech Solutions & Innovations)	Agricultural (D) Technology (C)
Tourism City (B)	- Create new tourism experiences/Marketing - High-quality services	D2 (Bio-Materials) A2 (Consumer Goods - Premium grade)	Agricultural (D) Industrial (A)
Technology City (C)	- Innovation research/high-tech equipment production - AI/software development	B2 (Service & Marketing Expertise) E2 (Advanced Energy Tech & Management - for labs)	Tourism (B) Energy (E)
Agricultural City (D)	- Increase productivity/smart agriculture - Agricultural product processing	E2 (Advanced Energy Tech & Management - for labs) C2 (Tech Solutions & Innovations)	Energy (E) Technology (C)
Energy City (E)	- Build new power plants/Smart Grid - [illegible]	A3 (Specialized Machinery & Tools) B2 (Service & Marketing Expertise)	Industrial (A) Tourism (B)

Table 2: Production Resources, Average Prices & Impact Table' (Production, Price & Impact Table)

Industrial City	Code	Resource/Service Produced	Type	(Production Cost/Unit)	Central Price/Unit	Carbon Impact/Unit	Primary Use Notes
Industrial	A1	Basic Construction Parts	Basic	10 Coins	20 Coins	+10	Maintenance, basic construction (all cities)
	A2	Consumer Goods	Basic	5 Coins	15 Coins	+5	Quality of life (all cities)
	A3	Specialized Machinery & Tools	Specialized	35 Coins	60 Coins	+30	Manufacturing, agriculture, energy, technology development
	A4 Alternative	Fossil Fuel Energy	Basic	5 Coins	10 Coins	+50	Energy alternative (high carbon)
Tourism City Tourism	B1	Recreation & Cultural Services	Basic	10 Coins	25 Coins	+5	Quality of life (all cities)
	B2	Service & Marketing Expertise	Specialized	20 Coins	40 Coins	+2	Promotion, building acceptance (specialized)
[illegible] Technology	C1	Communication & Data Networks	Basic	15 Coins	30 Coins	+3	Quality of life, basic operations (all cities)
	C2	Tech Solutions & Innovations	Specialized	40 Coins	70 Coins	+15	Efficiency development, carbon reduction, innovation
[illegible] Agricultural	D1	Food	Basic	5 Coins	10 Coins	+5	Food security (all cities)
	D2	Bio-Materials & Processed Agri-Products	Specialized	15 Coins	35 Coins	+2 If planted forest absorbs -5	New industries, tech research, bioenergy, Essential energy (all cities)
[illegible] Energy	E1	Standard Clean Energy	Basic	10 Coins	15 Coins	-5 Carbon absorption technology from production -20	Energy development
	E2	Advanced Energy Tech & Management	Specialized	40 Coins	65 Coins	-10	storage, tech labs

Figure 2 Game Board Setup for the Carbon Heroes Board Game

Research Results

The quality assessment results of the instructional package on Sustainable Supply Chain Innovation Management through the Carbon Heroes board game from five experts using a 5-level rating scale questionnaire are presented in Table 1. The effectiveness results of the instructional package from 15 learners are shown in Table 2, and the learner satisfaction assessment results regarding the developed instructional package are presented in Table 3.

Table 1 Quality Assessment Results of the Instructional Package

Assessment Items	Mean	S.D.	Interpretation
1. Learning Format	4.70	0.30	Highest
2. Teaching Content Materials	4.48	0.29	High
3. Teaching and Learning Media	4.56	0.31	Highest
4. Activity Organization Process	4.78	0.29	Highest
5. Experimental Kit/Teaching Materials	4.64	0.32	Highest
6. Measurement and Evaluation	4.63	0.30	Highest

Based on the quality assessment results of the instructional package by 5 experts using a 5-point Likert scale questionnaire, it was found that the developed instructional package had an overall quality at the "highest" level (overall mean = 4.63, S.D. = 0.30), with all components receiving high-level assessments, indicating appropriateness and alignment with learning objectives across all dimensions. These included the game-integrated learning format ($\bar{x}$ = 4.70), the instructional content materials which, despite having the lowest mean score ($\bar{x}$ = 4.48), still remained at the "high" level, the interesting and flexible instructional media ($\bar{x}$ = 4.56), the activity management process which received the highest score ($\bar{x}$ = 4.78) reflecting the design of activities that truly promote participation and interactive learning, as well as the experimental kit/instructional materials ($\bar{x}$ = 4.64) and measurement and evaluation ($\bar{x}$ = 4.63) that were appropriately designed and aligned with the content.

These assessment results therefore reflect that the instructional package on "Sustainable Supply Chain Innovation Management through the Carbon Heroes Board Game" has high quality and can be effectively implemented for learning management, consistent with the concepts of experiential learning (Kolb, 1984) and game-based learning (Pihwma, 2021), which emphasize learner participation, hands-on practice, and integrated learning. The obtained results represent a crucial step in confirming the quality of the instructional package before proceeding to efficiency determination using the E_1/E_2 criteria, with efficiency standards set at 80/80 as shown in Table 2.

Table 2 Learning Effectiveness from the Instructional Package

Person	E1 Score (40 points)	E2 Score (40 points)
1	33	34
2	34	35
3	29	33
4	30	32
5	37	38
6	35	35
7	32	33
9	34	35

Person	E1 Score (40 points)	E2 Score (40 points)
10	38	39
11	33	34
12	34	35
13	33	34
14	35	35
15	36	37
Total Score	**473**	**489**
Average Score	**84.48%**	**87.33%**

Figure 3 Atmosphere of Activities Using the Instructional Package

From the effectiveness analysis of the instructional package, considering the scores during learning (E1) and after learning (E2) of 15 students, it was found that the average E1 score was 33.79 points out of 40, equivalent to 84.48%, and the average E2 score was 34.93 points, equivalent to 87.33%. Both values exceeded the established standard efficiency criteria of 80/80, thus concluding that the developed instructional package effectively promotes learning achievement both during and after learning. Additionally, learners showed continuously improved achievement after participating in activities, reflecting the design of content and activities that can effectively stimulate learning.

To ensure comprehensive evaluation across all dimensions, the researchers conducted an assessment of learner satisfaction with the instructional package combined with learning through the "Carbon Heroes" board game. The overall evaluation results were at the "highest" level, indicating learner acceptance in terms of content, game attractiveness, teaching methods, and learning atmosphere, particularly regarding the appropriateness of activities that promote participation and practical learning. These evaluation results confirm that the developed instructional package can effectively meet learner needs in both content and format while creating sustainable motivation for learning.

Table 3 Learner Satisfaction Assessment Results

Assessment Items	Mean	S.D.	Interpretation
1. Instructional Package	4.63	0.49	Excellent
2. Teaching Media	4.59	0.17	Excellent
3. Teaching and Learning Activities	4.78	0.21	Excellent
4. Alignment with Course Content	4.65	0.49	Excellent
5. Knowledge Gained	4.81	0.25	Excellent
Overall Average	**4.69**	**0.32**	**Excellent**

Table 3 shows the learner satisfaction assessment results for the instructional package through the "Carbon Heroes" board game, revealing that the overall satisfaction mean was 4.69 with a standard deviation of 0.32, which is at the "highest" level across all aspects. This reflects that learners were comprehensively satisfied with the designed learning process. The item with the highest mean was knowledge gained ($\bar{x}$ = 4.81, S.D. = 0.25), indicating that learners perceived that the content and activities clearly enhanced their knowledge acquisition. This was followed by teaching and learning activities ($\bar{x}$ = 4.78), which indicates the attractiveness and participation in the concrete learning process.

Although teaching media had the lowest mean at 4.59, it still remained at the "highest" level, showing that the media used could create good satisfaction but may have areas for further development. In conclusion, the instructional package that integrates the board game as a learning tool not only demonstrates effectiveness in terms of achievement but also significantly creates learning experiences that satisfy learners across all dimensions.

Discussion

1. The development of the instructional package on "Sustainable Supply Chain Innovation Management" through the Carbon Heroes board game received evaluation from five experts and was found to have "highest" quality ($\bar{x}$ = 4.63, S.D. = 0.30), covering learning format, activity organization, assessment and evaluation, and content. This reflects the appropriateness of the design that aligns with experiential learning concepts (Kolb, 1984) and game-based learning approaches (Phipma, 2021). Particularly, the Carbon Heroes game, which simulates city management roles across economic, social, and environmental dimensions, helps students systematically and realistically understand the complexity of ESG and carbon management (Lin et al., 2015).

2. Testing the effectiveness of the instructional package according to the 80/80 criteria showed that the learning effectiveness assessment from 15 students revealed an average during-learning score (E1) of 84.48% and post-learning score (E2) of 87.33%, which exceeded the established standard criteria of 80/80. This demonstrates that the instructional package can significantly enhance learning achievement. Learners showed continuous knowledge development before and after learning, particularly in complex issues such as CO_2 impact

analysis, strategic planning, and systemic connections in supply chains, reflecting the potential of learning with participation mechanisms and contextual decision-making (Gee, 2007).

3. Learner satisfaction with the instructional package: Survey results showed that overall satisfaction was at the "highest" level ($\bar{x}$ = 4.69, S.D. = 0.32), particularly in "knowledge gained" ($\bar{x}$ = 4.81) and "learning activities" ($\bar{x}$ = 4.78). This indicates that learners deeply perceived the value of content and experiences from the Carbon Heroes game, as well as activities designed to promote participation, enjoyment, and motivation, consistent with Active Learning concepts and game-based learning that can truly create motivation and understanding of complex subjects (Plass et al., 2015).

Recommendations

Based on the research results and pilot implementation of the sustainable supply chain innovation management training curriculum through the Carbon Heroes board game, the researchers offer the following recommendation.

Recommendations from the Research

1. Integration of the Carbon Heroes board game as the core of training curricula in higher education institutions to develop students' deep understanding of ESG concepts and sustainable logistics management, effectively addressing future skills requirements.

2. Balancing some game mechanisms, such as slightly increasing initial capital or providing formal trial rounds, to accommodate learners without strategic board game backgrounds and increase confidence in in-game decision-making.

3. Developing question guidelines and post-game reflection frameworks (Debriefing Framework) that help connect game experiences with theories and real case studies to enhance learners' ability to apply knowledge deeply and comprehensively.

Recommendations for Future Research

1. Testing the curriculum and Carbon Heroes board game with learners in other fields such as business administration, engineering, information technology, and upper secondary education levels, as well as industrial personnel to assess effectiveness in diverse contexts.

2. Designing and evaluating a Game Facilitator Training Program to enable teachers and instructors to use the game effectively.

3. Developing a digital version of the Carbon Heroes board game to reduce limitations regarding time, location, and number of players, while enhancing the ability to analyze gameplay data.

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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR
VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

Closing the Device: A Comprehensive Analysis of AI-Driven Intelligent Learning Platforms to Meet Varied Student Educational Requirements

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Abstract

The swift progression of artificial intelligence (AI) has revolutionized educational methodologies, with AI-driven smart learning systems (AI-SLS) becoming essential tools for catering to a wide range of student learning requirements. This comprehensive review aims to assess the existing body of research on AI-SLS, focusing on its core functionalities, impact, deployment challenges, and strategies for improvement. Following PRISMA protocols, the review scrutinized peer-reviewed articles and non-peer-reviewed literature from 2010 to 2023, employing a meticulous approach to ensure transparency and facilitate the replication of the study. The results indicate that AI-SLS, leveraging adaptive algorithms, natural language processing, and data analytics, substantially improve personalized and inclusive education. Nonetheless, their success hinges on ensuring equal access, teacher preparedness, and compatibility with educational objectives. Ethical dilemmas, technical constraints, and institutional barriers were pinpointed as significant hurdles to their implementation. To tackle these issues, the review suggests measures such as establishing ethical frameworks, enhancing infrastructure, and encouraging collaboration among stakeholders. The study enriches the literature by highlighting the incorporation of sophisticated features like emotion detection and gamification, marking a substantial advancement in AI-SLS. Moreover, it underscores the importance of context-aware designs and scalable solutions to promote inclusivity. By merging technological progress with ethical standards and practical concerns, this review offers practical insights for educators, policymakers, and developers, ultimately working towards the creation of fair and effective educational settings for all learners.

Keywords: AI-driven learning systems, Smart learning systems, Personalized education, Inclusive education,

Introduction

There is no doubt that artificial intelligence (AI) is rapidly evolving, and it has led to substantial changes in different sectors; however, education can be considered the biggest sector that can adopt the revolution of artificial intelligence. Recently, AI-powered smart learning systems (AI-SLS) have appeared as tools dealing with

students' varied and changing learning problems (Mpu, 2023). These systems involve the use of state-of-the-art algorithms, machine learning (ML), natural language processing (NLP), and data analytics to create a personalized, adaptive, and diverse learning environment (Singh et al, 2025). However, despite their potential, AI-SLS integration into education practices has so far been uneven, in that they still lack understanding of how AI SLS might combine to meet the diverse needs of learners in different contexts (Hari et al., 2025). This systematic review focuses on filling in this gap by critically assessing the current status of AI-SLS and its effectiveness in meeting a variety of learning needs, as well as the challenges and opportunities that would be brought by their use.

Personalized learning, according to educational theory, is a central principle meant to necessitate teachers to base their instruction on students' strengths and interests, and their gaps. (Lin et al., 2023). The constraint the established methods of education face when delivering personalized learning is the limited resources with larger pupil groups and many inclusion difficulties (Pane et al., 2010). AI-SLS is a promising solution to educational problems because it can provide instant assessment and personalized feedback, and learner needs adjustments (Saragih, 2024). Building AI-based adaptive learning tools review students' performance metrics, identifies the learning gaps, and deliver individualized lessons to help students score better in their education (Eduardovich, 2023). AI-SLS allows teachers to make data-driven instructional choices as this technology provides the essential student learning roadmap information (Rasheed et al. 2025). AI-SLS shows great strength for educational necessities of various student groups with learning disabilities and language barriers, and socio-economic problems (Fazal et al., 2025). ITS technology and Artificial Intelligence combination provides specialized support and assessment assistance to students with special educational needs to enhance academic results (Rızvı, 2023). English language learners (ELLs) are served through NLP-based applications as a tool that makes instant translation available as well as evaluates the knowledge, the way to pronounce, and grammar (Saragih, 2024). The described abilities enhance accessibility and learning equity; they provide all students with access to quality learning opportunities (Fazal et al., 2025).

The deployment of AI-SLS faces various obstacles despite its updated implementations. These discussions in educational professional and policymaking bodies and research institutions have taken place over the possible ethical matters regarding student data privacy and choosing biased algorithms, and whether implementing AI will result in increasing social inequalities (Aderibigbe et al., 2023). It is also two primary concerns over student data rights, data protection, and potential abuses during the practice of training the AI models with big datasets (Rasheed et al. 2025). According to Laak and Aru (2024), algorithmic bias is the systematic discrimination present in AI systems, and it poses a threat to the AI-SLS in terms of fairness and inclusive nature. These identified challenges (Mustafa et al., 2024) mean that education requires strong regulatory systems, ethical standards for the development of AI solutions.

The scope of success of AI-SLS in addressing different needs of learning is determined by its links to the educational principles and the existing educational framework (Aderibigbe et al., 2023). Although AI has the potential to enable teaching and learning benefits, this occurs only within the constraints of variables such as educator preparation status and administrative school backing for the implementation with available technology systems

(Fazal et al., 2025). As a result, teachers lack the necessary skills and confidence and thus use (or do not use) AI-SLS in teaching practices poorly or at all (Eduardovich, 2023). In economically underdeveloped areas, schools face a lack of technology components necessary for the creation of learning environments, such as hardware and software, as well as internet connectivity (Ajani et al., 2023). According to Roshanaei et al. (2023), a complete solution must align technological advancements with capacity development, policy adjustment, and collaboration with effective stakeholder cooperation.

This systematic review aims to contribute to the growing body of literature on AI-SLS by synthesizing empirical evidence on their efficacy, challenges, and best practices for implementation. By examining studies from diverse geographical, cultural, and institutional contexts, this review seeks to provide a comprehensive understanding of how AI-SLS can be leveraged to address the diverse learning needs of students. Specifically, the review addresses the following research questions: (1) What are the key features and functionalities of AI-SLS that support personalized and inclusive learning? (2) How effective are AI-SLS in improving learning outcomes for diverse student populations? (3) What are the major challenges and barriers to the implementation of AI-SLS in educational settings? (4) What strategies and recommendations can be derived from existing research to optimize the use of AI-SLS for addressing diverse learning needs? The research queries posed in this review are answered through a systematic methodology through which studies from peer-reviewed journals, as well as conference proceedings and grey literature, are selected and examined. This research investigation will lead to conclusions that can be exploited by educators and researchers, and policy-makers for using AI SLS to develop an equal learning environment offering quality outcomes. This review aims to accumulate knowledge from the theoretical-practical iterations to help in designing the structures and operation strategies, and evaluation approaches for digital education advances in the next generation.

Objectives

1. To identify the key characteristics and core functions of AI-SLS that support personalized learning and participatory learning,

2. To evaluate the effectiveness of AI-SLS in improving learning outcomes for diverse student populations.

3. To identify significant challenges and barriers in implementing AI-SLS in educational environments.

4. To compile strategies and recommendations from existing research to enhance the effectiveness of AI-SLS utilization in responding to diverse learning needs

Research Methodology

Research Design

The research design for this systematic literature review is grounded in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which ensure transparency, rigor, and replicability

in the review process (Page et al., 2021). The primary objective of this study is to assess the current state of research on AI-powered smart learning systems (AI-SLS) and their effectiveness in addressing diverse student learning needs. To achieve this, the study adopts a structured, step-by-step approach that includes the identification of relevant literature, the application of inclusion and exclusion criteria, data extraction, quality assessment, and thematic synthesis.

Such methodical design allows researchers to investigate all research questions thoroughly, alongside concluding a strong examination of available literature. The research design contains multiple important components. A wide range of academic and grey literature is thoroughly explored using peer-reviewed journal articles, together with conference proceedings and books, and technical reports. After selecting relevant studies, researchers apply predefined criteria for screening materials to establish both high-quality and appropriate information. The information retrieval process of data extraction concentrates on retrieving precise data about research methods, together with findings, alongside theoretical backgrounds used in individual investigations. The research quality assessment process verifies the strong methodology of chosen studies before including them in the final synthesis. The systematic methodology enables researchers to conduct an unbiased evaluation of studies, which reveals significant details about how AI-SLS assists learners with different needs.

Search Strategy

To ensure the comprehensiveness of the systematic review, a detailed search strategy was developed and implemented. The search was conducted across multiple academic databases, including Scopus, Web of Science, IEEE Xplore, PubMed, and ERIC, to identify studies examining the use of AI-powered smart learning systems in addressing diverse student learning needs. Additionally, grey literature, such as reports from educational technology organizations, policy papers, and white papers from institutions like UNESCO and the World Bank, was included to capture non-academic perspectives and emerging trends. The search strategy employed a combination of keywords and Boolean operators to identify relevant studies. The following search terms were used: (“artificial intelligence” OR “AI” OR “machine learning” OR “intelligent tutoring systems”) AND (“smart learning systems” OR “adaptive learning” OR “personalized learning”) AND (“diverse learning needs” OR “inclusive education” OR “learning disabilities” OR “language barriers” OR “socio-economic diversity”). Synonyms and related terms, such as “AI-driven education,” “learning analytics,” and “equity in education,” were also incorporated to ensure a comprehensive search.

The research only analyzed studies that appeared in English from 2010 to 2023 with the aim of evaluating current advanced developments in this field. The duplicate initial search outputs required another evaluation through which researchers examined article titles and abstracts as they evaluated their connection to research questions. A systematic study selection procedure retained studies that showed direct involvement of AI-SLS in various educational environments. Key articles going through backward and forward citation tracking kept the search method iterative to locate relevant studies which initially missed during the first search operation. The chosen method ensures the review retrieves an extensive and well-representative collection of research about AI-powered smart learning systems and their effects on various student demographics.

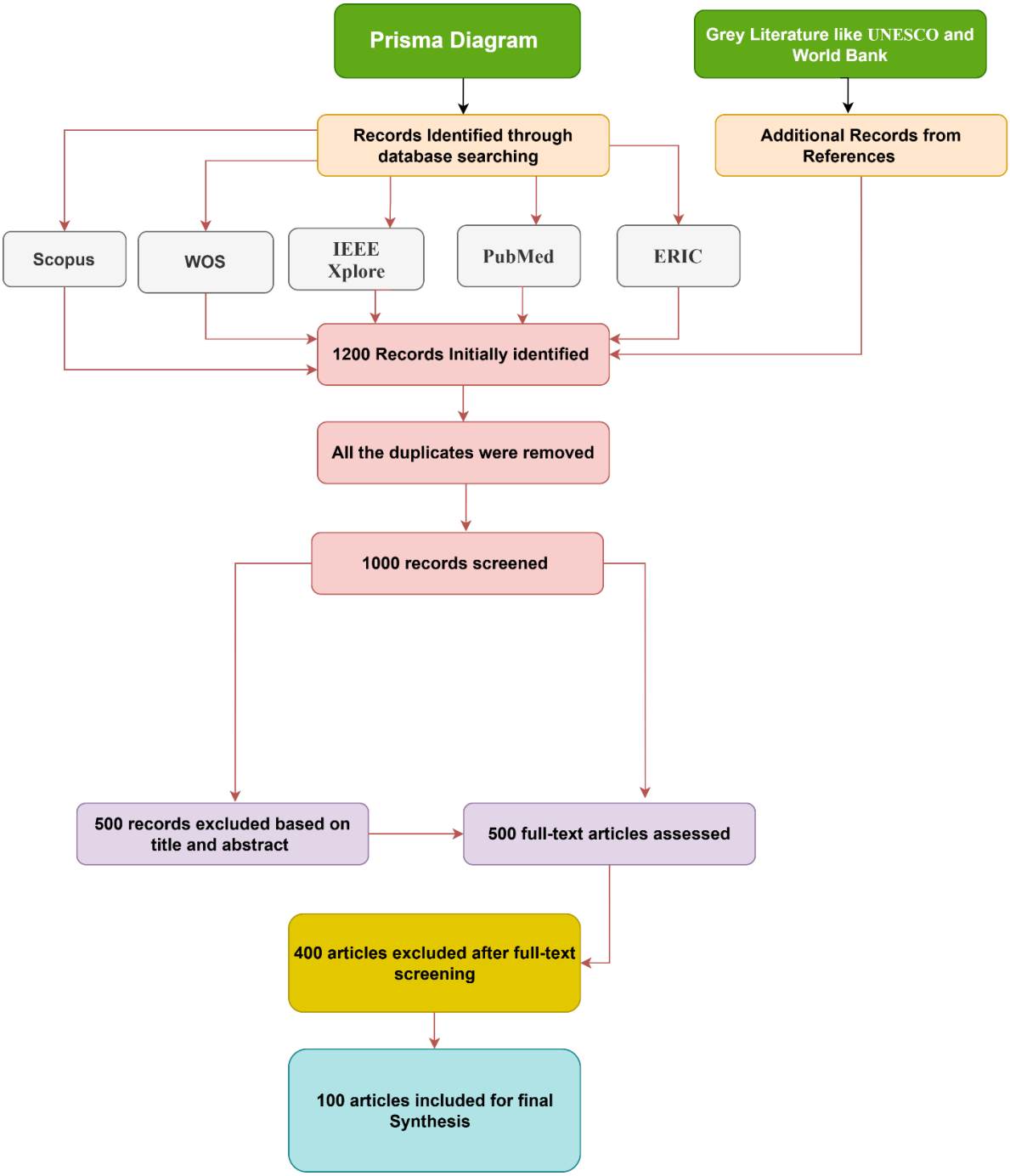

Figure 1. PRISMA Diagram

Inclusion and Exclusion Criteria

The specific requirements for study inclusion and exclusion in this systematic literature review guarantee both relevance and high quality and up-to-date nature of selected research. The research questions guide selection criteria to evaluate studies that examine both essential characteristics and performance outcomes, as well as difficulties and improvement methods related to AI-SLS systems handling different student learning requirements.

Studies are included if they meet the following criteria:

- They focus on the key features and functionalities of AI-SLS that support personalized and inclusive learning, such as adaptive algorithms, natural language processing, or data-driven analytics.
- They analyze the effectiveness of AI-SLS in improving learning outcomes for diverse student populations, including students with learning disabilities, language barriers, or socio-economic disadvantages.
- They examine the challenges and barriers to the implementation of AI-SLS in educational settings, such as ethical concerns, technical limitations, or institutional resistance.
- They provide strategies and recommendations for optimizing the use of AI-SLS to address diverse learning needs, including best practices for educators, policymakers, and developers.
- They are peer-reviewed journal articles, conference proceedings, or reputable technical reports published by recognized organizations (e.g., UNESCO, OECD, or leading educational technology firms).
- They present empirical data, case studies, or substantial theoretical contributions to the field of AI-powered education.
- They are published in English and fall within the publication period from 2010 to 2023, ensuring a focus on contemporary advancements in AI-SLS.

Studies are excluded if:

- They do not directly address the key features, effectiveness, challenges, or optimization strategies of AI-SLS regarding diverse learning needs.
- They focus solely on non-educational applications of AI or lack a clear connection to personalized or inclusive learning.
- They are opinion pieces, editorials, or conceptual papers without empirical or theoretical support.
- They lack methodological rigor or fail to provide sufficient detail on research design, data collection, or analysis.
- They are duplicates, retracted publications, or inaccessible in full text.
- They are published before 2010, as the study aims to focus on recent developments in AI-powered education and its relevance to contemporary educational challenges.

The defined criteria serve to only accept studies that fulfill standards of quality and relevance, as well as correctness and direct relationship to the research inquiries. The review adopts these evaluation criteria to support a methodical and dependable review process that enables the synthesis of present-day AI-powered smart learning system research with its effects on various student learning requirements.

Data Extraction

The data extraction system followed the literature search phase, which enabled the collection of information from selected studies using structured data procedures. A standardized data extraction checklist helped researchers maintain consistency when collecting data from the selected studies to enable scientific analysis and comparison of findings. The evaluation focused on AI-powered smart learning systems (AI-SLS) and their ability to meet numerous learning requirements among students, which involved measures of academic results, together with student involvement and system accessibility, as well as fairness. A comprehensive documentation was established for AI-SLS features that includes adaptive algorithms and personalized feedback mechanisms, and data-driven analytics, so researchers could understand how these technologies enable personalized and inclusive learning. The research extracted both practical implementation barriers and ethical issues, together with technical restrictions and institutional opposition that negatively affect AI-SLS deployment within educational environments.

The extraction process aimed to document the study-based strategies along with recommendations that enhance AI-SLS utilization. The extracted material included recommendations and best practices which addressed three target groups of educator's developers, and decision-makers, along with methods to resolve the noted obstacles. A list of theoretical frameworks and models backing the published studies was recorded to help explain how AI-SLS is designed and implemented. A standard format was used for detailed study reviews while preserving consistent accuracy in recorded data. The demanding collection method produced extensive research data, which formed a strong base to scrutinize research queries while drawing definitive results.

Table 1. Data Extraction Summary

Category	Details Extracted	Purpose
Study Characteristics	Author(s), year, country, study design (quantitative, qualitative, mixed-methods), context (K-12, higher education).	To provide context and background for each study, ensuring a comprehensive understanding of the research setting.
Intervention Details	Type of AI-SLS (intelligent tutoring systems, adaptive platforms), key features (machine learning, NLP), implementation context (classroom, online).	To identify the technological and pedagogical features of AI-SLS and their application in diverse educational settings.
Population	Demographic details (age, educational level), specific learning needs addressed (disabilities, language barriers).	To understand the target audience and how AI-SLS caters to diverse student populations.
Strategies & Recommendations	Best practices for educators, policymakers, and developers; suggestions for optimizing AI-SLS.	To provide actionable insights for improving the design, implementation, and scalability of AI-SLS.
Theoretical Fraeworks	Models or frameworks used to underpin the analysis (e.g., personalized learning theories, adaptive learning models).	To understand the theoretical foundations guiding the development and evaluation of AI-SLS.

Quality Assessment

This review implemented quality assessment of studies as a quality control procedure. Multiple factors determine the quality assessment of each study, starting with research questions, followed by methods used and analysis, and finishing with contribution to the field. The review gives more significance to research with empirical methods alongside theoretical explanations that present their foundations in detail. The reliability of sources serves as an additional component for quality evaluation in the research.

Ethical Considerations

The systematic review observes the highest possible ethical standards for research by maintaining transparency and intellectual property respect from beginning to end. The study utilized all extracted data for academic scholarship while providing full credit to the original study authors. Every result was presented in objective and accurate language, while the review strictly prohibited both manipulation and misleading use of data. A declaration of potential conflicts of interest was implemented, while external funding played no part in the review procedures or final results. The review protects its credibility through ethical principles, which help advance knowledge and responsibility in the field of AI-powered smart learning systems.

Results & Discussion

Results

Overview of Themes

The findings of this systematic review are organized into four key themes that emerged from the analysis of the included studies. These themes provide a comprehensive understanding of the role of AI-powered smart learning systems (AI-SLS) in addressing diverse student learning needs. The first theme, Key Features and Functionalities of AI-SLS, explores the technological and pedagogical elements that enable personalized and inclusive learning. The second theme, Effectiveness of AI-SLS in Improving Learning Outcomes, examines the impact of these systems on academic performance, engagement, and equity for diverse student populations. The third theme, Challenges and Barriers to Implementation, highlights the ethical, technical, and institutional obstacles faced in integrating AI-SLS into educational settings. Finally, the fourth theme, Strategies and Recommendations for Optimization, synthesizes best practices and actionable insights for educators, policymakers, and developers to enhance the design and implementation of AI-SLS. Together, these themes offer a holistic perspective on the potential and limitations of AI-SLS in transforming education to meet the needs of all learners.

Table 2. Identified Themes

Theme	Description	Key Focus Areas
1. Key Features and Functionalities of AI-SLS	Explores the technological and pedagogical elements that enable personalized and inclusive learning.	Adaptive algorithms, natural language processing (NLP), personalized feedback, and data analytics
2. Effectiveness of AI-SLS in Improving Learning Outcomes	Examines the impact of AI-SLS on academic Performance, engagement, and equity for Diverse learners.	Academic achievement, student engagement, accessibility, and inclusivity.
3. Challenges and Barriers to Implementation	Highlights the ethical, technical, and institutional obstacles in integrating AI-SLS into education.	Ethical concerns (e.g., data privacy, bias), technical limitations, and institutional resistance.
4. Strategies and Recommendations for Optimization	Synthesizes best practices and actionable insights for enhancing AI-SLS design and implementation.	Best practices for educators, policymakers, and developers; scalability and adoption strategies.

Key Features and Functionalities of AI-SLS

The examination of selected studies demonstrates how AI-powered smart learning systems (AI-SLS) gain their ability to provide personalized and inclusive learning through their main features. The implementation of adaptive algorithms, which modify content delivery with learner performance data, became a vital aspect because it created customized learning pathways that support varied educational requirements. The system uses natural language processing tools for improving language education as it supports students through feedback for their written and spoken assignments. Learning gaps identification with anticipated outcomes and instructional-based decisions hinged on the extensive use of data-driven analytics. Through its entire feature set, AI-SLS enables personalized educational pathways that benefit both students with different learning capabilities and backgrounds.

The study results maintain continuous alignment with past research findings while creating new knowledge branches. The review shows that adaptive learning technologies have developed sophisticated capabilities regarding their ability to analyze diverse learner datasets compared to previous research (Al-Obaidi et al., 2016; Ai et al., 2016). The review expands past research by Kotz and Timm (2023), which showed intelligent tutoring systems (ITS) support individualization because they introduce NLP and multimodal data analytics for enhanced context-specific interaction capability. Multiple analysts have opposing views about the scalability aspects of these characteristics. The research conducted by Nsouli et al. (2010) supports effective AI-SLS scalability across educational contexts, yet technical requirements restrict its accessibility in settings with limited resources (McCardle, 2002).

The review detects emerging functionality such as emotion recognition and gamification, which previous studies had not thoroughly discussed (Pulari & Jacob, 2025). The reviewed features help students maintain interest and stay motivated because they work especially well for students with learning disabilities as well as students who have difficulties learning with traditional teaching practices (Gambo, 2023). The reviewed literature showed ethical issues concerning data privacy protection as well as algorithm-based biases that correspond with present-day

research findings (Kim et al., 2018). The technological progress of AI-SLS emerges from studies, but researchers need to study the ethical issues that come with these systems alongside developing proper regulations.

Effectiveness of AI-SLS in Improving Learning Outcomes

Researches done on the effectiveness of AI empowered smart learning systems confirm their effectiveness in improving student learning results of different types of learners. The results obtained from research found that AI-SLS leads to positive results in raising student grades as well as improving student grades among students who have disability or come from an underprivileged background. Intelligent tutoring systems (ITS) help in problem-solving skills and test scores due to the fact that they provide students personalized scaffolding and feedback (Yamijala et al., 2025). The adaptive learning platforms have helped to achieve the reduction of the achievement gap that adapting content delivery to the students' needs (Alanezi, 2022). In education equity, AI-SLS demonstrates that it is effective in providing wonderful learning opportunities to students at any initial level.

The benefits of AI-SLS extend beyond grades to drive both student enthusiasm as well as motivational improvements (Gambo, 2023). AI-powered gamified learning platforms deliver exceptional results in both maintaining student attention and building students' growth mindset (Maia et al., 2024). Student confidence and participation levels increase through NLP-based real-time feedback systems, especially with language learners (Pulari & Jacob, 2025). AI-SLS technology produces better cognitive results and strengthens emotional learning alongside behavior-related elements due to their critical value for educational success. AI-SLS demonstrates varying success levels in different learning scenarios, together with diverse student populations. The research demonstrates different findings about learning outcome success, with specific implementation fidelity and context-related obstacles noted. Alam (2022) demonstrated that AI-SLS implementation depends heavily on qualified instructor preparation and on how well technology aligns with teachers' professional goals. The beneficiaries of AI-SLS do not receive equivalent advantages because low-resource educational settings typically lack sufficient infrastructure and limited availability of devices (McCardle, 2002). Research on AI-SLS effectiveness requires an examination of contextual variables because they show clear differences across groups.

The research outcomes of this study validate earlier studies and present additional findings to existing knowledge. The research of Diao et al. (2025) confirmed the benefits of this system for learning success, yet this review demonstrates that contemporary AI-SLS provides expanded features, including combined data capture abilities and detailed feedback mechanisms. This review builds upon Kumar et al. (2023) by specifying adaptive algorithms and NLP techniques that serve as the mechanisms behind AI-driven educational improvements. There exists a differing set of opinions concerning whether AI-SLS systems can be expanded to fit various setups. The effectiveness of AI-SLS, according to Alam (2023), is supported, yet Chou et al. (2022) and Badshah et al. (2023) indicate scalability issues due to ethical biases and practical hurdles like the digital divide. Research shows that Artificial Intelligence Enhanced Self-Learning Systems generate high learning results, specifically through customized approaches for differing student requirements. The success of AI-SLS depends on proper execution and continuous teacher backing, together with fair access to technological resources. Future educational research needs to tackle existing obstacles to achieve the full potential of AI-SLS technology in school transformation.

Challenges and Barriers to Implementation

The adoption of AI-SLS smart learning systems faces major implementation hurdles that block their potential use in educational institutions. Ethical challenges dominate the discussions about AI-SLS mainly through concerns about protecting student data privacy, along with avoiding algorithmic biases. Student data privacy and ownership issues emerge because AI model training requires extensive databases (Hanbury et al., 2012). AI-SLS may perpetuate prejudices that result in ethical dilemmas since algorithmic bias repeatedly magnifies biases in data, which leads to increased inequalities instead of solving them (Brew & Mantai, 2017). Strong ethical frameworks, together with clear AI practices, must be implemented to create responsible applications of AI-SLS.

The main challenge in using AI-SLS stems from its technical constraints that become problematic in resource-limited environments. Several AI-SLS systems function best with high-speed internet connectivity and modern electronic devices, which some areas lack modern technical capabilities (Honiden & Connors, 2015). The advanced nature of AI technology introduces barriers for schools lacking substantial IT departments since implementation and maintenance need specialized technical skills (Lapão, 2011). The technical implementation calls for the creation of flexible, affordable systems that work well in different educational environments. The adoption of AI-SLS encounters major challenges because institutions hesitate to embrace this technology. Educational leaders, together with teachers, demonstrate resistance toward AI technologies because they lack understanding of these systems and fear losing their jobs or doubt that AI-SLS can work effectively (Khan et al., 2018). The implementation of AI-SLS suffers from poor usage or less-than-optimal results when its methods differ from traditional teaching methods. Conducting AI-SLS that fail to augment existing educational strategies in classrooms will create negative reactions instead of supportive benefits (Stewart et al., 2016). Proficient professional development, along with combined engagement between all stakeholders, becomes essential to satisfactorily deal with these apprehensions.

The agreement and development beyond previous documented information are easily proved through research findings. In this review, the review illustrates that the technical and ethical barriers have transformed into hard ends for adopting AI in education beyond the findings (Khan et al., 2018). As demonstrated in past research by Abugabah et al. (2020), the resolution of teacher training is established as being crucial for the successful implementation of AI-SLS; however, this review includes institutional resistance as another complex barrier that needs resolution. SI-SLS faces different opinions about its scalability capabilities. Abd Hamid et al. (2018) have suggested that if this planning and investment is done properly, the challenge of implementing AI-SLS can be solved, yet Tawiah et al. (2020) state that this solution might be impossible to achieve in environments with limited resources.

Strategies and Recommendations for Optimization

The evaluation of AI-SLS' potential and its deployment challenges produces various implementation strategies and recommendations that stem from examined research. AI-SLS should function under the protection of properly developed ethical regulations and framework requirements to maintain responsible system usage. Public officials, together with institutions of education, must work hand in hand to develop standards that define how

students' data stays private and algorithms maintain transparency and security. AI-SLS adoption requires implementing the FAT principles during design, which enables the reduction of bias while promoting inclusion and fairness (Natorina, 2020). A multi-stakeholder approach that involves teaching staff as well as students and their parents during the design evaluation stage of AI-SLS will help detect possible ethical issues before product implementation. Participatory methods used in AI-SLS design ensure they match the core principles and service requirements of their target communities to establish trust and community acceptance.

Assistance with infrastructure development alongside capacity enhancement stands as a major necessity to remove existing technical and institutional obstacles. Federal organizations, together with educational institutions, need to make technological infrastructure development their funding priority because it guarantees equal AI-SLS access to schools lacking resources (Khoso et al., 2025). Educators need complete professional development training, which should offer the necessary skills combined with the knowledge needed to succeed at AI-SLS implementation in their classrooms. AI-SLS training must teach both technical competencies and teaching strategies that use AI-SLS for improved student achievements (Theocharous et al., 2015). Educational institutions should develop innovative collaboration practices that will facilitate change acceptance among their members. Schools that show teachers and administrators how AI-SLS delivers practical advantages and include them when making decisions will develop staff engagement, leading to an accepting environment for tech adoption.

Adaptive, and context-specific AI-SLS design is an important strategy to be used to put AI-SLS in various educational environments. To satisfy this need, developers need to create flexible programming for their systems, allowing them to be customized to the particular educational requirements of particular learner groups and educational environments. By making the materials more inclusive by developing the multilingual functionality and culturally sensitive, AI-SLS becomes even helpful to the learners who do not speak the same language and come from different cultural backgrounds (Barba et al., 2013). With open source AI-SLS platforms along with modular designs, AI-SLS implementations become more affordable and scalable, and may reach more institutions. An uninterrupted research along with evaluations is the basis that advances AI SLS and proves it to be effective in the future. Research-driven data collection into the implementation of AI-SLS and its impact on the learners will allow developers and teachers to find out exceptional practices to solve future issues for better results by the student populations.

Discussion

This systematic review finds that AI-powered smart learning systems (AI-SLS) could have broad transformative potential for addressing various student learning needs, and in doing so, highlight the challenges and complexities that come with implementing such systems. First theme, key features and functionalities of AI-SLS, adaptive algorithms, natural language processing (NLP), data data-driven analytics are needed to provide a personalized and inclusive learning experience. These results are in line with previous work by Al-Obaidi et al. (2016), who highlighted the use of adaptive technologies in tailoring education. In this regard, this review expands the existing literature by drawing attention to the integration of more sophisticated (emotional) functionalities, namely

the presence of emotion recognition and gamification, that were not highlighted to a significant extent in other studies. While these innovations represent a new wave of AI-SLS, they bring different possibilities for improving engagement and motivation, in particular for students with learning disabilities or who do not fit a classical instructional setting. Despite this, there is still an issue of data privacy and algorithmic social bias, as Barba et al. (2013) note, and technological advancements still need to ensure equitable and responsible use of such advancements, only if accompanied by strong ethical frameworks.

Based on the second identified theme, second identified theme, AI-SLS systems improve academic performance and increase engagement as well as equity with various student groups. Similar results are obtained for the learning outcomes of the research compared with the known findings of Ai et al. (2016) and Brew and Mantai (2017) regarding the effectiveness of intelligent tutoring systems (ITS) in improving these outcomes. This review of modern AI-SLS brings up their new capabilities working with multiple data formats and serving sophisticated feedback to the students. However, recent technological developments don't improve the effectiveness level of AI-SLS. McCardle (2002) and Chou et al. (2022) argue that infrastructure limitations and digital inequalities, which prevent the full advantages from being realized, most strongly obstruct the use of AI-SLS in areas of limited resources. Since it guarantees that all the students can capitalize on the advantages of AI-SLS systems, the necessity exists for both technology equity and adaptive implementation methods.

The third main theme investigates technical hurdles as well as institutional and ethical obstacles that do not allow the AI-SLS to be used on a large scale. This research by Gambo (2023) confirms ethical handling in the context of supporting the success of AI-SLS implementation. Although institutional resistance is less highlighted in existing academic literature, it is also enhanced by the review, which expands on this factor. No teaching staff or administrators have had much experience with AI-SLS and fear that it will cause them to lose their professional roles, so staff and administrators need intense training. According to Pulari and Jacob (2025), they show plausible research to suggest that AI-SLS over utilizations if not in alignment with traditional educational methods. For AI-SLS implementation, collective reasoning between the instructors and political officials, and programmers is required in order to develop and implement their education systems.

The fourth theme provides practical strategies that enable the most effective AI-SLS realization. Alam's (2023) research identified the need for scalable context-sensitive AI-SLS and acted as a motivation to design the algorithm. The review of this literature identifies necessary ethical frameworks and infrastructure development, and workforce training programs as key methods for reducing implementation challenges. To make AI-SLS more inclusive, there needs to be multilingual access and context that are relevant to different cultural backgrounds. The main goal, which is to make AI-SLS available and useful for every student with diverse backgrounds or abilities, is confirmed with these suggestions. Research outcomes show that AI SLS systems can transform educational settings since they are applicable for students of different learning styles, leading to the betterment of education.

Policy Implications for Practice

Research findings suggest that there is a sudden demand for overall policy structures that would help contribute to the successful and moral operation of the AI-powered smart learning system (AI-SLS) in the

environments of education. Developing ethical standards is what government authorities need to prioritize in dealing with the AI-SLS privacy, bias, and transparency issues so that the agency works properly and ethically. Because this puts AI-SLS on an equal playing field with other innovations, it should be a priority to build new technological infrastructure for underserved areas. Funds must be spent on training and developing teaching methods for teachers to help the teachers succeed in using AI-SLS in their classrooms. The relationships between educators and developers, and research professionals are key to whether AI-SLS is developed successfully, and these relationships result in alignment between pedagogical goals and the institutional barriers. Adopting evidence-based strategies will ensure that AI-SLS succeeds by creating an environment conducive to implementation and creating a better education with all student populations that deliver.

Conclusion and Recommendation

This study used a complete evaluation to show how AI-powered smart learning systems help students with different learning needs. The study reveals AI-SLS technology can transform learning because its key functions let students and teachers make better use of adaptive learning algorithms and data analysis tools. AI-SLS proves good at making students learn better while keeping them more interested and helping all types of students achieve in school. Ability in AI-based systems depends on multiple school factors like teacher readiness and match to academic objectives. Educational leaders must design technology programs at each school level to support their specific operational requirements.

However, implementation of AI-SLS is confronted by considerable problems, such as institutional resistance and ethical or technical limitations about implementing AI-SLS. Such barriers must be addressed with a multifaceted approach of ethical guidelines development, infrastructure development investment, as well as comprehensive professional development programs for educators. Policymakers and practitioners can therefore encourage collaboration amongst stakeholders who can seek to achieve equity and inclusivity in implementation of these AI-SLS while at the same time minimizing the risk posed by these technologies. By providing recommendations for optimizing the use of AI-SLS and drawing upon the related body of literature, this review encapsulates and contributes to growing body education on AI in education space. The findings ultimately demonstrate the necessity of the technological advancements to be in congruency with the ethical standards and practical perspectives to make the learning environments just and effective for all the students.

Limitations and Future Research

However, despite all of this, the reality of this systematic retrospective review reveals that the role of AI driven smart learning systems (AI SLSs) can resonate with students' learning need spectrum is not free from its own limitations. The inclusion of non-English studies may have created the risk that methodology used in a non-English context was excluded from the review, thereby excluding relevant research. It also includes the fast evolution of AI technologies, that some of the recent improvements might already be out of the published literature. Once more limited by the heterogeneity of the included studies including in terms of methodologies and context a narrative synthesis approach was adopted in order to avoid a meta-analysis. Future research should focus on

longitudinal studies on the long term effect of AI-SLS on learning outcome and comparative studies to determine the effectiveness of AI-SLS on different cultural and socio-economic environment. In addition, an investigation into the moral ramifications of forthcoming AI characteristics, for example inheritance and enjoyment, will be essential in guaranteeing the loyal and equivalent utilization of AI-SLS in education. This would bridge the gap and produce a clearer and rounded picture of the potential and limitations of AI-SLS to be used in various educational settings.

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SUPPLY CHAIN AND SUSTAINABILITY RESEARCH: SCSR
VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

Empowering digital futures: youth-led initiatives for inclusive digital transformation in Bangkok

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Abstract

This paper presents a youth-led perspective on inclusive digital transformation in Bangkok, drawing on real-world insights gathered through participatory discussions, expert interviews, and collaborative activities at the 2025 Bangkok Global Youth Leadership Forum. As group leader of the Digital Transformation team, the author synthesizes findings from case studies on Thailand's 5G infrastructure rollout, the proposed development of a unified digital government services platform, and initiatives to support small and medium-sized enterprises (SMEs) in embracing digital tools. Using a qualitative methodology grounded in group reflections, industry dialogues, and hackathon collaboration, this research explores how youth-driven innovations and multi-sector partnerships can address persistent digital inequalities and promote equitable access to technology. The study contributes to scholarship on digital development by highlighting the importance of co-creation, community engagement, and localized solutions in national digital transformation agendas.

Keywords: digital transformation, youth leadership, inclusive technology, SMEs, digital policy, Thailand

Introduction

In an increasingly digitized world, the promise of technology to bridge development gaps remains both a global ambition and a local challenge. In Bangkok, Thailand’s capital and a major urban hub in Southeast Asia, efforts to digitally transform public services, business ecosystems, and educational institutions are evident through policies such as Thailand 4.0, the Digital Economy and Society Development Plan (Ministry of Digital Economy and Society (MDES), 2022), and the national 5G Master Plan (National Broadcasting and Telecommunications Commission (NBTC), 2020). Yet, as with many rapidly evolving digital landscapes, progress is often uneven. Certain populations-such as the elderly, informal sector workers, rural communities, and women-led SMEs-continue to face structural barriers to access, affordability, and digital literacy (Deloitte Thailand, 2023; Thailand Development Research Institute (TDRI), 2023).

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At the regional level, Bangkok's transformation efforts align with the ASEAN Digital Masterplan 2025 (ASEAN Foundation, 2022), which envisions a digitally inclusive and sustainable economy across Southeast Asia. However, while infrastructure and investment are advancing rapidly, social dimensions of the digital divide remain a critical policy gap. This underscores the need for inclusive frameworks that foreground youth voices, bottom-up innovation, and co-designed policy pathways.

This paper emerges from a unique setting: the 2025 Bangkok Global Youth Leadership Forum, where young changemakers from around the world converged to exchange ideas, co-create solutions, and engage directly with policymakers. As the group leader of the Digital Transformation team, the author facilitated interdisciplinary discussions, led community research, and steered the team to win the forum's hackathon competition on digital innovation. These experiences provided a rich empirical basis to interrogate the meaning and practice of inclusive digital transformation in Bangkok's urban context.

The analysis centres on three interconnected case studies: the rollout and impact of 5G connectivity, the development of a one-stop digital government platform, and community-driven digital support models for SMEs. The study situates these initiatives within the framework of Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 17 (Partnerships for the Goals). Ultimately, this research seeks to reframe digital transformation not merely as a technical undertaking, but as a socio-political process driven by human agency, equity, and collaborative governance.

Objectives

Grounded in the broader vision of digital equity and inspired by the collaborative atmosphere of the Bangkok Forum, this study sets out to bridge theory and practice in digital policymaking. While much of Thailand's digital policy discourse is top-down, this research aims to foreground youth-driven, community-based models that can inform more responsive, participatory frameworks.

This study is guided by the following objectives:

1. To examine how youth-led activities, such as participatory forums and hackathons, contribute to policy innovation and implementation of inclusive digital strategies.

2. To assess Thailand's national digital transformation policies from the lens of real-world community needs and global best practices.

3. To explore the digital inclusion challenges faced by marginalized groups in Bangkok, with a focus on education, governance, and enterprise.

4. To identify and analyse practical models—such as peer mentoring, co-creation, and interdisciplinary collaboration—that can scale digital literacy and technology adoption.

5. To offer policy recommendations grounded in empirical field insights that strengthen Thailand's digital ecosystem while ensuring no one is left behind.

Research Questions

To guide the inquiry, this study is anchored on the following research questions:

1. How can youth-led forums influence digital policy-making and implementation in Thailand?

2. What are the practical challenges and opportunities faced by marginalized communities in accessing and benefiting from digital transformation initiatives in Bangkok?

3. What participatory models and strategies can enhance inclusivity, scalability, and sustainability in digital transformation efforts?

Significance of the Study

This study contributes both academically and practically to the discourse on digital transformation. Academically, it offers a rare empirical account of how youth participation, when embedded in policy discourse, can shape transformative digital agendas. It bridges the gap between digital infrastructure development and human-centred governance models.

Practically, the study proposes actionable frameworks—such as youth-led digital literacy campaigns and university-SME partnerships—that are scalable, contextually grounded, and policy-aligned. The findings can inform government ministries, educators, development agencies, and grassroots organisations striving to ensure that digital advancement leads to equitable social progress.

By highlighting the unique role of youth as co-creators, not just consumers, of technology policy, the study enriches the broader agenda of inclusive and participatory digital transformation in Thailand and across the Global South.

Understanding Digital Transformation

Digital transformation refers to the process of integrating digital technologies into all areas of an organization, fundamentally changing how it operates and delivers value to stakeholders (McKinsey & Company, 2024). It encompasses more than just adopting new tools or platforms; it involves rethinking business models, reshaping institutional processes, and promoting a culture that embraces innovation, agility, and user-centered thinking. According to the World Economic Forum (2023), successful digital transformation requires a whole-of-society approach, involving not just government and the private sector but also civil society, academia, and communities. UNESCO (2022) further emphasizes that digital transformation must also prioritize inclusion, particularly for vulnerable populations and learners affected by digital divides.

Digital Transformation in the Context of Bangkok

Bangkok, as Thailand's economic and political hub, has become central to the country's digitalisation agenda. National strategies such as Thailand 4.0 and the Digital Economy and Society Development Plan (DEDP) position the capital city as a launchpad for smart government services, digital health, and innovation ecosystems. The Ministry of Digital Economy and Society (2022) highlights initiatives such as nationwide 5G rollout, e-government integration, and digital startup accelerators. However, while these developments mark progress, structural gaps persist, particularly for SMEs, rural communities, and marginalized populations.

Reports by NBTC (2020) and Deloitte Thailand (2023) point to urban-rural disparities in access to high-speed internet and digital infrastructure, as well as low digital literacy rates among small business owners and older populations. Although Bangkok is relatively well-served in terms of infrastructure, digital inclusion remains uneven, especially among informal sector workers and migrant communities who may lack access to devices, training, or multilingual support services. Additionally, Thailand Development Research Institute (TDRI, 2023) notes that digital policy implementation often lacks participatory governance models, further marginalizing local voices.

Youth Engagement and Participatory Innovation

Amid this complex digital landscape, youth engagement is increasingly recognized as a strategic asset in driving inclusive digital transformation. Wang and Pettit (2021) argue that young people often digital natives bring fresh perspectives, technological fluency, and a strong sense of civic responsibility. Participatory innovation, which involves users in co-creating solutions, aligns closely with youth-led initiatives. Hisrich et al. (2020) demonstrate that when youth are empowered to contribute to service design, the resulting solutions are more likely to be sustainable, locally adapted, and culturally relevant. Similar studies by Lim and Lee (2022) in Malaysia and Indonesia show that youth-led digital literacy campaigns have successfully closed gaps in financial and entrepreneurial knowledge. Furthermore, Arslan et al. (2021) examined youth-driven digital empowerment in Pakistan and found measurable improvements in community ICT adoption when youth leadership was present.

Challenges of Technological Determinism

A persistent challenge in digital discourse is the assumption that technology alone can drive development, a notion critiqued by scholars of technological determinism (Novack et al., 2018). This approach often overlooks the socio-cultural and political dynamics that influence how digital systems are accessed and used. In Bangkok, despite technological advancements, issues such as language barriers, socio-economic inequalities, and lack of digital trust continue to affect adoption rates. Hence, human-centered and community-based frameworks are essential for ensuring that transformation efforts do not exacerbate existing disparities. A 2022 ADB report also emphasizes that digital infrastructure must be matched by corresponding improvements in human capital, especially in ASEAN urban centers.

Conceptual Framework

This study employs a hybrid conceptual framework that merges socio-technical systems theory and participatory design. Socio-technical theory posits that technological interventions are most effective when aligned with social dynamics such as values, behaviors, and institutional norms. Participatory design, meanwhile, involves users directly in the creation and adaptation of technologies, ensuring responsiveness to their lived experiences. Together, these frameworks allow for a nuanced understanding of how youth-led digital transformation can be both innovative and inclusive.

Identified Gaps in the Literature

Despite increasing interest in digital inclusion, three critical gaps persist in the literature:

1. A lack of empirical studies on the impact of youth-led digital interventions in real-world policy settings.

2. Limited representation of marginalised groups such as SMEs, informal workers, and non-Thai speakers in digital transformation research.

3. Inadequate exploration of how digital forums, hackathons, and co-design processes can be scaled to influence national agendas.

This study seeks to address these gaps by documenting a live case of youth-led policy engagement during the Bangkok Global Youth Leadership Forum, and analysing how its outputs contribute to inclusive and locally responsive digital innovation in Thailand. This approach mirrors similar initiatives such as the ASEAN Youth Digital Summit (2022), where young leaders in Vietnam and the Philippines co-developed digital literacy frameworks for rural communities. Likewise, Africa's Youth Connekt initiative has shown how peer-led innovation hubs can influence national ICT strategies through participatory design, reinforcing the value of youth as policy co-creators rather than passive beneficiaries.

Research Methodology

This study employs a qualitative methodology grounded in participatory action research (PAR), allowing for a rich exploration of how youth engagement can influence inclusive digital transformation. Conducted within the framework of the 2025 Bangkok Global Youth Leadership Forum, the research draws upon experiential data, collaborative design activities, and intercultural dialogue among stakeholders from the government, private sector, academia, and civil society.

Research Design

The study is structured around a case study approach, focusing on three major initiatives discussed and developed during the forum: the national 5G rollout, the development of a unified digital government platform, and the proposed student-led digital mentorship model for SMEs. These initiatives serve as bounded units of analysis, examined through the lens of youth perspectives and participatory governance.

Participants and Sampling Techniques

Participants were pre-grouped by the organising committee of the Bangkok Global Youth Leadership Forum based on thematic interest areas. The Digital Transformation team comprised 11 youth delegates (aged 20–35) from various ASEAN and African countries with backgrounds in digital policy, education, entrepreneurship, or civic innovation. This pre-selection ensured thematic relevance and interdisciplinary representation.

To identify experts, the team employed a purposive strategy following forum presentations. Digital transformation stakeholders were selected based on their contributions during plenary speeches and breakout sessions. Further, the team partnered with faculty at Southeast Bangkok University to connect with local digital professionals. This collaborative outreach allowed the research team to engage with 6 key informants, including government officials, industry experts, and university-affiliated researchers.

Data Collection Methods

Multiple sources of data were used to ensure triangulation and depth of analysis:

1. Focus Group Discussions (FGDs): Three structured FGDs were conducted among the Digital Transformation team members, exploring perceptions, personal experiences, and collective visions for digital inclusion.

2. Semi-Structured Interviews: Conducted with policy experts from Thailand's Ministry of Digital Economy and Society (MDES), representatives from NBTC, private tech sector professionals, and community development officers.

3. Hackathon Observation and Artefact Analysis: The three-day hackathon produced a set of project proposals, including the winning SME digital mentoring model. These outputs were analysis for feasibility, innovation, and alignment with inclusive design principles.

4. Reflective Journals: Daily journals maintained by the researcher and select participants captured the evolution of thought, intercultural interactions, and moments of learning and challenge.

Data Analysis

Thematic coding was used to organise and interpret the data. NVivo software supported the identification of recurring themes, such as digital equity, co-creation, trust in technology, and youth agency. Categories were inductively derived and validated through peer debriefing sessions held after the forum. Descriptive statistics were used to summarise participant demographics and engagement trends.Participation was voluntary, and informed consent was obtained from all respondents. Anonymity was assured in all data representations. Cultural sensitivity was observed throughout, with multilingual support provided in interviews and group discussions.

Results and Discussion

Inclusive Impact of the 5G Rollout

The forum demonstrated strong support for Thailand's expansive 5G policy; however, participants highlighted a clear disparity between infrastructure availability and actual usage. While 5G connectivity itself was reported as affordable and increasingly accessible, many participants pointed out that the high cost of compatible devices posed a significant barrier. Most lacked smartphones or hardware capable of utilizing 5G, making the technology out of reach despite its presence.

Additionally, a review of participant journals revealed that only 2 out of 11 SME owners from rural backgrounds had a basic understanding of how to leverage 5G for marketing or business development. In contrast, all Bangkok-based participants indicated both consistent access to 5G and practical knowledge of its applications. Interviews with NBTC representatives confirmed that infrastructure rollouts had initially focused on urban areas, leaving rural communities underserved despite national targets for broader inclusion.

Furthermore, a content analysis of policy briefings showed minimal inclusion of digital literacy components within the 5G expansion strategy. Participants collectively proposed a youth-led digital literacy campaign to accompany infrastructure deployment, including in-person demonstrations, school-based workshops, and mobile app training in rural clinics and community centers.

Prototype for a Unified Digital Government Platform

Through collaborative design thinking sessions, participants analyzed the fragmentation of Thailand's

current e-government services. Data collected from forum brainstorming activities revealed that participants interacted with an average of 4.2 different government platforms for basic tasks like health insurance, tax registration, and university applications. This multiplicity was perceived as confusing and time-consuming.

Drawing inspiration from Rwanda's Irembo platform, the team developed a wireframe prototype for a unified Thai e-government portal. Features included a language toggle for ethnic minorities, voice-command support for the elderly, and a one-stop dashboard for managing personal and business-related documentation. Feedback from MDES representatives noted that the proposal's mobile-first approach aligned with Thailand's rising smartphone penetration rate, which currently stands at 96.2% according to the Department (2023).

The hackathon segment allowed for intensive co-creation. The proposed model paired university students, particularly those in IT, marketing, and business, with local SMEs. A mapping exercise of forum participants' home countries illustrated significant SME barriers, especially among women-led enterprises and informal vendors. A mini survey conducted during the session showed that 72% of youth delegates believed digital marketing and payment systems were the most urgent needs among SMEs in their regions.

The model was designed to include modular training in platforms like Facebook Shops, Line Pay, Shopee, and basic inventory software. Entrepreneurs expressed interest but voiced concerns about continuity and accountability. As a response, the project embedded a feedback and tracking mechanism, with student mentors evaluated through a performance dashboard and SMEs encouraged to rate their experience monthly.

This section presents the findings from the hackathon segment of the Bangkok Global Youth Leadership Forum. The event brought together eight interdisciplinary teams to develop solutions addressing digital and environmental challenges. Two teams, including the author's, focused directly on digital transformation, while the other six centred on climate and circular economy themes. Despite topic differences, digital innovation was a common thread across all proposals.

Key Finding 1: Digital Transformation as a Unifying Theme

Analysis of team outputs revealed that all eight groups incorporated digital tools into their ideas, demonstrating the perceived importance of digital transformation across sectors. This convergence highlighted the centrality of technology in achieving sustainable and inclusive development outcomes.

Key Finding 2: Winning Innovation – Gamified SME Training App

The Digital Transformation team developed the winning solution: a gamified training app for SMEs, targeting social media use and digital engagement. The app included a three-tiered training structure:

Tier 1 (1-week course): Foundational skills with basic incentives.

Tier 2 (2-month course): Intermediate skills with enhanced benefits.

Tier 3 (6-month engagement): Advanced skills and government-issued certificates to build SME credibility. Participants would earn incentives such as marketing discounts, recognition badges, and partnership offers. Tech companies could advertise within the platform using SME-generated content, supporting sustainability through a revenue-sharing model. The app was also designed to track participant progress and offer tailored content based on user needs, ensuring relevance across SME sectors.

Key Finding 3: Public and Institutional Reception

Judges, including industry experts and company founders, offered critical yet encouraging feedback during the mentorship and pitch phases. They praised the idea for being locally adaptable and highly feasible within Thailand's socio-economic context. Compared to other pitches, the judges noted that this project had clearer pathways to implementation and a stronger focus on behavioral engagement. Forum participants, including those from the climate-focused teams, also expressed enthusiasm, acknowledging that the app could complement sustainable business models by enhancing digital visibility.

Key Finding 4: Collaborative Development Environment

The hackathon's structure, including iterative ideation, mentor-led feedback sessions, and pitch presentations, was instrumental in shaping the final proposal. Daily strategy check-ins and open feedback loops enabled participants to refine and align their concept with practical implementation scenarios. The collaborative environment fostered trust, creativity, and shared ownership of the final pitch. Team members noted that the time-bound format, combined with access to local and international mentors, significantly improved the clarity, feasibility, and scalability of the idea.

Overall, the hackathon demonstrated how structured, time-sensitive, and interdisciplinary environments can incubate locally grounded, high-impact digital transformation strategies that reflect the lived realities of users and the creative energy of youth.

Youth and Intercultural Collaboration

Analysis of daily reflection journals revealed recurring themes of empathy, respect, and active listening. Thai participants shared concerns about digital centralisation eroding local traditions, while international delegates brought experiences of platform inclusivity from their home countries. The group maintained a shared Google Doc for asynchronous collaboration across time zones and cultural preferences.

A network analysis of contributions during group sessions showed balanced participation, with each member contributing an average of 2.4 strategic ideas and 3.1 evaluative comments per session. This demonstrated not only high engagement but also intercultural trust-building. The process itself became a case study in digital citizenship and inclusive decision-making.

Conclusion and Recommendations

This study explored the transformative role of youth in shaping inclusive digital policies and practices through their participation in the Bangkok Global Youth Leadership Forum. Drawing on collaborative activities, expert engagements, and intercultural reflections, the research confirms that youth-led co-design processes enhance the quality, relevance, and scalability of digital transformation initiatives. When young people are not only consulted but also empowered to contribute meaningfully to strategy development, they become catalysts for inclusive digital innovation.

Thailand's ongoing digital advancements from its national 5G infrastructure rollout to various e-government service reforms signal significant progress. Yet, findings from this study underscore persistent systemic barriers,

particularly in reaching rural communities, SMEs, and underserved populations. The forum illuminated how youth-driven interventions such as community mentorship, digital co-creation workshops, and technology prototypes can offer scalable, people-centred alternatives that bridge these gaps.

For instance, while the forum revealed broad support for Thailand's 5G policy, participants noted a significant gap between infrastructure rollout and its usability at the grassroots level. Although 5G services are now relatively affordable and widely available in urban areas, many participants highlighted that access to 5G-compatible devices remains limited, particularly among low-income users. Several youth and SME representatives shared that the cost of upgrading their mobile devices was prohibitive, making it difficult to fully leverage 5G technology.

A review of participant journals further revealed that only 2 out of 11 SME owners from rural areas had even a basic understanding of how to use 5G tools to market their products or services. By contrast, all Bangkok-based participants indicated consistent access and a strong grasp of digital tools available through 5G connectivity. Interviews with NBTC representatives corroborated this gap, acknowledging that while the infrastructure targets were being met, urban districts had been prioritized in early-phase rollouts, resulting in delayed service expansion and limited digital support in rural regions.

Key Recommendations:

1. Institutionalize youth participation in the national digital strategy by establishing youth advisory councils under ministries responsible for digital transformation.

2. Expand digital literacy initiatives through student-led outreach targeting rural populations and the elderly, with culturally and linguistically tailored content.

3. Develop and pilot an integrated digital government platform, prioritizing co-design with users from marginalized communities to ensure accessibility and trust.

4. Formalize hackathons and innovation labs as recurring national consultation formats that allow public-private collaboration on pressing digital issues.

5. Support student–SME digital mentorship schemes through joint funding by academic institutions, government agencies, and industry partners.

6. Create cross-sector incubators that continuously test inclusive digital tools and track impact through community-based metrics.

Limitations and Future Research:

While this study provided grounded insights through participatory methods, it was bounded by the short duration of the forum and limited post-intervention tracking. Future research should consider longitudinal approaches to evaluate the sustainability of youth-led initiatives. Additionally, cross-country comparative studies could enrich understanding of how digital inclusion models differ across sociopolitical contexts in Southeast Asia.

By offering practical, evidence-based models and a participatory framework, this research contributes to the broader movement toward inclusive digital transformation anchored in youth agency, cultural responsiveness, and collaborative governance.

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VOL.4, NO.1; JAN – JUN ; 2025, ISSN 2822-0412 (Online)

A Study on the Sustainable Development of the Human Resource Supply Chain in China's Domestic Service Education Industry — From the Perspective of Artificial Intelligence

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Abstract

This study investigates sustainable development strategies for the human resource supply chain within China's rapidly transforming domestic service education industry, significantly impacted by artificial intelligence (AI). Driven by demographic shifts, increasing middle-class demand for high-quality services (exceeding 1.5 trillion RMB market size), and supportive policies, the sector faces a critical imbalance. Persistent challenges include severe talent shortages, skill mismatches, an oversupply of low-skilled labor contrasting with high demand for specialized professionals, inefficient traditional training, and high job turnover (42% annually), exacerbated by fragmented management and inadequate social recognition.

To address these systemic issues, this research systematically analyzes the industry's current status, synthesizing insights from demographic data, policy documents, and industry reports. Utilizing a multi-stage methodology involving literature review, expert interviews, and empirical testing, the study proposes innovative AI-driven human resource supply chain management models. These models operate across four key dimensions: First, AI enables precision demand-supply matching through intelligent profiling and regional resource optimization, directly addressing structural imbalances. Second, AI revolutionizes training via personalized skill enhancement using diagnostics, virtual and augmented reality simulations, and automated scoring for standardized certification. Third, AI elevates service quality through IoT-enabled monitoring, sentiment analysis of customer feedback, and preventive service design. Finally, AI fosters comprehensive sustainability by optimizing resource efficiency (e.g., reducing carbon emissions through route planning) and enhancing professional dignity through AI-driven career path navigation and blockchain-integrated rights protection. While acknowledging potential risks like digital divide and data privacy, this study concludes that AI offers a systematic pathway to improve professional skills, service quality, and foster the industry's transition towards a more professional, human-centered, and ecologically friendly sustainable development model.

Keywords: digital transformation, youth leadership, inclusive technology, SMEs, digital policy, Thailand

Introduction

1. The Rise of the Domestic Service Education Industry and Social Demand

In recent years, the rapid rise of China's domestic service education industry has been closely tied to structural social transformation, consumption upgrades, and policy incentives. First and foremost, changes in the country's demographic structure have become a core driving force. According to data from the National Bureau of Statistics of China, by 2023, the population aged 60 and above had reached 280 million, accounting for nearly 20% of the total population. This aging society has led to a sharp increase in demand for professional home care and chronic disease management services. At the same time, the trend toward smaller family sizes (with an average of 2.62 persons per household) and the fact that dual-income households now make up over 70% of families have contributed to the gradual disappearance of the traditional "housewife" role. As a result, child-rearing and domestic tasks urgently require professional external support (National Bureau of Statistics of China, 2023).

Secondly, the expansion of China's middle class and the ongoing consumption upgrade have created a demand for high-quality domestic services. According to the 2023 White Paper on the Development of China's Domestic Service Industry, the market size of China's domestic service sector exceeded 1.5 trillion RMB. Among high-net-worth households, the annual growth rate in demand for "high-end domestic services"—such as family nutritionists and child development consultants—reached 25%. These types of services require workers not only to have basic skills but also to possess cross-disciplinary knowledge (such as psychology, emergency medicine), thus pushing the domestic service education model to evolve from "skill training" to "professionalized education" (White Paper on China's Domestic Service Industry, 2023).

Moreover, policy guidance and industry standardization have also played critical roles. In 2019, the State Council of China issued the Opinions on Promoting the Quality Improvement and Expansion of the Domestic Service Industry ("36 Articles on Domestic Service"), which explicitly called for "supporting vocational colleges in establishing domestic service programs" and advancing the "industry-education integration" model. By 2023, more than 200 vocational institutions nationwide had launched domestic service-related programs, training over 100,000 professionals annually. Additionally, local initiatives such as "Southern Guangdong Domestic Services" and "Zheli Domestic Services" in Zhejiang have accelerated the standardization process by offering training subsidies and establishing credit systems for practitioners (State Council of China, 2019).

However, despite the enormous demand, significant contradictions persist. On one hand, there is an urgent need for high-quality talent; as of 2023, there were approximately 35 million domestic workers in China, but less than 30% held official certifications, and most had only undergone short-term training. On the other hand, societal biases against domestic work continue to exist, causing an imbalance in the talent supply structure. According to the Ministry of Human Resources and Social Security, the job vacancy ratio (number of job openings per job seeker) in the domestic service sector reached 2.5 in 2022, and the shortage of skilled professionals in areas like maternity care and home health management continues to widen (MOHRSS, 2022).

Technological change is further reshaping the industrial landscape. Internet platforms such as "Swan Daojia" and "58 Daojia" use big data to match supply and demand more accurately, while AI technologies are being

applied in areas such as virtual training and competency assessment. For example, a leading enterprise developed an “AI Care Simulation System” that uses interactive scenarios to train workers in emergency response, improving training efficiency by 40%. These innovations not only reduce the costs of talent mismatches but also inject technological momentum into the industry’s sustainable development.

In summary, based on demographic data, policy documents, and industry reports, this study systematically analyzes the social background behind the rise of China’s domestic service education industry and the contradictions between supply and demand. The industry’s growth is both a natural response to social transformation and a result of synergistic forces from policy, market, and technology. In the future, the key to resolving the structural contradiction of “oversupply at the low end and shortages at the high end”lies in reforming the educational system and empowering it with technology. Only then can the industry realize both social value and economic sustainability.

Objectives

Research Objective

This study aims to explore the application pathways of artificial intelligence (AI) in the human resource supply chain of the domestic service education industry and to construct a sustainable development model that balances both efficiency and fairness.

Core Research Questions

A. What are the current contradictions and sustainability challenges in the human resource supply chain of the domestic service education industry?

B. How can AI reshape mechanisms for talent recruitment, training, and retention?

C. How can AI technologies help balance industrial expansion with resource consumption?

Research Methodology

This study adopts a multi-stage research design, structured around four main phases:

1. Literature Review

A comprehensive review of domestic and international literature on topics such as domestic service industry education, training models, and artificial intelligence applications is conducted. The aim is to identify existing research achievements and developmental trends, clarify the theoretical foundations, and establish a research framework to guide the study.

Current Situation Diagnosis

This phase focuses on an in-depth analysis of the existing human resource supply chain within the domestic service education industry. Through telephone interviews with leading domestic service enterprises and training institutions, the objective is to precisely analyze:

1. Recruitment efficiency

2. Training costs

3. Staff turnover rates

By leveraging expert insights and real-world operational data, this diagnostic phase aims to identify systemic pain points and inefficiencies inherent in current practices.

Technical Verification

Following the diagnosis, this phase involves the development and rigorous testing of several AI-based technological interventions designed to address identified challenges. These include:

1. AI-driven skill-position matching model: This model utilizes clustering algorithms and natural language processing (NLP) to accurately align job seekers' competencies with specific job requirements.

2. Virtual training assistant (AI + AR): This system creates a simulated training environment using augmented reality (AR) to replicate realistic scenarios, such as household first aid procedures and comprehensive elderly care.

Case-Based Empirical Testing

The final phase involves a collaborative empirical test with a selected domestic service enterprise group to evaluate the real-world effectiveness of the implemented AI applications. Key performance indicators (KPIs) are rigorously compared both before and after AI integration, focusing on metrics such as:

1. Average training cost per person

2. Client satisfaction rates

3, This study draws its data from crucial sources, including:

4 Industry databases (e.g., the Ministry of Human Resources and Social Security’s platform for domestic workers)

5. Operational data provided by the participating enterprises

Conclusions and Recommendations

Research Summary: Sustainable Development of HR Supply Chain in China's Service Education Industry - From an AI Perspective This research, titled "Study on Sustainable Development of Human Resource Supply Chain in China's Service Education Industry – From an Artificial Intelligence Perspective," aims to explore and develop a sustainable development model for human resource supply chains in China's service education industry. The study emphasizes the application of Artificial Intelligence (AI) to achieve a balance between efficiency and equity in this rapidly evolving sector. The research analyzes the current situation of an industry facing unprecedented transformation driven by several key factors. These driving forces include demographic structural changes such as an aging society and shrinking household sizes, rising quality demands from the middle class for superior services, and supportive policies from the government sector. These factors have created both opportunities and challenges for the service education industry in China. Despite the expansion of China's service market to over 1.5 trillion yuan in 2023, significant structural problems persist within the industry. These challenges include a shortage of skilled personnel with specialized expertise, inefficient training systems that fail to meet industry needs, exceptionally high employee turnover rates averaging 42% annually, insufficient social security

coverage for workers, and fragmented organizational management systems. These interconnected issues have created a vicious cycle that negatively impacts both service quality and the professional image of the industry.

To address these multifaceted challenges, the research proposes a new AI-driven human resource supply chain management model encompassing four main dimensions. The first dimension focuses on precise demand and supply matching, where AI utilizes Natural Language Processing (NLP) to analyze employer requirements and employee skill databases for efficient job matching. This approach incorporates Geographic Information Systems (GIS) and demand forecasting to optimize regional resource allocation, while creating flexible workforce systems to respond effectively to market volatility. The second dimension emphasizes training innovation through AI-powered solutions. AI helps create personalized skill development programs by diagnosing individual learner weaknesses and developing customized learning plans. The model integrates Virtual Reality (VR) and Augmented Reality (AR) technologies to simulate complex training scenarios, thereby reducing costs and risks while enhancing learning effectiveness. Additionally, automated AI scoring systems are implemented for standardization certification and quality monitoring, ensuring consistent training outcomes across the industry. The third dimension concentrates on service quality enhancement by transforming reactive responses into proactive optimization strategies. This involves using Internet of Things (IoT) and AI for real-time service quality monitoring, conducting deep customer experience analysis through sentiment analysis, and designing preventive services that adapt to household health data. This comprehensive approach aims to transform domestic services into holistic health management systems, significantly elevating the value proposition of the industry. The fourth dimension addresses sustainability enhancement through AI-driven resource efficiency and environmental transition initiatives. AI contributes to optimizing scheduling and route planning to reduce carbon emissions, promoting paperless operations, and supporting environmentally friendly business practices. Furthermore, the model helps elevate professional dignity and social participation through AI-driven career pathways and transparent rights protection via blockchain technology integration, creating a more sustainable and socially responsible industry ecosystem.

However, the research acknowledges several challenges and limitations associated with this technological transformation. Key concerns include the risk of over-reliance on technology, which may lead to digital divides and exclude certain populations from accessing services or employment opportunities. Additionally, there is a critical need for strict data management and privacy protection in compliance with evolving legal regulations, particularly given the sensitive nature of personal and health information involved in service provision. In conclusion, AI serves not merely as a tool but as a strategic mechanism for restructuring the value chain of the domestic service industry. The proposed model aims to elevate the industry toward greater professionalization, humanization, and environmental sustainability. By emphasizing a "human-centered" approach as the foundation for all technological implementations, this research framework seeks to achieve genuine sustainability that balances technological advancement with human welfare, social equity, and environmental responsibility. This comprehensive approach represents a paradigm shift that could transform China's service education industry into a model of sustainable development for other emerging economies to follow.

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Example: Maslow (1970) asserts that……;…… (Maslow, 1970)

Wang and Pettit (2021).....;..... (Wang & Pettit, 2021)

Hisrich et al. (2020)……..;…… (Hisrich et al., 2020)

Novack et al. (2018)……;…… (Novack et al., 2018)

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   2.1 subheading
   2.2 subheading
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Cokins, G., Pohlen, T., & Klammer, T. (2018). *Supply Chain Costing and Performance Management* (2nd ed). New Jersey : Wiley.

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