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Editorial

Information Management and Business Review (IMBR) provides a digital forum for researchers to share their knowledge and publish research work in the fields of information management, business, management and related disciplines. The work submitted for publication consideration in IMBR should address empirical and theoretical developments in the subjects related to the scope of the journal in particular and allied theories and practices in general. Author(s) should declare that work submitted to the journal is original, not under consideration for publication by another journal and that all listed authors approve its submission to IMBR. It is IMBR policy to welcome submissions for consideration, which are original, and not under consideration for publication by another journal at the same time. Author (s) can submit: Research Paper, Conceptual Paper, Case Studies and Book Review. The current issue of IMBR comprises papers of scholars from different universities of Malaysia, Indonesia, Saudi Arabia, China, Bangladesh and Thailand. Examination of Intellectual, Emotional, Social and Adversity Quotient Towards Academic Success, Tipping Practices, Employee Motivation and Service Delivery Performance, Determinants of Employee Performance, A Holt-Winter Approach to Forecasting, Impacts of Social Network Characteristics on Digital Seizing Capabilities and Sustainable Performance, Digital Technologies and Youth Democracy, Enhancing Financial Reporting Quality, The Sustainable Water Management Through Waqf, Microcredit and Poverty Alleviation, Impact of Director Networks on Strategic Decision-Making, Challenges in Maintaining Halal Integrity in the Logistics Industry, Drivers and Constraints of Remanufacturing, Stakeholder Engagement to Circular Economy, Evolution of Disclosure Practices, Climate-Smart Governance and Food Security, Impact of Employees' AI Acceptance on Productivity, Impact of E-Money Usage on the Velocity of Money, Digital Currencies and Sustainable Finance, Web-Based Meal Ordering System Attributes and Social Innovation and Sustainable Value Creation are some of the major practices and concepts examined in these studies. All the submitted papers were first assessed by the journal committee and then the external editorial team for relevance and originality of the work and then blindly peer-reviewed by external reviewers depending on the subject matter of the paper. After the rigorous peer-review process, the submitted papers were selected based on originality, significance and clarity of the purpose. The issue will, therefore be a unique proposition, where scholars will be able to appreciate the latest results in their field of expertise and to acquire additional knowledge in other relevant fields.

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PAPERS

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An Examination of Intellectual, Emotional, Social and Adversity Quotient Toward Students' Academic Success

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Abstract: In understanding students' learning and student academic achievement, some factors need to be given attention. The primary objective of this research is to investigate a distinct type of quotient that affects students' learning. Previous research has revealed that Intellectual Quotient (IQ), Emotional Quotient (EQ), Social Quotient (SQ), and Adversity Quotient (AQ) are among the most significant variables influencing student academic success. This research employed a quantitative method, and university students were the target sample. In this study, a total of 211 responses from 326 samples were successfully collected via a survey questionnaire. A Pearson's Correlation was used to measure the relationships between the independent and dependent variables. The analysis revealed that the four quotients were found to have a significant relationship with students' learning; however, the degree of significance varies. The most significant finding from this research was that the adversity quotient exhibits the strongest relationship with students' academic success. This study is important to academicians because understanding students' traits can assist lecturers in enhancing and strengthening their teaching and learning methodologies, and improving the content of lectures for students, thereby producing successful students academically.

Keywords: *Intelligence Quotient (IQ), Emotional Quotient (EQ), Social Quotient (SQ), Adversity Quotient (AQ), Students' Success in Academics.*

1. Introduction and Background

Producing the best graduates is one of the most important and challenging objectives of institutes of higher learning. Today, it has become more challenging for universities to formulate the best strategy to produce high-quality students due to technological advancement, economic landscape, and other factors that change rapidly. This study is conducted to examine how students' intelligence, emotional, social, and adversity quotient influence the learning process. Past studies revealed that the learning process for students depends on their ability to manage and overcome challenges. For that reason, not every learner has the ability to overcome obstacles and difficulties during the learning process, which certainly has an impact on student progress and academic success. Tarmedi, Buhari, and Mulyadi (2016) posited that intellectual and emotional quotient alone are not sufficient to assist students in achieving better academic results. If a student has a superior intellectual and emotional quotient, but does not possess a strong work ethic and a lack of perseverance, the learning process would be meaningless. For that reason, this study is conducted to uncover the importance of students having important quotients through their learning process.

2. Literature Review

Intelligence Quotient (IQ)

A study by Khan (2019) revealed that a person's psychological age compared to their chronological age can be used to measure someone's intellectual attributes. The ability to reason, or IQ, is tested by looking at students' short- and long-term memory, knowledge, and logical thinking. A student's intellectual quotient may differ between intense concentration and mind-wandering (Bolaji & Friday, 2025). The ability to understand, process, and regulate one's environment, as well as to follow instructions, is known as the intelligence quotient (Soemaryani, 2017). The main function of IQ is to resolve logical problems or tactical issues, and there are steps in understanding IQ, namely logical thought, analysis ability, and in-depth understanding (Soemaryani, 2017). Wiratna and Hamdiah (2020) added that the notion of intelligence quotient (IQ) comprises the evaluation of a

person's ability to observe, analyze and interpret details intensely. The mental capacity to organize, apply, understand, solve a problem, follow rules, communicate, and solve complicated mathematical problems is also known as the intelligence quotient (Isnain, 2021). He added that IQ can also be explained by someone's ability to think logically, to use numbers, and mathematical symbols to solve complex problems. The intelligence quotient (IQ) is also known to assist someone in developing self-competencies; in other words, practice makes perfect (Peter and Unimke, 2025). Nurwahidah, Kartini, and Angela (2021) asserted that learning attainment characteristics are positively related to intelligence quotient and student success. A study from Wiratna and Hamdiah (2020) examined a group of students where they mixed students with high IQ levels and a group of students with low IQ levels in exams, and it is not a surprise that students with high IQ levels surpassed the achievement of students with low IQ levels. Thus, the intelligence quotient was seen to be important in the process of teaching and learning. For that reason, one hypothesis is offered:
H1: *There is a significant relationship between intelligence quotient and students' academic success.*

Emotional Quotient (EQ)
A study by Kucukkaragoz (2020) revealed that a child's emotional quotient is mainly influenced by the socioeconomic status and educational background of their parents. He added that, unlike cognitive intelligence (IQ), emotional intelligence can be developed during all stages of someone's life. Cognitive and emotional quotient interact dynamically with one another (Huda, 2021). She added that a person's emotional intelligence was derived from self-motivation, feelings, and empathy. Someone who masters emotional intelligence is likely to have the ability to distinguish, understand, and control their emotions and be able to control them towards others (Yotha, Khaopraay, Narkprom, & Rungruang, 2023). According to Khan (2019), when compared to the intellectual quotient, the emotional quotient is known to be a better indicator of understanding someone's characteristics. Research by Soemaryani (2017) discovered that emotional intelligence helps someone's emotional expression and the process of developing self-persistency. According to Nguyen, Chau & Nhi (2022), a person with a high level of emotional quotient can easily control their emotions and is a good decision maker. For that reason, emotional quotient was seen to be an important facet of students' academic success. Therefore, a hypothesis is recommended:
H2: *There is a significant relationship between emotional quotient and students' academic success.*

Social Quotient (SQ)
Social intelligence can be defined as the ability to interact with people effectively and the ability to understand human behavior appropriately (Widodo, Suendarti, & Hasbullah, 2020). Zakirova and Frolova (2014) supported that contention by suggesting that effective interpersonal communication and social adaptability depend on this facet. Someone with high social intelligence was found to be able to solve problems objectively (Soemaryani, 2017). Hashem (2021) explains that social intelligence is also one of the crucial factors in determining someone's success, and it builds self-confidence, resilience, and a sense of positivity. He added that someone who manages to understand, interact, and act appropriately towards different situations was found to master the social quotient. A study revealed that social intelligence increases someone's sociability and strengthens social relationships among peers (Jack & Oguntayo, 2020). Hence, social intelligence was seen to be important because, if a student were to be successful in academics, they must be able to socialize with friends, lecturers, and support staff in the university. One hypothesis for social quotient is offered, and they are:
H3: There is a significant relationship between social quotient and students' academic success.

Adversity Quotient (AQ)
A person's ability to deal with difficulties and be able to turn them into opportunities is known as the adversity quotient. Scholars postulated that a person's performance correlates well with adversity quotient (Safi'i, Muttaqin, Hamzah, Chotimah, Junaris, & Rifa'i, 2021). The ability to face challenges perseveringly was also part of the definition of the adversity quotient (Juwita & Usodo, 2020). They added that different individuals have different skills to solve and overcome problems. Additionally, adversity quotient also describes someone's trait, efficiency, and effectiveness (Stoltz, 2019). Stoltz further commented that some people turn their difficulties into opportunities and work harder to achieve success, which inspires them to take positive actions and develop a good strategy to overcome problems. According to Jumareng and Setiawan (2021), the capacity of someone to overcome difficulties and obstacles strengthens someone's adversity quotient. A person who has a high degree of adversity quotient in general was found to easily overcome challenges and solve a problem effortlessly (Hulaikah, Degeng & Murwani, 2020). To support this contention, to possess an adversity quotient

is seen to be imperative to students, because the learning process requires students to analyze, synthesize, understand, and make decisions towards difficult situations in the learning process. Hence, one hypothesis is offered for this reason:

H4: *There is a significant relationship between the adversity quotient towards students' success in academics.*

Students' Success in Academics

Learning process can be defined as the progression of gaining knowledge, and student success in academics is the outcome of it; these two were found to be highly correlated (Tarmedi, Buhari, & Mulyadi, 2016). According to Kustyarini (2020), students' positive reaction to the class lecture was found to influence students' learning. The success of student learning is highly influenced by how students perceive active learning, e.g., think-pair-share exercises, jigsaw discussions, and even simply pausing for clarification during a lecture (Davidoff and Jayusi, 2025). Previous studies have revealed that students with strong academic performance are likely to have a bright future in employment and career development. Furthermore, student learning is a result of consistent learning (Bhardwaj, Zhang, Tan, and Pandey, 2025). A study by Shoib, Shamer, and Iqbal (2025) revealed that college students who scored higher GPAs (Grade Point Averages) tend to have a more fulfilling life, while those with lower GPAs are more likely to struggle in their future; however, emotional, social, and adversity quotient were found to assist low-grade students. The relationship between an effective learning process and successful learning outcomes was found to be the key to students' academic success (Kutsyarini, 2020). According to Nurwahidah, Kartini, and Anggela (2021), students' learning achievement in class is closely tied to their intellectual quotient (IQ), meaning that the higher the students' IQs, the higher the chance for them to achieve excellent academic results. Nevertheless, other than intellectual quotient, emotional, social, and adversity quotient cannot be neglected in the process of learning.

3. Methodology

In this study, the researchers employed a quantitative approach to assist in examining, analyzing, and producing the results for this study. A set of questionnaires is developed as a tool to collect valuable data. The questions/items for this study were adopted from Bonwell (1995) and Silberman (1996) for intellectual quotient, as for emotional quotient, Petrides, Frederickson, and Furnham's (2004) works were adopted. For the social quotient, Suyono's (2007) study was adopted, and Stodolski's (1997) research on the adversity quotient was found to support this study. The measure for students' academic success was adopted from Cook, Heat, and Thompson's (2000) work.

Table 1: Instrumentation

NO	QUOTIENT	QUESTIONS	YEAR
1	Intelligence Quotient	1. I actively express opinions related to the material presented by the lecturer. 2. I always participate in groups working on/ discussing the task given. 3. I can explain the subject matter well.	(Bonwell, 1995) and (Silberman, 1996)
2	Emotional Quotient	1. I often agree to do something only because I do not want to disappoint someone. 2. Others tell me that I rarely speak about how I feel. 3. It is easy for me to make friends.	Petrides, Frederickson, and Furnham (2004)
3	Social Quotient	1. I can understand and be sensitive to the needs and rights of other people. 2. I can adjust (presence) in certain situations. 3. I can be trustworthy.	(Suyono, H. 2007)
4	Adversity Quotient	1. I know how to deal with problems in my learning. 2. I have the learning skills I need. 3. When I get advice and guidance, I do my best for my achievement.	(Stoltz, 1997)

5	Students' Success in Academic	1. Weigh the pros and cons of possible solutions to a problem. 2. Make sure that all group members have the opportunity to contribute to group activities and outcomes. 3. Develop ways to resolve conflict and reach an agreement in a group.	(Cook, Heath, and Thompson. 2000)

As for sampling in this study, students who are undergoing studies in Hospitality Management [undergraduate and diploma students] are chosen. This study employed probability sampling (stratified sampling) because this study targeted respondents with a specific characteristic, and they are UiTM students from the Faculty of Hotel and Tourism Management in Penang. Hence, respondents who are undergoing hospitality management courses from the Faculty of Hotel and Tourism Management, UiTM Permatang Pauh, will only be selected. In other words, students who do not fit the sampling characteristics in the screening process were omitted. Another reason was that it guarantees that each stratum is fairly represented in the sample, as well as lowering sampling error and group variability. The sample size was calculated using Rao Soft to decide the exact number of sample of students for the survey. From the 2,123-student population of the Faculty of Hotel and Tourism Management, UiTM Penang Branch Campus, 326 students were used as the sample size (n). In this research, a total of 211 responses were successfully collected, representing 64.72% of the total sample size. The researcher used a survey questionnaire to collect the data, and a 6-point Likert scale was employed to measure the degree of acceptance towards each question. The scale consists of the following: (1) Strongly Disagree, (2) Disagree, (3) Neither agree nor disagree, (4) Somewhat agree, (5) Agree, and (6) Strongly agree. The questionnaire contains six sections (6), and they are questions related to demographics, intelligence quotient, emotional quotient, social quotient, adversity quotient, and students' success in academics. The questionnaire link was sent to respondents via social media and e-mail. The collected data were then transferred to Microsoft Excel and moved to Statistical Package for Social Sciences (SPSS) for further in-depth statistical analysis.

4. Results

Demographics

This section presents the profile of respondents in this study, from 211 respondents, 131 of whom were female, representing 62.1% of the sample population, and 80 were male, representing 37.9%. In this sample, the majority of the respondents were found to be female. The highest age range of respondents, representing 60.2% of the sample, is derived from the respondents from the age range of 21 to 23 years old (21.3%), and the second-highest age range of respondents fell between 24 to 26 years old. Additionally, 18.5% of respondents who were 18 to 20 years old made up the smallest age group of the respondents. Respondents with a degree qualification were the highest, representing 56.4% of the total respondents, and 43.6% of the sample hold a diploma. According to the data gathered, hotel management students made up most of the respondents, which represents 129 students (61.1%), and the remaining 82 students were from the culinary arts management program (38.9%). Malay students account for 210 students (99.5%), and Bajau represents 0.5% of the sample.

Table 2: Profile of Respondents

Demographic variables	Categories	Frequency	Percentage (%)
Gender	Female	131	62.1
	Male	80	37.9
	Total	**211**	**100.0**
Age	18 - 20	39	18.5
	21 - 23	127	60.2
	24 - 26	45	21.3
	27 - 29	0	0
	Total	**211**	**100.0**
Level of Education	Diploma	92	43.6
	Degree	119	56.4
	Total	**211**	**100.0**

Course	Hotel Management	129	61.1
	Culinary Arts Management	82	38.9
	Total	**211**	**100.0**
Race	Malay	210	99.5
	Bajau	1	0.5
	Total	**211**	**100.0**

Reliability and Validity Test

A pilot study was conducted on 40 respondents to measure the degree of reliability and validity of each variable: intelligence quotient, emotional quotient, social quotient, adversity quotient, and students' success in academics, each with three (3) items. Intelligence, emotional, and social quotient Cronbach Alpha values are 0.915, 0.770, and 0.885, respectively. Meanwhile, the adversity and students' success in academics shared the same value, which is 0.903. The result is depicted in Table 3.

Table 3: Reliability and Validity Test

Variable	Cronbach's Alpha	No. of Item
Intelligence quotient	0.915	3
Emotional quotient	0.770	3
Social quotient	0.885	3
Adversity quotient	0.903	3
Students' success in academic	0.903	3

Mean and Standard Deviation

Intelligence Quotient

From the analysis of mean and standard deviation for intelligence quotient, I always participate in groups in working on discussing the task given, scoring the highest mean with 4.3555 (SD=1.26178). The second question [I actively express opinions related to the material presented by the lecturer] records the second-highest score of 4.2417 (SD=1.19657) and the third question [I can explain subject matter well] shows the lowest mean score of 4.2180 (SD=1.23822).

Table 4: Mean and Standard Deviation for Intelligence Quotient

Statement	N	Mean	SD
I always participate in groups in working on/ discussing the task given.	211	4.3555	1.26178
I actively express opinions related to the material presented by the lecturer.	211	4.2417	1.19657
I can explain the subject matter well.	211	4.2180	1.23822

Emotional Quotient

For emotional quotient, the first question [I often agree to do something only because I do not want to disappoint someone] has the highest mean score of 4.4360 (SD=1.25335), the second question [It is easy for me to make friends] received the second-highest mean score of 4.3175 (SD=1.37966) and the third question [Others tell me that I rarely speak about how I feel], showed the lowest mean score of 4.3128 (SD=1.35111).

Table 5: Mean and Standard Deviation for Emotional Quotient

Statement	N	Mean	SD
I often agree to do something only because I do not want to disappoint someone.	211	4.4360	1.25335
It is easy for me to make friends.	211	4.3175	1.37966
Others tell me that I rarely speak about how I feel.	211	4.3128	1.35111

Social Quotient

Next, for the social quotient. "I can be trustworthy" was the highest mean score from the analysis with 4.5071 (SD=1.25117). "I can understand and be sensitive to the needs and rights of other people," showed the second-highest mean score of 4.4123 (SD=1.27079). Besides, the statement "I can adjust (presence) in certain situations" was the lowest mean score of 4.3365 (SD=1.21716).

Table 6: Mean and Standard Deviation for Social Quotient

Statement	N	Mean	SD
I can be trustworthy.	211	4.5071	1.25117
I can understand and be sensitive to the needs and rights of other people.	211	4.4123	1.27079
I can adjust (presence) in certain situations.	211	4.3365	1.21716

Adversity Quotient

Then, for the adversity quotient. "When I get advice and guidance, I do my best for my achievement," was the highest mean with 4.5261 (SD=1.12251). "I have the learning skills I need." received the second-highest mean score of 4.4408 (SD=1.19525). The statement of "I know how to deal with problems in my learning" was the lowest mean score of 4.3318 (SD=1.18478).

Table 7: Mean and Standard Deviation for Adversity Quotient

Statement	N	Mean	SD
When I get advice and guidance, I do my best for my achievement.	211	4.5261	1.12251
I have the learning skills I need.	211	4.4408	1.19525
I know how to deal with problems in my learning.	211	4.3318	1.18478

Students' Success in Academic

Lastly, for students' success in academics, the analysis showed, "Weigh the pros and cons of possible solutions to a problem." It was the highest mean, with 4.3791 (SD=1.21825). "Make sure that all group members have the opportunity to contribute to group activities and outcomes" was the second-highest mean score of 4.2559 (SD=1.32410). The statement "Develop ways to resolve conflict and reach agreement in a group" received the lowest mean score of 4.2038 (SD=1.29879).

Table 8: Mean and Standard Deviation for students' success in academic

Statement	N	Mean	SD
Weigh the pros and cons of possible solutions to a problem.	211	4.3791	1.21825
Make sure that all group members have the opportunity to contribute to group activities and outcomes.	211	4.2559	1.32410
Develop ways to resolve conflict and reach an agreement in a group.	211	4.2038	1.29879

Pearson Correlation

The tables below show the correlation analysis for intelligence quotient, emotional quotient, social quotient, and adversity quotient towards students' success in academics. The findings of this correlation analysis between intelligence quotient and students' success in academics are shown in Table 9, where intelligence quotient is the independent variable and students' success in academics is the dependent variable. Analysis revealed that there was a positive relationship between intelligence quotient and students' success in academics, which is .714, more than 60%.

Table 9: Pearson's Correlation Overall Analysis

		IQ	E_Q	SQ	AQ	SSA
IQ	Pearson Correlation	1	.697**	.741**	.848**	.714**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	211	211	211	211	211
E_Q	Pearson Correlation	.697**	1	.754**	.683**	.646**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	211	211	211	211	211
SQ	Pearson Correlation	.741**	.754**	1	.789**	.748**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	211	211	211	211	211
AQ	Pearson Correlation	.848**	.683**	.789**	1	.782**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	211	211	211	211	211
SSA	Pearson Correlation	.714**	.646**	.748**	.782**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	211	211	211	211	211

**. Correlation is significant at the 0.01 level (2-tailed).

5. Discussion

Based on the study, a few discussions were offered. Firstly, it was found that there is a significant positive relationship between intelligence quotient and academic success in academics of the selected students in this study. Since intelligence is regarded as one of the most significant cognitive variables responsible for the variances in accomplishment scores, intelligence and academic performance are distinct but linked concepts (Akubuilo, Iloh, Onu, Ayuk, Ubesie, & Ikefuna, 2020). Secondly, there is a mild positive relationship between the emotional quotient and the academic success of the selected students in this study. According to Akpur (2020), the cognitive domain of emotional intelligence is now recognized as a critical competence for academic achievement. Given the favorable effects of higher emotional intelligence on mood states, it is especially beneficial when people experience difficulties when working on and doing difficult tasks because it makes stress, irritation, helplessness, etc., tolerable. A person with emotional intelligence has a solid foundation from which to build self-adjustment, life skills, and success in school, society, and the workplace (Sitsira, 2020).

Thirdly, there is a significant relationship between the Social Quotient and the student's success in academics of the selected student in this study. According to research, people with higher social intelligence generally outperform those with lower social intelligence in terms of academic achievement (Kharluni, 2020). This suggests that if students want to succeed academically, they should start by raising their social intelligence because it is closely related to academic achievement (Kharluni, 2020). Lastly, the Adversity Quotient has a high positive relationship with the students' success in academics of the selected students in this study. Previous research demonstrated the various benefits of the adversity quotient aspect concerning student academic achievement and efficiency in educational institutions (Suheri Setyosari, Utaya, & Djatmika, 2021). To adjust to the new learning environment, students must be able to maintain self-control. Therefore, for students to overcome learning obstacles, students must develop and strengthen their Adversity Quotient (AQ).

Limitation/Delimitation

In this research, some limitation was found to appear; the sampling is rather small as the study tries to establish a preliminary study that can be further extended to a bigger sample. The study period was only 6 months, as a longer time is needed to reach a larger sample that presumably includes other universities and colleges. As for delimitation, it was suggested that more variables could be included in this study, as the researcher limited the items/questions for the questionnaire. The reason is to adopt the most suitable questions for the study underlying. Overall, those limitation and delimitations was handled successfully. The study found that the intelligence quotient, emotional quotient, social quotient, and adversity quotient have a positive relationship that could have an impact on students' success in academics. The success of the students in academics is influenced by their cognitive ability, overcoming emotions and stress, socializing skills, and how someone turn a hardship into a spirit to attain success in academics and life. Our awareness of the existence of the four quotients is very necessary to have a good impact on students. In addition, it can broaden our knowledge about things we never knew before.

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Tipping Practices, Employee Motivation and Service Delivery Performance among 4 and 5-star Hotel Employees in Pulau Pinang

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Abstract: Tipping is a prevalent phenomenon that is best understood as a result of various cultural norms and payment practices. The anticipation of receiving the tips is considered work motivation; it acts as a catalyst for employees to elevate their service delivery. While it may a common for others, tipping is not customary among Malaysians. This paper examined the interconnection between tipping, employee motivation, and service delivery performance within the 4 and 5-star hotels in Pulau Pinang, Malaysia. Using a quantitative research approach, a total of 348 usable responses (collected among F&B employees) were retrieved for analysis. The findings revealed a significant positive relationship between all tested variables and employee motivation fully mediates the relationship between tipping practices and service delivery performance. The outcome from this study is hoped to provide valuable insights for academicians into consumer behavior and cultural practices, while offering the hotel industry strategies to improve the service delivery performance.

Keywords: *Tipping, Motivation, Service Delivery Performance, Hotel Employees, Pulau Pinang.*

1. Introduction and Background

Customers frequently provide additional payments to service providers, commonly referred to as tips or gratuities, or similar terms (Lynn, 2021a). A tip is a voluntary payment made by guests or customers to reward service (Pala, 2020) and is defined as a gift given for services rendered. The amount of a tip varies based on the customer and the situation, which distinguishes it from regular transactions (Azar, 2020). Tipping is influenced by cultural norms and payment practices (Kakkar & Li, 2022). Some customers tip out of goodwill to support service workers, especially when they are underpaid, while others do so to display their social status (Lee et al., 2020). As a result, tips are not always given based on a consistent rationale.

In the hotel industry, employees often receive tips directly from customers (Lynn, 2021b). The expectation of receiving tips can act as a motivator for employees. Motivation, as defined by Pinder (1998), is the drive behind work-related actions, and Diefendorff and Seaton (2015) described it as an internal force that influences behavior. Motivation is critical to an organization's success (Mustafa & Domniku, 2018), and in the hotel sector, motivated employees are key to delivering high-quality service (Khoung & Linh, 2020). Research by Olusadum and Anulika (2018) found that without proper motivation, employees may develop negative attitudes toward their work, thus affecting performance.

This research identifies several key issues related to tipping within the hotel industry, particularly in Malaysia. First, there is little known research on how tipping practices affect employee motivation and service delivery in this country, especially from the employees' perspective. Previous studies mainly focused on customer motivations to tip in high-end hotels, creating a gap in understanding how tipping influences hotel employees (Md Rus et al., 2017; Zahari et al., 2011). Second, most tipping research has been conducted in regular restaurants, rather than in luxury hotel settings, where the dynamics of service and tipping may differ (Md Rus et al., 2017; Guéguen & Jacob, 2005). Third, tipping in Malaysia is uncommon, with service charges often automatically included in bills; hence it is imperative to study the effect of voluntary tipping on employee motivation. Therefore, this study seeks to address these gaps by investigating the relationship between tipping, employee motivation, and service delivery performance among Pulau Pinang's 4 and 5-star hotels F&B employees.

2. Literature Review

The Hotel Industry in Malaysia: The tourism industry, which includes hotel operations and tour services, is vital to Malaysia's economy, with the hotel sector making a significant contribution to the country's GDP (Romero & Tejada, 2019; Awan et al., 2020). The expansion of the hotel industry has likewise stimulated the growth of related sectors like food and beverage, entertainment, and retail (Poon & Low, 2005). Beyond its economic impact, the hotel industry is often associated with luxury and comfort, especially in luxury hotels, which are gaining attention in Asia as a growing market (Padma & Ahn, 2020). Guests at luxury hotels prioritize service quality and location over cost (Zhang et al., 2011), with four- and five-star hotels in Malaysia classified as luxurious according to the Ministry of Tourism, Arts and Culture (2023). Pulau Pinang, a well-known tourist destination for its cultural heritage, beaches, and cuisine, is home to 31 such luxury hotels (Sing & Awang, 2022), making it the focus of this study.

Hotel Employees Hierarchy: In a hotel, employees are typically divided into two groups: rank-and-file as well as managerial employees (Bakhtiar et al., 2021; Simpao, 2018). Rank-and-file employees, such as waiters, housekeepers, bellmen, and front desk clerks, perform operational tasks, interact directly with customers, and do not hold leadership positions (Bakhtiar et al., 2021; Fu et al., 2020). These employees, known as Front-of-the-House (FOH) staff, are the most visible to guests and are likely to receive tips for good service. According to Theory M by Weaver (1988), employees are motivated when they feel they are compensated fairly, often through tips, which are typically given when guests are satisfied with their service. As such, rank-and-file employees are more likely to receive tips, as they directly serve the guests (Dyussembayeva et al., 2022).

Tipping Culture: Tipping, a practice that originated in England as a way for guests to reward exceptional service, is now widespread globally (Chandar et al., 2019). It is defined as a voluntary payment made by customers for services rendered (Karabas et al., 2020). Historically, tips were given in advance to ensure greater service delivery, while today, tips are typically given at the end of service performance, with the amount depending on service quality (Dyussembayeva et al., 2022). Tipping is particularly relevant in the hospitality industry, where employees' service quality directly influences the tips they receive (Lynn, 1997). Most existing studies have concentrated on customers' tipping behaviors (Azar, 2020; Lynn, 2015), with studies exploring factors such as employee-guest interaction (Guéguen & Jacob, 2012; Shih et al., 2016), tipping norms (Zahari et al., 2011; Gössling et al., 2020), and payment methods (Kakkar & Li, 2022). However, studies on employee perspectives, particularly motivation related to tipping, are limited (Whaley, 2019).

In Malaysia, tipping is relatively uncommon, as a 10 percent service charge is already being included in the total bill. Research on tipping is limited, focusing mainly on customer practices and norms (Zahari et al., 2011; Md Rus et al., 2017). Tipping decisions are influenced by the quality of service, with higher tips given for better service (Ford et al., 2012). For employees to receive higher tips, they must provide excellent service, which requires motivation (Whaley et al., 2019). Motivation, as a driver of performance, encourages employees to align their personal goals with organizational objectives (Jamal Ali & Anwar, 2021). However, cultural differences in tipping norms may affect employee motivation (Shkoler & Kimura, 2020), and in Malaysia, where tipping was not traditionally expected, this has implications for employee motivation (Zahari et al., 2011). This study will explore how receiving tips affects employee motivation in Malaysia's hospitality industry.

Motivation and Service Delivery: Motivation is a critical determinant of employee performance and service delivery, as it aligns with the fundamental aspects of human behaviour (Olusadum & Anulika, 2018). It is regarded as the desire to act or the underlying reason for expressing behaviour in certain ways. In organizational contexts, motivation is seen as the force that influences individuals to act in certain ways (Onah, 2008). Although research linking tipping practices to motivation is limited, Curtis et al. (2009) found that tipped employees often exhibit different motivational factors compared to non-tipped employees. Tips, as a form of recognition, can counterbalance the stress of low pay (Stamper, 2003). However, many scholars agree that motivation primarily stems from the individual employee's internal drive (Nicholson, 2003).

In the hotel industry, service delivery is crucial for customer satisfaction and, ultimately, financial success (Kim et al., 2013). High-quality service not only strengthens customer interactions but also fosters employee job satisfaction and supports the overall success of the organization. Employees are instrumental in shaping guests'

experiences, and enhancing their service delivery is crucial to the success of a hotel (Dorta-Afonso et al., 2021). Research by Kusluvan et al. (2010) suggests that improved employee–customer interactions lead to higher customer satisfaction, which subsequently enhances the organization's financial performance. To improve service delivery, employees must feel motivated, and this study aims to explore how tipping influences employee motivation. As such, when a waiter receives tips, it can boost their morale and motivate them to continue delivering excellent service to earn more tips.

3. Research Methodology

To assess respondents' perceptions of tipping practices, motivation, and service delivery performance among employees of four and five-star hotels in Pulau Pinang, a quantitative research design utilizing a self-administered survey was employed. A total of 348 valid responses were collected after excluding 16 cases identified as straight-lining or patterned responses.

A five-point Likert scale was used to measure respondents' level of agreement with statements representing the study's main variables—tipping practices, motivation, and service delivery performance. Data were gathered through an online survey distributed via Google Forms. To facilitate comprehension, the questionnaire was provided in dual languages, English and Bahasa Melayu.

Screening questions were included to ensure participation from qualified respondents. Descriptive statistics, frequency analysis, mean scores, correlation tests, and mediation analysis were subsequently conducted using the Statistical Package for the Social Sciences (SPSS) Version 28.

4. Results

Profile of Respondents: Table 1 shows a summary of respondents' demographics in the study. Of 348 respondents, the majority are female (62.9%) compared to males (37.1%). Nearly half of them (48.3%) were between 18 and 29 years old, followed by 44.8% in the 30 to 39 age range, and a smaller group of 6.9% aged 40 to 49. Educationally, respondents were evenly split between those with a high school education and those holding a certificate, diploma, or degree, each comprising 49.1% of the sample. Only a small portion (1.7%) had a postgraduate qualification. Regarding work experience, most respondents had either 6 to 9 years of experience (45.7%) or less than 5 years (31.9%), with the remaining 22.4% having over 10 years of experience in their field.

Table 1: Demographic info of respondents

VARIABLE	FREQUENCY	PERCENTAGE
GENDER		
Males	129	37.1%
Females	219	62.9%
Total	**348**	**100%**
Age		
18-29	168	48.3%
30-39	156	44.8%
40-49	24	6.9%
Total	**348**	**100%**
Education		
High School (SPM)	171	49.1%
Certificate/Diploma/Degree	171	49.1%
Post-Graduate Qualification	6	1.7%
Total	**348**	**100**
Years of Experience		
Less Than 5 Years	111	31.9%
Between 6 To 9 Years	159	45.7%
More Than 10 Years	78	22.4%
Total	**348**	**100%**

Descriptive Statistics: Table 2 displays the mean scores and standard deviations for the statements pertaining to tipping practices, motivation, and service delivery among the respondents. In the "Tipping Perception" category, mean scores reveal that respondents moderately agreed with statements about receiving tips (TP1, mean = 2.87) and the infrequent nature of tipping (TP4, mean = 3.44). However, they rated the statement regarding receiving large tips (TP2, mean = 2.43) and organizational practices of equal tip distribution (TP3, mean = 2.81) lower.

Regarding "Motivation," respondents expressed strong agreement that tips motivated them in several ways. High mean scores were observed for statements indicating that tips motivated them to do their work (MO5, mean = 4.32), be courteous (MO2, mean = 4.06), and work harder (MO1, mean = 3.83). The lowest mean score in this category was for "I'm motivated to earn tips" (MO3, mean = 2.41), suggesting variability in respondents' intrinsic motivation toward earning tips.

In the "Service Delivery" category, respondents generally agreed that tipping positively influenced their job satisfaction (SD1, mean = 3.98) and encouraged them to be kinder to tipping guests (SD2, mean = 4.39). The highest mean score was observed for the statement that they are kinder to guests who issue tips (SD2, mean = 4.39), and there was also strong agreement with delivering better quality service when receiving tips (SD3, mean = 4.23). Willingness to do extra work when given tips (SD4, mean = 3.29) received a more moderate level of agreement. These results indicate that tipping is perceived as a significant motivator and enhancer of service quality, although the extent to which it is expected or equally distributed may vary among respondents.

Table 2: Descriptive Statistics

Variable	Description	Mean	Std. Dev.
TP1	I often received tips	2.87	1.043
TP2	I received a huge amount of tips	2.43	1.006
TP3	The organization divided the tips equally	2.81	0.790
TP4	Tipping is rare and not expected to be received	3.44	1.260
MO1	Tips motivate me to work harder	3.83	0.963
MO2	Tips motivate me to be courteous	4.06	1.066
MO3	I'm motivated to earn tips	2.41	1.047
MO4	Tips are financial stimulators at work	3.68	1.001
MO5	Tips motivate me to do my work	4.32	1.092
SD1	I am satisfied with my job when I receive a tip	3.98	0.978
SD2	I'm always kinder to guests who issue tips	4.39	1.106
SD3	I deliver better quality service when I receive tips	4.23	1.130
SD4	I'm willing to do extra work when given tips	3.29	0.969

Correlation Analysis: Correlation analysis was conducted to examine the relationships among the study variables, and the results are presented in Table 3.

The correlation analysis indicated a significant positive relationship among all the examined variables. Tipping practices positively influenced both employee motivation and service delivery, and higher motivation levels in employees were linked to improved service quality. These findings highlight the interconnected and mutually reinforcing roles of tipping, employee motivation, and service delivery.

Table 3: Correlation Analysis

Correlations				
		Tipping Practices	Employee's Motivation	Employee's Service Delivery
Tipping Practices	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	348		
Employee's Motivation	Pearson Correlation	.649**	1	
	Sig. (2-tailed)	.000		
	N	348	348	
Employee's Service Delivery	Pearson Correlation	.597**	.872**	1
	Sig. (2-tailed)	.000	.000	
	N	348	348	348

**. Correlation is significant at the 0.01 level (2-tailed).

Mediation Analysis: According to Baron and Kenny (1986), a variable can be considered a mediator in a causal sequence when regression analyses demonstrate statistically significant relationships across three primary conditions. First, the independent variable must significantly predict the dependent variable (X → Y). Second, the independent variable must significantly predict the mediator (X → M), where the mediator functions as a dependent variable relative to the independent variable. Third, the mediator must significantly predict the dependent variable while controlling for the influence of the independent variable (M → Y). These three conditions collectively establish the presence of a direct effect. If any of these relationships are not statistically significant, mediation cannot be inferred and is considered improbable. Once statistical significance is confirmed, a fourth step is undertaken to determine the nature of the mediation—whether it is full or partial. Full mediation is indicated when the independent variable no longer exerts a significant effect on the dependent variable after accounting for the mediator, implying that the relationship between X and Y becomes insignificant. Conversely, partial mediation occurs when the effect of the independent variable on the dependent variable remains significant but is attenuated. Generally, a smaller coefficient "c" reflects a stronger mediating effect.

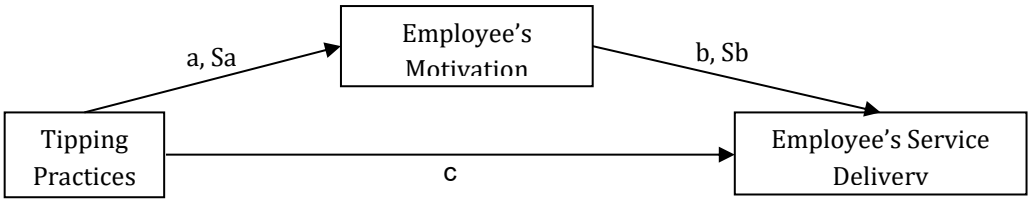


Table 4: Tipping Practices (X) → Service Delivery (Y)

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.866	.212		-4.077	.000
	Tipping Practices	.903	.065	.597	13.852	.000

a. Dependent Variable: Employee Service Delivery

Table 4 indicates that the independent variable, Tipping Practices, significantly predicts the dependent variable, Employee Service Delivery ($t = 13.852$, $p < 0.05$). In other words, the unstandardized coefficient "c" ($\beta = 0.903$) is statistically significant.

Table 5: Tipping Practices (X) → Employee's Motivation (M)

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.521	.184		-2.839	.005
	Tipping Practices	.893	.056	.649	15.851	.000

a. Dependent Variable: Employee Motivation

Table 5 demonstrates that the independent variable, Tipping Practices, is also a significant predictor of the mediating variable, Employee Motivation ($t = 15.851$, $p < 0.05$). In other words, the unstandardized coefficient "a" ($\beta = 0.893$) is statistically significant.

Table 6: Tipping Practices (X) → Employee's Service Delivery (Y), Employee's Motivation (M) → Service Delivery (Y)

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.388	.131		-2.958	.003
	Tipping Practices	.083	.052	.055	1.598	.111
	Employee Motivation	.918	.038	.836	24.185	.000

a. Dependent Variable: Employee Service Delivery

Table 6 indicates that, after controlling for the independent variable (Tipping Practices), the mediating variable (Employee Motivation) remains a significant predictor of the dependent variable (Employee Service Delivery) ($t = 24.185$, $p < 0.05$). Specifically, the unstandardized coefficient "b" ($\beta = 0.918$) is statistically significant. However, when Employee Motivation was included in the regression analysis, Tipping Practices no longer significantly predicted Employee Service Delivery ($b = 0.083$, $\beta = 0.052$, $t = -1.598$, $p > 0.05$). This finding suggests that employee motivation fully mediates the relationship between tipping practices and employee service delivery.

5. Discussion, Limitations and Recommendations for Future Research

The study findings provide policymakers and hotel managers with insightful information and feasible solutions to improve staff motivation and service quality. Managers can adjust their strategies to maximize customer happiness and service delivery by knowing how tipping practices affect employee behavior. Fostering a positive work environment and promoting exceptional service experiences can be achieved through the implementation of incentive programs, training initiatives, and performance management systems that are in line with the motivational effects of tipping.

It is important to recognize the limitations of this study, despite its valuable insights into the relationships among employee motivation, tipping practices, and service delivery within the hospitality sector. First, the study was confined to a single geographic location, which may limit the generalizability of the findings to the broader population of hospitality employees. Additionally, the cross-sectional research design provides only a snapshot of data at a specific point in time, thereby restricting the ability to infer causal relationships between the examined variables. Furthermore, the utilization of self-report measures allows for the possibility of response bias and social desirability effects, which could potentially impact the precision and dependability of the gathered data. Moreover, the validity of the study's conclusions may be influenced by the underlying assumptions of the mediation analysis, such as the absence of unmeasured confounding variables and the assumption of linear relationships, which may not consistently hold true in real-world contexts. Notwithstanding these drawbacks, the work establishes the foundation for further investigations that seek to overcome these limitations and deepen our knowledge of tipping practices, employees' motivation, and service delivery in the spectrum of the hospitality sector.

Extensive studies could potentially explore the moderating factors that impact the relationship among tipping

practices, employee motivation, and service delivery. Examining contextual elements such as dynamics distinct to the industry, organizational rules, and cultural norms may aid in our understanding of the complexities underlying these relationships and offer direction for targeted interventions and management strategies. Comparative studies carried out in diverse hospitality environments and areas may also highlight cultural variations in tipping practices and how they impact employee behavior and customer service.

Conclusion

This study investigates the relationship between tipping, employee motivation, and service excellence in four- and five-star hotels in Pulau Pinang, Malaysia, where tipping is not a customary practice. Using a quantitative approach and data from 348 food and beverage employees, the findings reveal a strong positive correlation among tipping practices, employee motivation, and service performance. Notably, employee motivation was found to fully mediate the relationship between tipping practices and service delivery, highlighting its pivotal role in enhancing service quality within the hospitality sector.

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Determinants of Employee Performance: Empirical Evidence from Indonesia

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Abstract: The purpose of this study was to investigate how employee performance is impacted by perceived ease of use, perceived usefulness, training efficacy, and motivation. The goal of this study is to raise the calibre of workers at the Republic of Indonesia's Ministry of Defence by using a sample of all work units. Purposive sampling was the method of sampling that was applied. In order to conduct this study, questionnaires with primary data, which were obtained from the responses of up to 60 employees with varying positions, were examined. Using the Smart Partial Least Squares (PLS) version 3.0 tool, test the variables using the Structural Equation Modelling (SEM) technique. The study found that while perceived usefulness had a significant impact on employee performance, perceived ease of use had no significant effect, training effectiveness had a significant effect, and motivation had a significant effect on employee performance. It is anticipated that contributions to ministries or institutions will enhance public sector governance and provide the public with input for policy formulation and full execution in ministries or institutions.

Keywords: *Perceived Ease of Use, Perceived Usefulness, Training Effectiveness, Motivation, and Employee Performance*

1. Introduction

As part of an effort to overhaul information systems in the public sector, the government introduced a set of state finance rules in 2003. The information technology application system was introduced at that time and was intended to be utilised for budgetary, planning, and execution tasks, all the way up to reporting. Since 2005, a number of application systems have been in place, including SAS (State Property Management and Accounting System), SIMAK-BMN (State Property Management and Accounting Information System), SAIBA (Accrual-Based Institutional Accounting System), and RKAKL-DIPA (Ministry of Budget Work Plans, Budget Implementation Lists). Inventory, SILABI (Agency Treasurer Report System), and Work Unit Application System (Ikhsan & Krisnadi, 2017). Although the application's database is distinct, the input and output are related. Such that many data entry procedures are needed in order to record a transaction. This increases the possibility of system or human error as a result of various application data entry procedures. Inconsistent data entry by users can lead to human error, rendering the final data invalid for use in subsequent accounting procedures (Djuitaningsih & Arifiyantoro, 2020). The fact that these applications are all offline—that is, accessible only through a computer with the application installed—means that the head of the work unit (Satker) is unable to keep an eye on budget management in real time. The fact that the current application is not directly linked to the SPAN (State Treasury and Budget System) application presents another drawback when sending a payment bill to the State Treasury Service Office (KPPN). 2014 saw the launch of the SPAN application, which served as a prelude to the Integrated Financial Management Information System (IFMIS). Achieving a high degree of accuracy and transparency is the goal of this integrated system for handling state finances (Bppk, 2018).

In the public sector, information technology that is already accessible is being developed by the Directorate General of Defence Potential of the Ministry of Defence of the Republic of Indonesia (Ditjen Pothan Kemhan) in an attempt to enhance its work performance. The Directorate General of Treasury developed the SAKTI (Agency Level Financial Application System) in 2015 as a reform of the development of information systems in state financial management at the work unit level. The SPAN application was the first single database formed in the context of developing information technology in the public sector. The goal of the SAKTI application is to make work easier, faster, and more precise. In an effort to improve employee performance in treasury and state budgeting activities at the agency level, SAKTI is an integrated system that consolidates a number of current applications into a single container (Ikhsan & Krisnadi, 2017). When SAKTI is implemented, it causes a number of problems. First off, the SAKTI program is still not very user-friendly compared to other applications already in use, which means that people still don't fully comprehend how to use it. Second, there are updates from

references and apps, since the SAKTI application's regulations are dynamic and change frequently, necessitating that users modify their operations.

After that, according to Sony Rizky Nugroho, a staff member at the Directorate General of Pothan Kemhan, there are issues with internet connections and unstable networks when operating online, which prevents users from accessing SAKTI at the Directorate General of Pothan Kemhan; Human Resources' (HR) lack of preparation stems from its ignorance of accrual-based accounting, which makes it difficult for HR to use this application. Because SAKTI is a single database, transactions that encounter technical issues cannot be erased as readily as they once were. New procedures will be implemented in the future; thus, contacting the admin is required first. If barriers like this are not fixed right away, the results will be erroneous.

If the information system is simple for its users to utilise, then it is considered successful. The degree to which a person feels that a system may make things simpler for users to encourage them to utilise it is known as perceived ease of use. Users will not use the system if they consider it to be difficult to use (Muzakki, 2016). Davis and Wiedenbeck (2001) asserted that consumers anticipate systems or software to be easy to use, meaning it won't take extra effort to understand or operate. This is known as perceived ease of use (PEOU). Thus, for its users to understand this system, it must be made simple and succinct. Because it is based on the user's assessment of how simple it is for them to effectively do the intended task using computer systems and software, it can therefore be seen as a measure of self-efficacy. Perceived simplicity of use is also seen to have a direct impact on perceived usefulness. A person's perception of the system's ability to help them perform better at work is known as perceived usefulness (PU) (Davis, 1989).

Aside from that, insufficient human resource competency is another element that constitutes a barrier. Every employee needs training to reduce these barriers. For it to supply skilled and capable human resources. Furthermore, a nation must build a skilled labour force through education and training to experience economic progress or development. Higher formal education has been established by the government in an attempt to produce a better-skilled workforce. In actuality, though, the education system hasn't made a significant contribution to raising the calibre of human resources. Both on-the-job training and formal education are thought to support the expansion of human resources. Particularly, trained employees typically outperform untrained ones in assigned duties because the primary goal of vocational training is to improve employees' abilities and responsibilities. Thus, job training and increased employee productivity are tightly associated. Put differently, vocational training helps employers hire better workers (Kang & Na, 2020). The success of the company's training program to enhance participants' knowledge, skills, and talents so they can perform better at work is what determines how effective the training is.

In the process of inspiring workers to do their best effort, achieving impactful performance is still another crucial component. Motivated workers are more likely to try to finish tasks, which can lead to improved performance, according to Omar, Munir, Kaizan, Noranee, and Malik (2019). This is so because worker performance is impacted by motivation. Better work will be produced by employees who are happy with their jobs than by those who are not. In order to boost employee performance and make them more productive and efficient, the company must be able to motivate staff to use new technology and offer perks. Employees with negative behaviour have the ability to permeate the organisation, create uneasiness in the workplace, and inspire a desire to quit, regardless of the technology they use. It has been demonstrated that motivation plays a crucial part in organising procedures and accomplishing goals (Kuswati, 2020).

2. Literature Review and Hypothesis Development

Self-efficacy theory is another name for social cognitive theory. Davis and Wiedenbeck (2001) define social cognition theory as "self-efficacy beliefs and result expectations." Self-efficacy is the conviction that one can effectively complete particular tasks. Two primary cognitive factors that impact proficient computer usage are result expectations and self-efficacy beliefs. Meanwhile, self-efficacy influences performance indirectly through result expectancies. High computer performance is less likely to be attained by staff members who have low computer self-efficacy beliefs. To carry out duties in an experienced manner, a person needs to possess the necessary competence and a high degree of self-confidence in their capacity to use their abilities. Expected outcomes are beliefs or assessments of oneself regarding the actions taken to produce the intended outcomes.

Perceived utility is utilised as a proxy for result expectations. User perception of ease of use is a key indicator of self-efficacy. Next, as a gauge of expected results, perceived utility, training effectiveness, and drive. When Davis and Wiedenbeck (2001) looked into how system features affected how strongly users judged usability and ease of use, they found that interaction style and prior IT experience had a significant influence. Therefore, under this theory, performance has generally been predicted by self-efficacy and outcome expectations.

Placing or matching new information with existing information is the process of assimilation theory. According to the notion of assimilation, it is typified by a growth in behaviour or a shared viewpoint, yet occasionally it is emotional to accomplish the intended outcome. Past studies have shown that assimilation theory encompasses two different forms of learning: meaningful learning and rote learning. When the learning and memorisation process is applied to similar conditions as when the skill was originally achieved, exceptional performance can result. This method works for computer training since it necessitates both deliberate and memorisation learning for effective performance.

Employee performance: According to Aswar (2019), work performance, also known as performance, is the perception of an activity's accomplishment in an attempt to meet the organization's mission, vision, and goals. Employee performance is defined as everything that employees do or do not do for the company, including the output of their labour in terms of output volume, output quality, output independence, and output time management in relation to the tasks that they are given (Rizwan, Tariq, Hassan, & Sultan, 2014). Five factors are used by Robbins (2006:260) to assess employee performance: independence, quantity, quality, timeliness, effectiveness, and job commitment.

Perceived ease of use: According to Davis (1989), user-friendliness is a measure of how much someone thinks using a computer is simple and requires little effort. In their earlier study, Lanlan, Ahmi, and Popola (2019) discovered that qualified accountants needed to be proficient with computers and know how to enter accounting transactions using Computerised Accounting Systems (CAS). System designers, therefore, need to understand what users anticipate from the system in terms of ease of use. According to the study, a user's perception of the information system's ease of use will influence how well they can use it. Susanto and Aljoza (2015) outline five metrics—such as simple navigation, quick reaction times, appropriate and well-designed interfaces, and accessibility—that are used to gauge how easy a user feels about their experience.

Perceived usefulness: According to Davis (1989), usability is the confidence people have in the system to accomplish their tasks after using it. Therefore, the research indicates that every person believes that utilising technology and systems will benefit them and feels that technology will boost their productivity at work. In the meantime, there are five ways to quantify perceived utility, according to research by Susanto and Aljoza (2015): cost reduction, energy savings, time savings, fullness of information, and usable information.

Training Effectiveness: Efficiency. Any corporation or organisation must provide training. The primary reason is that training will help the company or organisation accomplish specific objectives. According to Rivai (2011), the activities in a training program must meet a certain standard of efficacy for the training to be successful. According to Suryanto (2018), a successful training program is one that the organisation arranges for each participant to enhance their knowledge and abilities so they can perform their jobs more effectively. The research by Handaru and Mardiyati (2014), which claimed that indicators including reactions, learning, behaviour, and results were used to quantify the success of training, was chosen as the basis for this measurement.

Motivation: Motivation, according to Ek and Mukuru (2013), is an internal or external drive that persuades people to act in a particular way, usually in order to reap advantages. Almusaddar, Ramzan, and Raju (2018) elucidate the concept of intrinsic and extrinsic motivation. Extrinsic motivation refers to behaviour that is motivated by obtaining outside benefits like money or positive reinforcement. On the other hand, intrinsic motivation refers to the drive to perform tasks solely for their own sake. Intrinsic variables include things like fulfilling employment, accomplishment, progress, and acknowledgement. In the meantime, Mandey and Sahagggamu's (2014) research was used to quantify motivation using metrics like reward, security, social, and physiological.

Hypotheses and Conceptual Framework: The development of the hypothesis in this study is based on the factors that are thought to affect employee performance, so it is formulated as follows:

The Effect of Perceived User Ease on Employee Performance: Davis and Wiedenbeck (2001) noted that user convenience significantly affects user performance based on prior studies. The social cognitive theory that is pertinent to the user convenience variable as a gauge of self-efficacy is known as perceived ease of use (PEOU). PEOU is the measure of how much people expect a software or system to be easy to use and understand. PEOU can be thought of as a measure of self-efficacy because it is based on users' perceptions of how simple it is for them to complete desired tasks using computer systems and software (Davis, 1989). Employee performance will directly improve if they can effectively use the new technology and will have an easier time adjusting to it. Similarly, Pramanda and Azizah's (2016) research notes that employee performance and user convenience are significantly influenced. It has been demonstrated that an employee's ability to use information technology more easily will impact the amount of work they do. The explanation above allows for the formulation of the following hypothesis:
H1: Perceived ease of use affects employee performance

Effect of Perceived Usefulness on Employee Performance: Omar et al. (2019) note that there is a significant relationship between employee performance and usability based on prior studies. Perceived usefulness (PU) as a gauge of expected outcomes can be analysed using the social cognition theory of PU. PU is the measure of how much a computer system or software will improve work performance. Because PU is dependent on the user's assessment of the information technology's usefulness in achieving the intended outcomes for their task, it is regarded as a result expectation. Staff members who have a behavioural intention to use technology are more likely to use it regularly. Furthermore, there may be a significant improvement in worker performance. The reasoning provided above allows for the formulation of the following hypothesis:
H2: Perceived usefulness affects employee performance

Effect of training effectiveness on employee performance: Santoso and Jonathan (2018) elucidated that employee performance is significantly impacted by the efficacy of training, drawing from prior studies. In the meantime, employee performance is unaffected by the efficacy of employee training, according to Rizwan et al. (2014). This is because efforts to increase employee performance through employee training have not received enough backing. The term "Effectiveness of Training" (EOT) refers to the assimilation theory, which is employed because it describes how rote learning and training success are related, and how crucial these two elements are for workers to perform well. Only the level of behaviour change—reaction level, learning rate, and behaviour change—affects employee performance, according to Handaru and Mardiyati's (2014) analysis of the three factors. This demonstrates how employee behaviour may be changed through training, raising the bar for overall performance. The reasoning provided above allows for the formulation of the following hypothesis:
H3: Effectiveness of training affects employee performance

The Effect of Motivation on Employee Performance: According to Asim's (2013) earlier research, employee motivation significantly affects how well employees perform. One of the key elements in the operation of the company is employee motivation. According to the social cognitive theory, motivation is a function of outcome expectations. Because motivation refers to the user's assessment of the significance of both internal and external incentives in offering a reward or reward for reaching a shared objective, motivation is seen as a measure of result expectations. Furthermore, Ek and Mukuru (2013) clarify that there is a strong relationship between employee performance and motivation. It is emphasised that employees are more affected by intrinsic than by extrinsic causes. Employee motivation and performance are significantly correlated, according to research by Rizwan et al. (2014). Motivated workers are more likely to work hard and provide quality work. The reasoning provided above allows for the formulation of the following hypothesis:
H4: Motivation affects employee performance

3. Research Methodology

Employees of SAKTI users at the Jakarta Ministry of Defence make up the population used. Purposive sampling is used to select the sample for this study. Purposive sampling is the utilisation of a sample with unique qualities

that the researcher needs to meet specific requirements. 22 work units (Satker) make up the sample, which has 132 respondents overall. The following criteria were applied during the sampling process:

Table 1: Respondent Criteria

	Criteria	Number of people
Age	< 30 years old	65
	> 30 years	67
Gender	Man	68
	Woman	64
Level of education	High school	15
	Diploma	40
	Bachelor	65
	Master	12
Years of service	< 5 years	54
	> 5 years	78

In addition, the employed questionnaires—primary data—were used for their data gathering. Several types of statements are presented in the questionnaire that is used as a data collection strategy and is delivered to respondents directly in order to test and measure the variables to be examined. People who feel that the Ministry of Defence uses the SAKTI information system will receive this questionnaire in exchange for a statement that has been put together by the researcher. The statements and self-identity of the responder are used in the questionnaire.

Table 2: Variable Measurement

Variables	Measurement		Source
Perceived User Ease	1.	Easy navigation	Susanto and Aljoza (2015)
	2.	Prompt response	
	3.	Nice and appropriate interface	
	4.	Can be accessed anywhere and anytime	
Perceived usefulness	1.	Useful information	Susanto and Aljoza (2015)
	2.	Saving working time	
	3.	Energy saving	
	4.	Cost savings	
	5.	Complete information	
Training Effectiveness	1.	Reaction	Mathis and Jackson (2006)
	2.	Learning	
	3.	Behavior	
	4.	Results	
Motivation	1.	Physiological	Mandey and Sahagggamu (2014)
	2.	Security	
	3.	Social	
	4.	Awards	
Employee performance	1.	Quality	Robbins (2006)
	2.	Quantity	
	3.	Punctuality	
	4.	Effectiveness	
	5.	Independence	
	6.	Work Commitment	

4. Results and Discussion

Employees of SAKTI users at the Republic of Indonesia's Ministry of Defence make up the study's population. Purposive sampling is used in the sample selection process. The personnel departments of each inspectorate,

as well as the inspectorate secretariat, helped with the questionnaire distribution procedure. This study's data gathering process gathered 60 replies over the course of 30 days, yielding a 45.5% response rate.

Table 3: Descriptive Statistics

Variables	Total question items	Mean	Std. Deviation
Perceived User Ease (PEOU)	7	4,29	0,175
Perceived Usefulness (PU)	6	4,27	0,060
Training Effectiveness (EOT)	7	4,15	0,061
Motivation (M)	6	4,45	0,084
Employee Performance (EP)	6	4,22	0,069

Table 3 descriptive data indicates that, with 7 statement items out of 60 respondents and a standard deviation of 0.175, the mean perceived ease of use is 4.29. Perceived usefulness follows, with a mean score of 4.27 and a standard deviation of 0.60. Furthermore, the training efficacy has a mean of 4.15 and a standard deviation of 0.061. The motivation's mean and standard deviation are 4.45 and 0.084, respectively, after that. At last, the mean for employee performance is 4.22, with a standard deviation of 0.069.

Table 4: Convergent Reliability Test and Validity Test

Variable	AVE	Composite Reliability	Cronbach Alpha
PEOU	0,870	0,895	0,820
PU	0,645	0,916	0,894
EOT	0,654	0,850	0,738
M	0,785	0,835	0,857
EP	0,620	0,866	0,798

The AVE value for each variable in the study model that is greater than 0.5 is displayed in Table 4. Employee performance (EP), the endogenous variable, has the lowest AVE value of 0.620. Thus, all variables are deemed to be legitimate. Furthermore, all of the constructs in this study had composite reliability values greater than 0.7, indicating that all of the constructs are estimated to have exceeded the requirements. It is possible to conclude that all of the variables in this study have good reliability for each construct because the training effectiveness variable (EOT) in this research model has the lowest value, which is 0.850. The effectiveness of training (EOT) variable has the lowest Cronbach's Alpha value, which is 0.738. Based on this, it can be said that all the variables in this study have good reliability on each construct.

Table 5: Testing PLS Path Algorithm and Bootstrapping

Variables	Path Coefficient	T-statistics	P-values
PEOU->EP	0,132	1,188	0,235
PU->EP	0,331	2,996	0,003
EOT->EP	0,230	2,337	0,020
M->EP	0,253	2,078	0,038

According to Table 5, there is a positive correlation between perceived ease of use and employee performance, as indicated by the path analysis coefficient of 0.132 between the variables of perceived ease of use (PEOU) and employee performance (EP). The employee performance (EP) path coefficient for the perceived usefulness variable (PU) is 0.331. The study found a favourable correlation between employee performance and the perceived usefulness measure. Thus, the path coefficient value of the training effectiveness variable (EOT) on employee performance (EP) is 0.230. This suggests that there is a positive relationship between employee performance and the training effectiveness variable. Lastly, employee performance (EP) on motivation (M) has a path analysis coefficient of 0.253. It has a strong correlation with worker performance, the statement says. Therefore, it is possible to claim that motivation, perceived utility, perceived ease of use, and training effectiveness all affect worker performance.

The effect of perceived ease of use (PEOU) on employee performance (EP) was found to be 1.040, 1.99444 after the first hypothesis was tested using the t-statistic test. A significant value of 0.299 > 0.05 indicates that the

perceived ease of use (PEOU) does not have a significant effect on employee performance (EP), so Ha1 is re-examined. These results are in line with the study conducted by Davis and Wiedenbeck (2001), which discovered no discernible relationship between employee performance (EP) and the perceived ease of use (PEOU) measure. This suggests that depending on the participant's level of experience, some operations can be deemed challenging to complete. One could describe the individuals in this study as novices or first-time users. Therefore, when they need to work on it, any benefit they gained from using the first kind of word processing tool is not applicable. Nonetheless, a study conducted in 2016 by Pramanda and Azizah found that employee performance (EP) was significantly impacted by perceived ease of use (PEOU). This is because information technologies at Brawijaya University, Malang, help staff members do their duties more efficiently and combine them to achieve high productivity.

The t-statistical test, which produced a tcount > ttable of 3,433 > 1,99444 and a significant value of 0.001 0.05, indicating that perceived usefulness (PU) has a significant effect on employee performance (EP), further supports the second hypothesis that there is a significant relationship between PU and EP. These results are in line with those of Omar et al. (2019) and Pramanda and Azizah (2016), who discovered that the perceived usefulness variable (PU) significantly affects employee performance in their investigations (EP). This illustrates that employees at the Ministry of Defence of the Republic of Indonesia perform better the more often they use the application system. Descriptive analysis, which demonstrates that the average score for all statement items that feel effective in carrying out tasks using the SAKTI application system is 4.27, which is good, further supports this. It has been demonstrated that a highly accurate information system can reduce worker workload. Additionally, because of its high perceived utility, it might improve worker productivity. Conversely, the study conducted by Davis and Wiedenbeck (2001) discovered that employee performance (EP) was unaffected by perceived usefulness (PU). This is because information system users don't know how word processing software will help them in their next classes. Lastly, there is no relationship between perceived usefulness and employee performance. Furthermore, the study discovered that the participants were virtual beginners, which made it challenging to forecast how they would utilise or profit from word processing software in the future.

Following the execution of a statistical t-test> t table of 2,337 > 1,99444 with a significant value of 0.020 0.05, the third hypothesis indicates that employee performance (EP) is impacted by training effectiveness (EOT). Ha3 is accepted since these results demonstrate that training efficacy significantly affects employee performance. These results are in line with the study conducted by Santoso and Johnathan (2018), which discovered a substantial relationship between employee performance (EP) and the training effectiveness variable (EOT). This indicates that workers in the Ministry of Defence of the Republic of Indonesia perform better when their training is implemented. However, in their study (EP), Rizwan et al. (2014) discovered that there was no significant relationship between employee performance and the training effectiveness measure (EOT). This is because PT Pakistan's workforce has not improved in quality as a result of prior training. The study's employees received training, but based on their remarks, they felt it was ineffective; thus, they did not apply the training in their regular teaching. Their performance at work suffers as a result of their dissatisfaction with the training they received.

The fourth hypothesis shows that motivation (M) affects employee performance (EP) after the t-statistical test is done; it has a significant value of 0.031, 0.050 and a t-count> t-table of 2.164 > 1.99444. These results lead to the acknowledgement of Ha4. An employee's motivation significantly improves their performance. These results corroborate those of Mandey and Sahagggamu (2014), Ek and Mukuru (2013), Davis and Wiedenbeck (2001), and Omar et al. (2019), who discovered a substantial relationship between employee performance (EP) and the motivation variable (M). This is because workers at the Ministry of Defence have a great deal of zeal, persistence, and excitement for carrying out their responsibilities when utilising the SAKTI application system. As a result, an increasing number of workers who embrace the application system with great zeal and passion enhance worker performance. Additionally, perseverance is a crucial attribute for workers as it enables them to keep their motivation levels up in the face of difficulties and disappointments. Therefore, when reward demands are satisfied, workers will perform better. However, in their study (EP), Sudibya and Utama (2012) discovered that there was no significant relationship between employee performance and the motivation variable (M). This is because, even if there is excellent employee motivation at the Bali Provincial Public Works Office, it is not enough to raise worker productivity.

5. Conclusion

This study set out to investigate and ascertain the impact of employee performance at the Ministry of Defence of the Republic of Indonesia, Jakarta, on perceived utility, ease of use, efficacy of training, and motivation. The following conclusions can be made in light of the results and discussions that have been detailed: The association between perceived ease of use and employee performance is good but not statistically significant. This suggests that since the participants are novices or first-time users, some operations can be deemed challenging to complete. However, when information systems are utilised by knowledgeable individuals, they become simpler to use and can enhance worker productivity. Furthermore, there exists a noteworthy and affirmative correlation between perceived usefulness and employee performance. This demonstrates that improved performance results from employees using information systems that are beneficial to them more frequently. Subsequently, there is a strong and positive correlation between employee performance and training efficacy. This demonstrates that employees perform better when they receive more effective training. Lastly, there is a strong and positive correlation between employee performance and motivation. This demonstrates that an employee's performance increases with the number of them who embrace the information system with great zeal.

The offers several useful recommendations for future researchers based on the findings of this study. These recommendations include the addition of additional variables, such as interaction style or leadership style, that are known to affect employee performance and help further researchers develop their research findings. In order to learn more about how well employees use the SAKTI application system, it is also envisaged that the interview method would be able to supplement research data collection. It is also anticipated that the study will broaden and not just concentrate on the Republic of Indonesia's Ministry of Defence.

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A Holt-Winter Approach to Forecasting Admission in the Psychiatric Department

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Abstract: Psychiatric admissions predictive modeling is a crucial step in hospital resource and service management. Prediction models are essential for medical facilities to account for patient arrival fluctuations that could potentially overextend their resources. The present study used the Holt-Winters method to forecast psychiatric admissions at Hospital Universiti Sains Malaysia (HUSM). The estimation and evaluation phases are based on historical admission data from 2017 to 2024 to extract trends, seasonal and level components. The dataset was split into training and testing phases to ensure robust model selection. Mean Absolute Scaled Error (MASE), Root Mean Squared Error (RMSE) and Mean Absolute Percent Error (MAPE) are used to compare the performance. This paper examines two forms of the Holt-Winters model: additive and multiplicative. The results reveal that the Additive Holt-Winters model consistently has the lowest error across all performance metrics. Thus, it is the best for predicting psychiatric patient admissions. The forecasting results indicate an overall increase in admissions with variations driven by seasonal factors. An accuracy assessment reveals that most predictions match actual admissions to some extent, suggesting the model is reliable. These include certain months that demonstrate standout differences, suggesting that other confounding factors may be influencing admission rates. It demonstrates the robustness of Holt-Winters' forecasting methodology in healthcare and its implications for hospital administrators seeking to improve efficiency in the deployment of resources. Future work might also focus on combining other predictive tools to improve forecast quality.

Keywords: *Admission, Forecast, Holt winter, Psychiatric, efficiency*

1. Introduction

The global COVID-19 pandemic has profoundly impacted various aspects of healthcare systems worldwide, including the mental health sector. (Yıldırım et al., 2022). Psychiatric disorders, which are influenced by both environmental and biological factors, have seen a notable rise in prevalence due to the stress, uncertainty, and isolation associated with the pandemic. Thus, understanding the trends and patterns of psychiatric admissions is crucial for effective resource allocation, policy formulation, and intervention planning (Boldrini et al., 2021; Hambleton et al., 2022; Xiang et al., 2020).

Research into psychiatric admissions has demonstrated that the pandemic triggered a surge in mental health issues, including anxiety, depression, and substance use disorders. Studies have also documented an increase in emergency department visits for mental health crises, especially during periods of lockdown and social restrictions (Dong et al., 2020; Mendez-Lopez et al., 2022; Mustikasari et al., 2022). For instance, research in various regions revealed a marked increase in admissions related to acute stress and suicidal ideation. On the other hand, some studies have paradoxically reported a decline in psychiatric admissions during the initial phases of the pandemic, potentially due to fear of contracting the virus and restricted access to healthcare facilities. While these findings underscore the profound impact of COVID-19 on mental health, they also highlight the complexities and inconsistencies in patient admission trends, warranting further investigation (Jones et al., 2021; Nearchou et al., 2020).

Despite these efforts, there remain significant gaps in understanding the long-term trends and patterns in psychiatric admissions during and after the pandemic. Previous studies have often focused on short-term observations or specific subpopulations, limiting their generalizability. Additionally, few studies have employed robust statistical forecasting methods to predict future trends, leaving healthcare planners without reliable tools for anticipating demands in psychiatric services (Herrera et al., 2023; O'Donoghue et al., 2022; Rodrigues et al., 2022). Therefore, addressing these gaps is essential for developing proactive strategies to meet the growing mental health needs of populations worldwide.

This article seeks to address these gaps by applying the Holt-Winters exponential smoothing method to analyze and forecast the number of psychiatric admissions. The research focuses on examining the temporal patterns in psychiatric admissions before and after the COVID-19 outbreak, identifying key inflection points and seasonal variations. The objectives of this study are twofold: first, to provide a comprehensive analysis of the changes in psychiatric admission trends influenced by the pandemic, and second, to develop a reliable forecast model using the Holt-Winters approach. This model, which incorporates both seasonal and trend components, offers valuable insights for healthcare policymakers and practitioners. By bridging the gap between current observations and future projections, this study contributes to advancing knowledge in psychiatric epidemiology and healthcare forecasting. Ultimately, it aims to support data-driven decision-making and enhance the capacity and preparedness of psychiatric departments to address emerging mental health challenges.

2. Literature Review

Forecasting hospital admissions, particularly in psychiatric departments, is crucial for efficient resource allocation and management. The COVID-19 pandemic has underscored the significance of accurate forecasting models for adapting to sudden changes in healthcare demand. A study examining admissions to psychiatric hospitals before and during the pandemic highlighted the effectiveness of various forecasting models, including machine learning and time-series models, in predicting admissions. The study revealed that time series models, such as exponential smoothing, were particularly adept at adjusting to the shock effects of the pandemic, outperforming simpler models like the seasonal naive forecast (Wolff et al., 2021). This underscores the need for robust forecasting methods that can handle both regular patterns and unexpected disruptions.

Forecasting hospital admissions is essential for ensuring that resources are available to meet fluctuating patient needs. The COVID-19 pandemic has further underscored the importance of accurate forecasting models that can respond to sudden and unprecedented changes in healthcare demand. Previous studies have highlighted the rise in psychiatric admissions linked to stress, anxiety, and other disorders during the pandemic, while also noting short-term declines in service use due to restricted access and fear of infection (Hay et al., 2021).

Psychiatric admissions present unique forecasting challenges, as they are influenced by clinical needs, social, cultural, and external events. During COVID-19, psychiatric hospitals experienced inconsistent patterns: some reported surges in demand, while others observed temporary declines due to access restrictions (Boldrini et al., 2021; Tarricone et al., 2023; Reece & Sams, 2022). Understanding long-term patterns beyond the pandemic requires robust forecasting techniques that integrate both trend and seasonality.

The ability to accurately forecast patient inflow can enhance resource allocation and improve patient care. Research has demonstrated that the Holt-Winters method can effectively model seasonal variations in healthcare data, allowing hospitals to prepare for fluctuations in patient numbers (Mohd Lip et al., 2020; Mahmoodpour-Azari et al., 2023). For instance, studies have demonstrated the successful application of the Holt-Winters approach in forecasting healthcare utilization, which is critical for planning staffing and resource management (Valsamis et al., 2019). Moreover, the method's ability to provide short-term forecasts makes it particularly valuable in dynamic environments such as psychiatric departments, where patient needs can change rapidly (Erişen et al., 2017; Oral, 2019). The integration of Holt-Winters with other forecasting techniques, such as artificial neural networks, has also been explored, suggesting that hybrid models may further enhance predictive accuracy (Rodriguez et al., 2016; Ortiz, 2016).

The Holt-Winters method, a classical time-series forecasting technique, has been widely used for its ability to model seasonality and trends effectively. The method incorporates three recursive processes to estimate the level, growth rate, and seasonal parameters, making it suitable for various applications, including hospital admissions (Kays et al., 2020). A study on the application of the Holt-Winters method for forecasting hospital admissions in cities like St. Petersburg demonstrated its effectiveness in rapidly changing situations, such as those caused by the COVID-19 pandemic. The study justified the use of the Holt-Winters method for its ability to adapt to dynamic processes and provide reliable forecasts (Klyapko, 2021). This adaptability is crucial for psychiatric departments, where patient admission patterns can be influenced by numerous external factors.

The Holt-Winters approach exhibits patterns of growing or decreasing trends with seasonality. There are two variations of the Holt-Winters smoothing method, depending on whether the seasonal pattern in the series is represented in an additive or multiplicative manner. According to Djakaria and Saleh (2021), they used Holt-Winters exponential smoothing to forecast the COVID-19 pandemic for a given period, with the result indicating that the pattern of COVID-19 cases in Gorontalo Province will not end anytime soon, as the model does not indicate a decreasing trend. Furthermore, Lima et al. (2019) compared the precision of Holt-Winters models (additive and multiplicative) for forecasting economic time series and also brought new perspectives about the methods used through this technique, with the five measures of evaluation calculated and discovered that the multiplicative model has high accuracy and forecast performances of the e-commerce retail sales time series of Portugal.

The Holt-Winters model, also known as triple exponential smoothing, has been widely documented in the literature and has been demonstrated to be successful in projecting energy consumption with high accuracy. (Almazrouee et al., 2020). However, Bridge et al. (2020) Used the Holt-Winters forecasting model for the same study and observed no significant change in the level or trend of suicide after the show was released for both overall and by gender. Furthermore, Rostami et al. (2019) Used the Holt-Winters' multiplicative smoothing approach to investigate the changes in monthly suicide rates in Iran's most inhabited western region, discovering a significant seasonal variation in suicide with a record high in August.

The application of Holt-Winters exponential smoothing methods in forecasting has gained significant attention across various fields, including healthcare. The Holt-Winters method, which incorporates seasonality, trend, and level, is particularly suitable for time series data that exhibit these characteristics. This method has been widely validated in the literature, demonstrating its robustness across contexts, including economic indicators, tourism, and healthcare utilization (Atoyebi et al., 2023; Mohd Lip et al., 2020). The adaptability of the Holt-Winters model allows for capturing complex seasonal patterns, which is essential for understanding patient flow in psychiatric settings where admissions may vary significantly due to seasonal factors or external events, such as public health crises (Mahmoodpour-Azari et al., 2023; Valsamis et al., 2019).

The literature suggests that the Holt-Winters method, with its ability to model seasonality and trends, is a valuable tool for forecasting admissions in psychiatric departments. Its effectiveness in adapting to sudden changes, as demonstrated during the COVID-19 pandemic, makes it particularly suitable for healthcare settings where demand can fluctuate unpredictably. By incorporating dynamic adjustments, the method can further enhance forecasting accuracy, providing psychiatric departments with the insights needed for efficient resource management and planning. As healthcare systems continue to face challenges, adopting robust forecasting models, such as the Holt-Winters method, will be essential to maintaining optimal patient care and operational efficiency. Despite its success in other sectors, Holt-Winters has not been systematically applied to psychiatric admissions in Malaysia, especially in the post-pandemic context. This study addresses this gap by demonstrating how Holt-Winters can capture both long-term upward trends and seasonal variations in psychiatric admissions, providing hospital administrators with evidence-based insights for resource allocation and planning.

3. Methodology

Data Description

Secondary data were collected from the Psychiatric Department of Hospital Universiti Sains Malaysia (HUSM) from January 2017 to December 2024. A total of 96 admissions each month were recorded. The data series had been split into estimation and evaluation sections before further work on the model could be performed. It is a common procedure to divide all available labelled data into estimation and evaluation, with a 75 % estimation and a 25 % evaluation part. The predicted values will be compared to the original values retained in the evaluation section.

Holt-Winter

The Holt-Winters method is frequently referred to as an approach to exponential smoothing. Multiplicative Seasonal Method (Multiplicative Seasonal Method), used for seasonal variation of data that has raised or reduced (fluctuation), and Additive Seasonal Methods, which are used for continuous seasonal variation, are

the two sections of this method. (Pongdatu & Putra, 2018). For a model with a linear trend and an exponential trend, the additive models are used. For data with trend and seasonality that do not get larger and larger, the Holt-Winters additive model is adequate. (Talkhi et al., 2021). Assuming that there is a multiplicative relationship between these elements, the equations are written as follows:

Additive Holt-Winters Model

The Additive Holt-Winters Model is presented in the following equations:

Level: $L_t = \alpha\left(Y_t - S_{t-s}\right) + \left(1-\alpha\right)\left(L_{t-1} + b_{t-1}\right)$, (1)

Trend: $b_t = \beta\left(L_t - L_{t-1}\right) + \left(1-\beta\right)b_{t-1}$, (2)

Seasonal: $S_t = \gamma\left(Y_t - L_t\right) + \left(1-\gamma\right)S_{t-s}$, (3)

Forecast: $F_{t+m} = L_t + b_t m + S_{t-s+m}$. (4)

The initials for Holt-Winters Additive Model are:

$L_s = \frac{1}{s}\left(Y_1 + Y_2 + \ldots.. + Y_s\right)$, (5)

$b_s = \frac{\sum\left(Y_{s+1} - Y_t\right)}{s^2}$, (6)

$S_s = Y_i - L_s$, (7)

$F_{t+1} = L_t + b_t + S_{t+1-s}$. (8)

Multiplicative Holt-Winters Model

The Multiplicative Holt-Winters Model is presented in the following equations:

Level: $L_t = \alpha\left(\frac{Y_t}{S_{t-s}}\right) + \left(1-\alpha\right)\left(L_{t-1} + b_{t-1}\right)$, (9)

Trend: $b_t = \beta\left(L_t - L_{t-1}\right) + \left(1-\beta\right)b_{t-1}$, (10)

Seasonal: $S_t = \gamma\left(\frac{Y_t}{L_t}\right) + \left(1-\gamma\right)S_{t-s}$, (11)

Forecast: $F_{t+m} = \left(L_t + b_t m\right)S_{t-s+m}$. (12)

The initials for Holt-Winters Multiplicative Model are:

$L_s = \frac{1}{s}\left(Y_1 + Y_2 + \ldots.. + Y_s\right)$, (13)

$b_s = \frac{\sum\left(Y_{s+1} - Y_t\right)}{s^2}$, (14)

$S_s = \frac{Y_i}{L_s}$, (15)

$F_{t+1} = \left(L_t + b_t\right)S_{t+1-s}$, (16)

Where denotes an estimate of the level of the series at time t, b_t denotes an estimate of the trend of the series at time t, S_t is an estimate of the seasonality at time t, and is the seasonality length, which is the number of

weeks in a year (S=52). Meanwhile, F_{t+m} is the forecast for the m time ahead and F_{t+1} is the forecast within the data set.

Model Validation

Goodness of fit is a measure of the accuracy of a forecast model compared to the actual values. Mean Absolute Scaled Error (MASE), Root Mean Squared Error (RMSE) and Mean Absolute Percent Error (MAPE) are model accuracy measurements based on the time series data used to create the model. The best model was chosen by comparing the results of the statistical test with the lowest error measures.
The model forecast accuracy was measured by the following criteria:

Mean Absolute Error (MAE): $\frac{\sum|e_t|}{n}$, (17)

Root Mean Square Error (RMSE): $\sqrt{\frac{\sum e_t^2}{n}}$, (18)

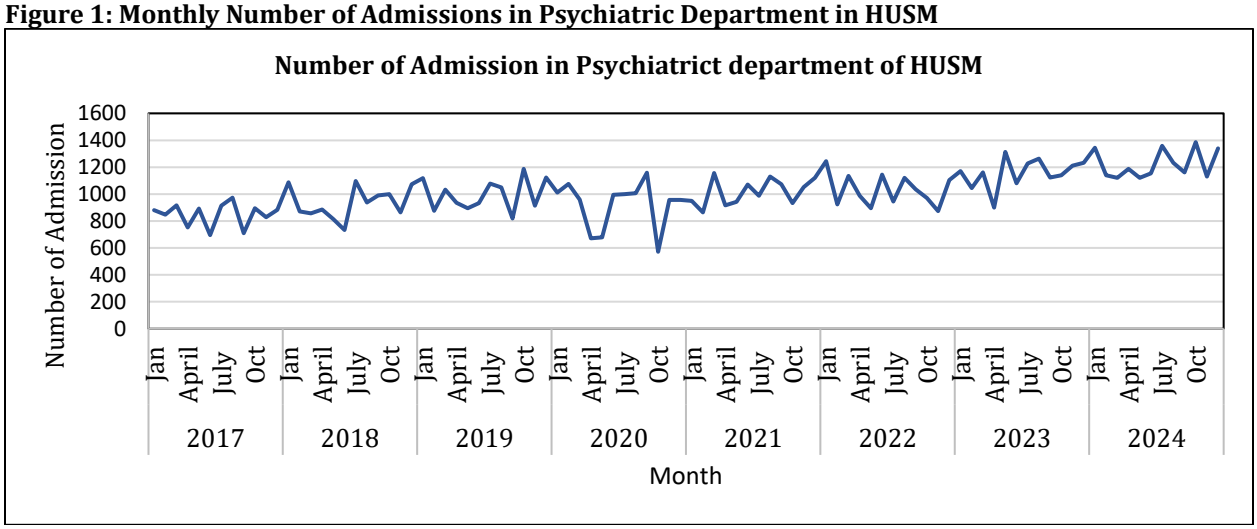
Mean Absolute Percentage Error (MAPE):
$\left(\frac{1}{n}\sum\left|\frac{e_t}{Y_t}\right|\right)(100)$, (19)

Where the forecast error is e_t, and it is calculated by subtracting the forecast value from the series' actual value, Y_t. Here n Is the number of effective observations used to match the model? Minimum values of these accuracy measures provide the best fitting models.

4. Result and Discussion

The figure illustrates the monthly number of admissions in the Psychiatric Department at HUSM from January 2017 to October 2024. The data indicates fluctuations over the years, with admissions generally increasing. Notable drops are observed around mid-2020, potentially reflecting the impact of external factors like the COVID-19 pandemic. After this period, admissions gradually rise, displaying an upward trend from 2021 onward. The highest admissions occur in 2024, suggesting a steady increase in demand for psychiatric services over time.

Figure 1: Monthly Number of Admissions in Psychiatric Department in HUSM



Data Analysis and Results Presentation

In this study, the data were divided into two parts: estimation (75%) and evaluation (25%). In the estimation part, the data selected are from January 2017 (n = 1) to December 2022 (n = 72). Data from January 2023 (n = 73) to December 2024 (n = 96) were used in the evaluation part. The data used for estimation were used to identify the level component, the trend component, and the seasonality component. The forecast values were calculated during the evaluation. R software was used to determine the best combination of α , β and γ , as outlined in Table 1.

Table 1: Measurement Errors of the Holt-Winters Model's Parameters

Model	α	β	γ
Multiplicative Holt-Winters	0.12	0	0.43
Additive Holt-Winters	0.12	0.04	0.39

Table 2: Measurement errors of the Holt-Winters Models

Model	MAE		RMSE		MAPE	
	Estimation	Evaluation	Estimation	Evaluation	Estimation	Evaluation
Multiplicative Holt-Winters	98.9864	100.9005	137.6300	137.3795	11.0508	8.2131
Additive Holt-Winters	96.7523	96.7688	134.0152	132.8561	10.8117	7.8476

The table presents measurement errors for the Multiplicative and Additive Holt-Winters models using three error metrics, MAE, RMSE, and MAPE, in both the estimation and evaluation phases. The Additive Holt-Winters model consistently produces lower errors across all metrics than the Multiplicative model. Specifically, the Additive model has lower MAE (96.7523 in estimation, 96.7688 in evaluation), RMSE (134.0152 in estimation, 132.8561 in evaluation), and MAPE (10.8117 in estimation, 7.8476 in evaluation), indicating better forecasting accuracy for psychiatric admissions. This suggests that the Additive Holt-Winters model performs better in this context, making it a preferable choice for forecasting. The predicted monthly number of attendances at HUSM's Psychiatric Department is based on data from the evaluation part in 2024, which were computed using the best model selected as summarized in Table 3.

Table 3: Predicted Number of Attendances at the Psychiatric Department of HUSM

Month	Predicted Number of Attendances	Actual Number of Attendances	Accuracy (%)
January	1561	1345	86.16
February	1384	1142	82.51
March	1526	1121	73.46
April	1372	1187	86.52
May	1334	1120	83.96
June	1488	1154	77.55
July	1461	1360	93.09
August	1562	1234	79.00
September	1496	1161	77.61
October	1412	1386	98.16
November	1431	1130	78.97
December	1575	1340	85.08

The table presents the predicted and actual attendance figures for each month, alongside the calculated accuracy percentages. Accuracy varies throughout the year, with the highest being in October (98.16%) and July

(93.09%), indicating close alignment between predictions and actual numbers. On the other hand, March recorded the lowest accuracy at 73.46%, reflecting a significant gap. Most months, including January (86.16%), April (86.52%), and December (85.08%), achieved accuracies in the mid-80% range, indicating relatively reliable predictions. However, lower accuracies were noted in June (77.55%), August (79.00%), and November (78.97%), suggesting moderate prediction discrepancies for those months. Overall, the predictions yield a reasonably high level of accuracy, with most months exceeding 75%. This suggests that the forecasting model is effective at estimating patient attendance, though some months exhibit greater deviations between predicted and actual values. The variation in accuracy indicates potential seasonal or external factors influencing psychiatric attendance.

The predicted number of psychiatric admissions at HUSM in 2025 was computed using the selected best model, as outlined in Table 3.

Table 4: Predicted number of psychiatric admissions at HUSM in 2025

Month	Predicted Number of Psychiatric Admissions
January	1581
February	1383
March	1371
April	1436
May	1372
June	1416
July	1563
August	1585
September	1461
October	1501
November	1550
December	1610

Table 4 presents the predicted number of psychiatric admissions at HUSM for the year 2025. Predictions ranged from 1,371 in March (the lowest) to 1,610 in December (the highest). The first half of the year generally yields lower predicted values, ranging from 1,371 to 1,436. In contrast, the second half of the year reflects a rise in predictions, with admissions ranging from 1,461 in September to a peak of 1,610 in December. This indicates a gradual increase in predicted psychiatric admissions as the year progresses, with a noticeable surge toward the end of the year.

5. Conclusion and Recommendations

The analysis of psychiatric admissions at HUSM between 2017 and 2024 highlights a general increase in patient numbers, with notable fluctuations observed over the years. A sharp decline in mid-2020 corresponds with a period of significant global disruptions, which may have influenced hospital attendance. However, an upward trajectory is evident from 2021 onwards, culminating in the highest recorded admissions in 2024. To better understand and predict future trends, forecasting techniques were applied, with the Holt-Winters model used to generate estimates. Two variations of the model were assessed, and performance was measured through MAE, RMSE, and MAPE. The Additive Holt-Winters model demonstrated superior predictive capability compared to its Multiplicative counterpart, as indicated by consistently lower error values across all assessment metrics. Monthly forecasts for 2024 were compared with actual data, revealing generally high prediction accuracy, particularly in October and July, which recorded alignment rates of 98.16% and 93.09%, respectively. Conversely, March exhibited the lowest accuracy at 73.46%, highlighting possible seasonal influences or external factors affecting patient attendance. Despite variations, most months presented prediction accuracy exceeding 75%, indicating the forecasting approach is largely effective. Using the most reliable model, psychiatric admissions for 2025 were projected, revealing a gradual increase over the year. The lowest expected admission rate is in March (1,371), while the highest is in December (1,610), suggesting an upward trend as the year progresses. The first half of the year maintains relatively stable figures. In contrast, the latter months exhibit a notable rise, potentially signalling an increase in demand for psychiatric services toward the year's end. These findings reinforce the growing need for psychiatric care and the importance of

accurate forecasting methods in resource planning and hospital management. While the predictive model provides valuable insights, some discrepancies suggest that further refinement could enhance reliability. At the same time, factors such as seasonal trends, external events, and institutional policies may influence patient numbers, and incorporating these variables into future models could improve forecast accuracy. The continuous rise in psychiatric admissions underscores the necessity for ongoing capacity expansion, staffing considerations, and policy adjustments to accommodate increasing patient needs effectively.

In conclusion, applying a Holt-Winters approach to forecast admissions in the psychiatric department of HUSM offers a promising avenue for enhancing operational efficiency and patient care. The method's established efficacy across multiple domains, coupled with ongoing advances in its optimization, underscores its potential utility for healthcare forecasting. By leveraging the strengths of the Holt-Winters model, HUSM can better anticipate patient admissions, ultimately leading to improved resource management and patient outcomes. Therefore, future research should focus on validating these forecasting models within the specific context of psychiatric care, exploring the integration of additional variables that may influence patient flow, and assessing the impact of accurate forecasting on clinical operations. (Ponziani, 2021; Fauzi et al., 2020).

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Impacts of Social Network Characteristics on Digital Seizing Capabilities and Sustainable Performance: Evidence from Advanced Manufacturing Clusters in China

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Abstract: This study investigates how social network relational characteristics (SNRC) and structural characteristics (SNSC) influence sustainable performance (SP) in China's advanced manufacturing clusters, with particular attention to the mediating role of digital seizing capability (DSZC). Drawing on Social Network Theory and Dynamic Capabilities Theory, SP is conceptualized as a second-order construct that integrates economic, environmental, and social performance. Using survey data from 236 firms across eight national-level clusters, the analysis was conducted through Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings demonstrate that SNRC significantly improves SP both directly and indirectly through DSZC. At the same time, SNSC affects SP only indirectly, underscoring the central role of DSZC in transforming network advantages into sustainability outcomes. These results extend theoretical insights by linking social networks and dynamic capabilities to sustainable competitiveness, though the reliance on data from a limited number of Chinese clusters may restrict broader generalization. The study contributes by offering new evidence on the mechanisms through which inter-firm networks foster digital-enabled sustainability, providing practical guidance for managers and policymakers in the Industry 4.0 era.

Keywords: *Social network characteristics; digital seizing capability; sustainable performance; advanced manufacturing clusters*

1. Introduction

China's advanced manufacturing clusters (AMCs), despite their industrial scale and technological sophistication, face persistent challenges in achieving sustainable performance. High-profile examples, such as Suzhou's high-end scientific instruments cluster, reveal a disconnection between industrial growth and ecological sustainability, with energy-intensive processes driving significant carbon emissions and resource depletion (Elaouzy & El Fadar, 2024; Mendrela et al., 2024). Many firms, particularly small and medium-sized enterprises (SMEs), struggle to meet stringent green certification requirements due to fragmented knowledge sharing and limited access to sustainable technologies. These challenges are compounded by global supply chain disruptions and rising environmental, social, and governance (ESG) demands, placing additional operational pressures on cluster members.

Institutional and structural factors exacerbate these issues. High pollution control costs disproportionately burden SMEs, while rigid administrative mandates often discourage market-driven collaborations and underutilize self-organized networks for resource sharing and green technology diffusion (Zheng & Zhang, 2023). Moreover, a core–periphery paradox persists, with core firms monopolizing green resources and externalizing environmental costs to peripheral actors, as seen in new energy vehicle clusters, 2023. Homogeneous competition and price wars further hinder sustainability, leading to redundant investments, weakened corporate social responsibility, and energy consumption per GDP unit above global benchmarks.

While prior research has examined network structures and innovation within clusters, little is known about how relational dimensions of inter-firm networks—rather than structural ones—drive capability development that supports sustainability outcomes (Henao et al., 2019; Napoli, 2023). In the context of digital transformation, digital seizing capability is increasingly recognized as a critical dynamic capability for translating network-derived knowledge into sustainable performance gains (Heredia et al., 2022; Kump et al., 2018). By integrating Social Network Theory and Dynamic Capabilities Theory, this study addresses this gap by investigating how SNRC influences SP through DSZC in China's AMCs, providing both theoretical insights and practical guidance for advancing sustainability in highly interconnected industrial ecosystems.

2. Literature Review and Hypothesis Development

Theoretical Background: Theoretical Framework Integration

This study develops an integrated framework combining social network theory and dynamic capability theory to elucidate how firms utilize network advantages to attain sustainable performance. Social network theory emphasizes the ability of enterprises to access critical resources embedded in external networks (Granovetter, 1983; Granovetter, 1973), whereas dynamic capability theory explains how firms internally reconfigure such resources—through processes of sensing, seizing, and transforming—to adapt to environmental shifts and generate value (Teece, 2007; Teece et al., 1997). In the proposed model, network characteristics act as "inputs", sustainable performance represents the "outputs", and digital capture capability—the pivotal manifestation of dynamic capability in the digital era—constitutes the central "black box" mechanism that translates inputs into outputs.

Social Network Characteristics

Literature commonly categorizes social network characteristics into two dimensions: structural and relational. The structural dimension refers to the overall architecture of the network and the position of a firm within it, including attributes such as centrality, structural holes, and network size (Borgatti et al., 2009). These features determine the diversity and novelty of information and resources accessible to the firm. For instance, centrally positioned enterprises tend to acquire information more rapidly, while those with extensive and diverse partnerships are more likely to obtain heterogeneous knowledge. The relational dimension, in contrast, pertains to the quality of ties developed through ongoing interactions, exemplified by trust, reciprocity, and tie strength (Granovetter, 1973). These characteristics influence the actual acquisition and utilization of resources, particularly in terms of depth and reliability. Strong trust-based relationships, for example, facilitate the sharing of tacit knowledge and enhance joint problem-solving capacity, while also reducing transaction costs (Uzzi, 1997).

Despite extensive evidence supporting the positive influence of network characteristics on innovation and general firm performance (Chen et al., 2024; Landherr et al., 2010; Yin & Shi, 2019)Their specific mechanisms for driving sustainable performance—particularly across the economic, environmental, and social dimensions of the triple bottom line—remain inadequately understood. Many studies focus exclusively on either structural or relational aspects, lacking an integrative view. More importantly, in the evolving context shaped by digitalization and sustainability imperatives, the critical capability processes that connect network attributes to sustainable outcomes remain underexplored.

Sustainable Performance

Sustainable performance has emerged as a central paradigm in modern corporate strategic management. It transcends traditional financial metrics by emphasizing the simultaneous pursuit of economic prosperity, the minimization of environmental impact, and proactive social responsibility—conceptualized as the triple bottom line.(Elkington, 1998). Within the context of manufacturing clusters, this translates into specific outcomes: economic performance, environmental performance and social performance. Achieving this integrated objective necessitates fundamental process and product innovation, which is highly dependent on both the acquisition of external knowledge and the reconfiguration of internal capabilities (Paulraj, 2011). Existing research on the antecedents of sustainable performance has primarily focused on three key dimensions: technological, organizational, and governmental regulatory factors.

Regarding technological factors, the correlation between technological innovation and sustainable performance has become a prominent research stream. Studies indicate that artificial intelligence techniques can enhance the enduring quality of financial reports (Gshayish & Faik, 2023), while big data analytics (BDA) is considered a main pillar of sustainable manufacturing. The effectiveness of BDA is heavily dependent on data accessibility and directly impacts a firm's sustainable competitive advantage (Baig et al., 2023; Ikumapayi et al., 2023). Furthermore, green innovation has been demonstrated to significantly correlate with overall business sustainability (Anaya & Qutaishat, 2022). Concerning organizational factors, internal practices such as corporate governance, human resource management, and supply chain management are crucial. Organizational and production knowledge management are regarded among the most powerful instruments for enhancing sustainable organizational performance (Sun et al., 2023). Resource management capabilities have been found

to partially mediate the relationship between dynamic sustainability capabilities and corporate environmental and social performance (Shang et al., 2020). Concurrently, continuous learning, both within and between organizations, is a critical strategic factor for successfully implementing sustainable management and maintaining future competitiveness (Oelze et al., 2016). Collaboration and coordination within supply chains have also been shown to significantly affect sustainable supply chain performance (Nayal et al., 2022). In terms of government regulation, public policies and schemes are widely recognized as accelerators for corporate economic growth and sustainable transformation. Research highlights that regulatory instruments, such as industrial land policies, exert differential effects on regional industrial land green use efficiency (Xie et al., 2016) and are identified as key drivers for the financial, social, and environmental performance of manufacturing SMEs (Lopes De Sousa Jabbour et al., 2020). However, academic consensus on this is not uniform. Some studies found that cost implications were the most significant factor influencing the implementation of sustainable manufacturing, with government regulations perceived as having the least impact (Xu et al., 2024), indicating the context-dependent nature of policy effectiveness.

Despite these valuable insights, a critical perspective remains relatively underexplored: the mechanism linking social network characteristics to corporate sustainable performance. Although the benefits of social networks are widely acknowledged, research explicitly connecting them to sustainable development remains nascent. A few pioneering studies have begun to explore this intersection. For instance, Abbas et al. (2019) were among the first to empirically investigate the relationship between entrepreneurial business networks and the sustainable performance of small firms, identifying dynamic capabilities as a mediating factor. Similarly, Li et al. (2013) assessed the impacts of network structural and relational characteristics on performance, including their moderating effects on spatial relationships. These studies suggest that mechanisms such as collaboration, information sharing, mutual trust, communication, and commitment within networks are vital for performance enhancement. Nevertheless, significant limitations persist in the extant literature. Most studies focus exclusively on either the structural or the relational dimension of networks, lacking an integrated theoretical perspective. More importantly, within the dual context of digitalization and sustainability, the key capability processes (i.e., the mediating 'black box') that connect network attributes to sustainable outcomes remain inadequately theorized and investigated. Therefore, a deeper inquiry into how the structural and relational characteristics of social networks influence a firm's economic, environmental, and social performance through specific dynamic capabilities (such as digital capture capability) is essential to address this theoretical gap.

Digital Seizing Capabilities

Rooted in dynamic capability theory, “seizing” refers to the organizational processes through which a firm mobilizes, invests, and reconfigures resources in response to perceived opportunities (Teece, 2007). In the context of Industry 4.0, this notion evolves into what we define as digital seizing capability—the ability of an enterprise to evaluate, integrate, and deploy digital technologies and data resources to seize value-creating opportunities (Kump et al., 2018; Warner, 2018). This capability encompasses activities such as collecting data from external partners, translating digital solutions into concrete projects or operational processes, and coordinating cross-departmental resources to enable rapid implementation.

The theoretical connection proposed here addresses a significant gap in the current literature. While numerous studies have directly examined the relationship between "social network characteristics" and "digital capabilities," few have considered digital seizing capability as the essential mediating pathway. Social networks supply the critical "raw materials"—such as novel information and knowledge—necessary for innovation. Digital seizing capability, in turn, acts as the "production line" that processes and transforms these inputs into tangible value. Without such an internal capacity, even the highest-quality external resources cannot be effectively converted into sustainable outcomes. It is precisely this theoretical and mechanistic gap that the present study seeks to fill.

Review of Key Concepts and Hypothesis Development

Social Network Characteristics and Sustainable Performance: Social network relational characteristics encompass the trust, frequency of interaction, and stability of relationships between firms and their network partners. In high-quality relational contexts, firms benefit from stronger commitments, more open communication, and the willingness to share critical knowledge, which together foster mutual growth and innovation (Grant, 1996; Tallman et al., 2004). These relational conditions reduce transaction costs, enhance

problem-solving efficiency, and create fertile ground for adopting sustainable practices such as green technology implementation, cleaner production processes, and resource optimization.

Within the triple bottom line framework—covering economic, environmental, and social performance—robust relational ties have been linked to cost savings, improved return on investment, reduced emissions, greater resource efficiency, enhanced workplace safety, and stronger community engagement (Liu et al., 2018; Paulraj, 2011). In advanced manufacturing clusters, these benefits are amplified through collaborative projects and shared technological platforms that align industrial competitiveness with sustainability goals.
H1: Social network relational characteristics (SNRC) have a positive effect on sustainable performance (SP).
H2: Social network structural characteristics (SNSC) have a positive effect on sustainable performance (SP).

Social Network Characteristics and Digital Seizing Capability
Digital seizing capability refers to the ability to mobilize resources and implement solutions after identifying promising opportunities (Kump et al., 2018). Firms embedded in strong relational networks are better positioned to engage in deep, (Bhatti et al., 2024; Vo Thai et al., 2024). Trust-based exchanges that yield valuable tacit knowledge and technical insight. Such relational contexts promote secure data sharing, foster collaborative innovation, and accelerate the adoption of advanced digital tools such as IoT platforms and big data analytics.
By providing timely access to external expertise and collaborative partners, a strong SNRC can enhance a firm's agility in seizing emerging digital opportunities. This, in turn, allows for faster integration of new technologies into operations, improving competitiveness and enabling more responsive sustainability strategies.
H3: Social network relational characteristics (SNRC) have a positive effect on digital seizing capability (DSZC).
H4: Social network structural characteristics (SNSC) have a positive effect on digital seizing capability (DSZC).

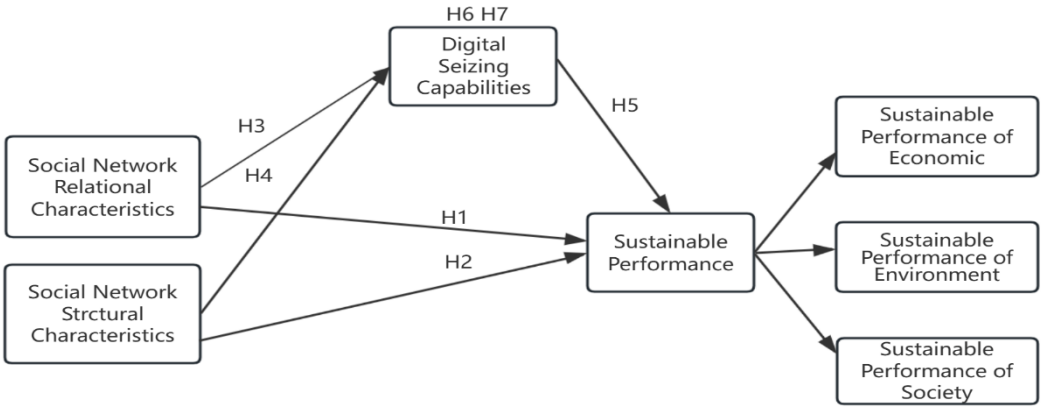
Digital Seizing Capability and Sustainable Performance
Digital seizing capability empowers firms to transform identified opportunities into tangible outcomes such as process innovations, product advancements, and improved service delivery (Frishammar et al., 2018). In the sustainability domain, this capability facilitates the adoption of low-carbon technologies, the optimization of energy consumption, and enhanced supply chain transparency (Lopes De Sousa Jabbour et al., 2020). By efficiently integrating external resources and aligning them with sustainability objectives, firms can realize significant improvements in economic, environmental, and social performance.

In advanced manufacturing clusters, DSZC plays a crucial role in bridging the gap between technological potential and practical application, ensuring that digital investments directly contribute to sustainability goals.
H5: Digital seizing capability (DSZC) has a positive effect on sustainable performance (SP).

The Mediating Role of Digital Seizing Capability
While social network relational characteristics (SNRC)may exert a direct influence on SP, a substantial portion of this relationship is mediated through capability development (Pinho & Prange, 2016). Relational characteristics provide the foundational access to high-quality external knowledge, trusted partnerships, and collaborative opportunities. DSZC serves as the conversion mechanism that transforms these relational resources into measurable sustainability achievements.

When firms excel in evaluating, integrating, and acting upon knowledge from their networks, they are better equipped to implement sustainability-focused innovations, enhance resource efficiency, and strengthen social responsibility initiatives. This positions DSZC as a key mediator linking relational networks to sustainable performance outcomes.
H6: Digital seizing capability (DSZC) positively mediates the relationship between social network relational characteristics (SNRC) and sustainable performance (SP).
H7: Digital seizing capability (DSZC) positively mediates the relationship between social network structural characteristics (SNSC) and sustainable performance (SP).

Figure 1: Proposed Model With All the Hypotheses



Source： Authors' own elaboration

3. Research method

Sample Characteristics

The target population for this study comprised all enterprises operating within the 80 national-level advanced manufacturing clusters in China, as designated by the Ministry of Industry and Information Technology (MIIT) in 2022 and 2024. These clusters represent strategic emerging industries, including new-generation information technology, high-end equipment, biomedicine, and new energy. Due to the diversity and scale of the population, a combination of stratified and purposive sampling techniques was employed to ensure representation of different cluster characteristics relevant to the research objectives. Eight clusters were selected from the 80 national-level clusters based on industry representativeness, geographical distribution, and accessibility for data collection, as shown in Table 1.

Table 1: Sampling Clusters List

Type of Industry Clusters	Total Number	Selected Number	Sampling Clusters List
New Generation IT and High-end Equipment	16	2	Beijing-Tianjin-Hebei Integrated Circuit Cluster; Beijing-Tianjin-Hebei New-Generation Information Technology Application and Innovation Cluster
High-end Equipment	29	2	Beijing-Tianjin-Hebei Safety and Emergency Equipment Cluster; Harbin Aviation Cluster
Biomedicine and High-end Medical Devices	7	1	Beijing-Tianjin-Hebei Life and Health Cluster
Consumer Goods	6	1	Foshan Dongguan Pan-Home Furnishings Cluster
New Energy and Intelligent Connected Vehicles	5	1	Beijing-Tianjin-Hebei Intelligent Connected New Energy Vehicle Cluster
Photovoltaics	2	1	Yancheng Suhuai Photovoltaics Cluster

Source: Authors' own elaboration based on MIIT (2024).

Within each selected cluster, a designated key contact person facilitated data collection by distributing 30 questionnaires to firms meeting the inclusion criteria: active engagement in manufacturing activities within the cluster and respondents possessing relevant managerial or operational experience. This approach was chosen

for three main reasons. First, purposive sampling is well-suited for specialized research contexts where access to qualified respondents is restricted (Etikan, 2016). Second, stratification ensured that a variety of industrial sectors and regional contexts were represented, thereby enhancing the diversity and contextual relevance of the collected data. Third, the involvement of key contacts improved the response rate and data quality.

Out of 240 distributed questionnaires, 236 valid responses were obtained, yielding a response rate of 98%. While purposive sampling may limit the statistical generalizability of the findings, it is considered appropriate for theory-testing research in specialized industrial settings. Ensuring that all respondents were knowledgeable and directly involved in cluster-related activities increased the accuracy and contextual validity of the collected data.

The demographic profile of respondents is presented in Table 2. The respondent pool was nearly balanced by gender (49.6% male, 50.4% female) and largely composed of young to middle-aged professionals, with 48.3% aged between 25 and 35. Educational attainment was high, with 61% holding a Bachelor's degree, and 75.8% holding a Bachelor's degree or higher. Most respondents occupied middle management positions (77.5%), followed by top management (14.8%) and CEOs/MDs (7.6%).

The sample was dominated by small and medium-sized enterprises (SMEs), with 74.6% of firms employing between 21 and 299 people, and over 60% having been established for between 1 and 10 years. The industry representation included new-generation information technology, high-end equipment, and new energy, ensuring the generalizability of the study's findings within the advanced manufacturing cluster context. Notably, 95.8% of leaders reported prior experience with digital projects, and 97.9% indicated a high level of attention to digitalization and sustainability, providing a robust foundation for analyzing the relationships proposed in this research.

Measures

The questionnaire was designed based on existing literature (Appendix A). Social Network Relational Characteristics (SNRC) and Social Network Structural Characteristics (SNSC) were measured using adapted scales from established instruments in prior studies (Chen et al., 2024; Shi et al., 2019). SNRC was conceptualized through three key dimensions: tie strength, tie quality, and tie stability (including network breadth). To enhance contextual relevance to Chinese advanced manufacturing clusters and reduce redundancy, conceptually overlapping items from the original scales were consolidated, and wording was simplified for clarity. For example, two separate items assessing tie stability and network breadth were merged into a single statement, and reverse-coded items were rephrased positively to minimize potential response bias. The final adapted SNRC scale consisted of four items, each rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Reliability and validity analyses confirmed that the adapted instrument maintained satisfactory measurement quality.

Digital Seizing Capability (DSZC) was measured using an adapted scale based on prior works (Kump et al., 2018; Warner, 2018). The construct reflects a firm's ability to mobilize resources and implement solutions to capture identified opportunities in a digital context. In the setting of advanced manufacturing clusters, the adapted items emphasize concrete actions such as collecting and integrating data from external partners, extracting valuable information for internal analysis, and establishing cross-departmental data sharing mechanisms to ensure timely access to operational information. The final scale consisted of four items, each rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Reliability and validity tests confirmed that the adapted scale achieved satisfactory measurement quality.

Sustainable Performance (SP) was operationalized as a second-order reflective construct comprising three first-order dimensions: economic performance, environmental performance, and social performance, following the triple bottom line framework(Carter & Rogers, n.d.; Paulraj, 2011). Economic performance items capture improvements in financial efficiency and competitiveness, such as reductions in material and energy costs and increased returns on investment. Environmental performance items assess reductions in emissions, resource usage, and environmental incidents, as well as improvements in energy efficiency. Social performance items measure enhancements in stakeholder welfare, occupational health and safety, community engagement, and environmental awareness among partners. The adapted scale consisted of 15 items—five for each dimension—measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). All three dimensions

demonstrated satisfactory reliability and validity, and the second-order model structure was supported by confirmatory analysis.

Data Analysis

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4.0. PLS-SEM was selected to analyze data (Peng and Lai, 2012).

Measurement model

The reliability and validity of the measurement model were assessed following established criteria (Fornell & Larcker, 1981)As shown in Table 4, all constructs exhibited strong internal consistency reliability, with Cronbach's alpha (α) values ranging from 0.882 (SNRC) to 0.973 (SP), all exceeding the recommended threshold of 0.70. Composite reliability (CR) values ranged from 0.918 to 0.975, well above the 0.80 benchmark, indicating high internal consistency.

Convergent validity was evaluated using outer loadings, composite reliability, and average variance extracted (AVE). The average outer loading values for each construct were 0.859 (SNRC), 0.876 (SNSC), 0.877 (DSZC), 0.9168 (SPEC), 0.9002 (SPEN), and 0.8976 (SPSO), all well above the minimum threshold of 0.50 and significant at $p < 0.001$. AVE values ranged from 0.724 to 0.841, surpassing the 0.50 criterion, thereby confirming satisfactory convergent validity.

4. Results and Discussion

Table 4: Results of Reflective Measurement Model

First Order Construct	Type	No of Items	Item Description	Outer Loadings	AVE	CR	Cronbach's alpha (α)
SNRC	Reflective	4	SNRC1	0.857	0.738	0.918	0.882
			SNRC2	0.852			
			SNRC3	0.856			
			SNRC4	0.871			
SNSC	Reflective	5	SNSC1	0.906	0.768	0.943	0.925
			SNSC2	0.892			
			SNSC3	0.857			
			SNSC4	0.853			
			SNSC5	0.874			
DSZC	Reflective	4	DSZC1	0.887	0.77	0.93	0.9
			DSZC2	0.878			
			DSZC3	0.847			
			DSZC4	0.897			
SPEN	Reflective	5	SPEN1	0.9	0.81	0.955	0.941
			SPEN2	0.901			
			SPEN3	0.892			
			SPEN4	0.895			
			SPEN5	0.913			
SPSO	Reflective	5	SPSO1	0.922	0.806	0.954	0.94
			SPSO2	0.888			
			SPSO3	0.879			
			SPSO4	0.879			
			SPSO5	0.918			
SPEC	Reflective	5	SPEC1	0.932	0.841	0.964	0.953
			SPEC2	0.915			
			SPEC3	0.892			

SPEC4	0.911
SPEC5	0.934

Discriminant validity was evaluated using the Fornell–Larcker criterion, cross-loadings, and the heterotrait–monotrait ratio (HTMT). As shown in Table 5, the square root of AVE for each construct (diagonal values) was greater than the corresponding inter-construct correlations, satisfying the Fornell–Larcker criterion. Cross-loading results indicated that all indicators loaded highest on their associated constructs compared to other constructs, with no severe cross-loadings, further supporting discriminant validity.

Table 5: Fornell-Larcker criterion

	DSZC	**SNRC**	**SNSC**	**SP**	**SPEC**	**SPEN**	**SPSO**
DSZC	0.877						
SNRC	0.468	0.859					
SNSC	0.402	0.403	0.877				
SP	0.565	0.581	0.356	0.851			
SPEC	0.499	0.521	0.363	0.938	0.917		
SPEN	0.518	0.525	0.306	0.939	0.818	0.9	
SPSO	0.577	0.592	0.333	0.943	0.825	0.834	0.898

The HTMT values (Table 6) between first-order constructs were below the conservative threshold of 0.85 and the more lenient threshold of 0.90, indicating adequate discriminant validity. For the second-order construct Sustainable Performance (SP), the HTMT values with its three first-order reflective dimensions—economic performance (SPEC), environmental performance (SPEN), and social performance (SPSO)—were 0.974, 0.982, and 0.986, respectively. These elevated values are theoretically expected, as the three dimensions are reflective indicators of the same higher-order construct and thus share substantial variance. Such high interrelations do not indicate a lack of discriminant validity but rather confirm the conceptual and empirical coherence of the SP construct in a reflective–reflective higher-order model (Hair & Sarstedt, 2019).

Table 6 : Results of Discriminant Validity-HTMT

	DSZC	SNRC	SNSC	SP	SPEC	SPEN	SPSO
DSZC	1						
SNRC	0.523	1					
SNSC	0.437	0.447	1				
SP	0.603	0.626	0.372	1			
SPEC	0.539	0.568	0.384	0.974	1		
SPEN	0.562	0.575	0.326	0.982	0.863	1	
SPSO	0.627	0.65	0.354	0.986	0.871	0.887	1

Overall, the combined evidence from Fornell–Larcker, cross-loadings, and HTMT assessments confirmed that the measurement model demonstrated satisfactory reliability, convergent validity, and discriminant validity.

Structural model

The structural model was evaluated by examining multicollinearity, coefficient of determination (R^2), effect sizes (f^2), and predictive relevance (Q^2). First, collinearity was assessed using the variance inflation factor (VIF). As shown in Table X, all VIF values ranged from 1.000 to 1.378, far below the threshold of 5.0, indicating no multicollinearity concerns(Khan et al., 2021; Peng & Lai, 2012).

Table 7: Collinearity Statistics (VIF) – Inner Model

Path	VIF
DSZC → SP	1.376
SNRC → DSZC	1.194
SNRC → SP	1.378
SNSC → DSZC	1.194
SNSC → SP	1.283
SP → SPEC	1
SP → SPEN	1
SP → SPSO	1

The explanatory power of the model was evaluated using R^2 values. The R^2 for DSZC was 0.273, indicating that 27.3% of the variance in DSZC is explained by SNRC and SNSC. The R^2 for SP was 0.450, showing that 45.0% of the variance in SP is explained by DSZC, SNRC, and SNSC. The three first-order dimensions of SP (SPEC, SPEN, and SPSO) exhibited high R^2 values of 0.880, 0.882, and 0.889, respectively, indicating strong explanatory power for these dimensions. Third, the f^2 statistic was used to assess the effect size of each exogenous construct on endogenous constructs (Cohen, 1998). The results show that SNRC (f^2 = 0.201) and DSZC (f^2 = 0.173) have medium effects on SP, while SNSC has a negligible effect on SP (f^2 = 0.004). The effects of SP on its three first-order dimensions (SPEC, SPEN, SPSO) are extremely large (f^2 > 7.0), which is expected for a reflective–reflective higher-order construct. Finally, predictive relevance was assessed using the Stone–Geisser Q^2 test via the blindfolding procedure(Hair, 2020). All Q^2 values for endogenous constructs were greater than zero, indicating good predictive relevance. Specifically, Q^2 was 0.207 for DSZC, 0.321 for SP, and above 0.70 for SPEC, SPEN, and SPSO, suggesting that the model has strong predictive accuracy for both the higher-order and first-order constructs (Khan et al., 2021; Peng & Lai, 2012).

Table 8: Predictive relevance

Construct	R^2	Q^2
DSZC	0.273	0.207
SP	0.45	0.321
SPEC	0.88	0.735
SPEN	0.882	0.71
SPSO	0.889	0.712

Table 9: The f-square values

Path	f^2	Effect Size Interpretation
DSZC → SP	0.173	Medium
SNRC → DSZC	0.154	Medium
SNRC → SP	0.201	Medium
SNSC → DSZC	0.075	Small
SNSC → SP	0.004	Negligible
SP → SPEC	7.321	Very Large (expected)
SP → SPEN	7.507	Very Large (expected)
SP → SPSO	7.987	Very Large (expected)

Hypothesis Testing

We used the bootstrapping procedure (n = 5000) in Smart PLS to examine both the direct and mediating effects in the proposed model (Table 10). The results indicate that Digital Seizing Capability (DSZC) exerts a significant positive effect on Sustainable Performance (SP) (β = 0.361, $p < 0.001$), supporting H5. Social Network Relational Characteristics (SNRC) significantly influence DSZC (β = 0.365, $p < 0.001$) and SP (β = 0.390, $p < 0.001$), confirming H1 and H3. Social Network Structural Characteristics (SNSC) significantly affect DSZC (β = 0.255, p

< 0.001), supporting H4; however, its direct effect on SP is not significant (β = 0.053, p = 0.382), thus H2 is not supported. For the second-order construct SP, the three reflective dimensions—Economic Performance (SPEC), Environmental Performance (SPEN), and Social Performance (SPSO)—are all strongly predicted by SP (β = 0.938, 0.939, and 0.943, respectively; all p < 0.001).

Regarding mediation effects, DSZC significantly mediates the relationship between SNRC and SP (β = 0.490–0.492, all p < 0.001) as well as between SNSC and SP (β = 0.136–0.137, p < 0.05), supporting H6 and H7. Specifically, DSZC indirectly influences SPEC (β = 0.339, p < 0.001), SPEN (β = 0.340, p < 0.001), and SPSO (β = 0.341, p < 0.001) through SP. The indirect effects from SNSC to the three sustainability dimensions via DSZC and SP are smaller but still significant (β ≈ 0.136–0.137, p < 0.05).

The total effects analysis shows that SNRC has the strongest influence on SP (β = 0.522, p < 0.001), followed by DSZC (β = 0.361, p < 0.001) and SNSC (β = 0.145, p < 0.05). These results emphasize that relational network characteristics play a more substantial role than structural ones in enhancing DSZC, which in turn promotes sustainable performance in advanced manufacturing clusters.

Table 10: Path Coefficients and Hypotheses Testing of the Mediating Relationship

Path	β (Original Sample)	t-value	p-value	Significance
SNRC → DSZC	0.365	4.983	0	***
SNSC → DSZC	0.255	3.665	0	***
DSZC → SP	0.361	4.549	0	***
SNRC → SP	0.39	5.56	0	***
SNSC → SP	0.053	0.875	0.382	n.s.
SNSC -> DSZC -> SP	0.092	2.731	0.006	***
SNRC -> DSZC -> SP	0.132	3.188	0.001	***

Discussion

This study set out to examine the mechanisms through which Social Network Relational Characteristics (SNRC) and Social Network Structural Characteristics (SNSC) influence Sustainable Performance (SP) in the context of Chinese advanced manufacturing clusters, with a particular focus on the mediating role of Digital Seizing Capability (DSZC). Drawing upon Social Network Theory and Dynamic Capabilities Theory, the findings provide several noteworthy theoretical and practical implications.

First, the results confirm that SNRC exerts a significant positive effect on both DSZC and SP, supporting the notion that strong, trust-based, and stable relationships in enterprise networks facilitate the transfer of high-quality information, knowledge sharing, and collaborative innovation (Borgatti et al., 2009; Nahapiet & Ghoshal, 1998). These findings are consistent with prior studies showing that relational embeddedness can directly enhance organizational performance by fostering mutual trust and reducing transaction costs (Granovetter, 1973). Moreover, the significant indirect effect of SNRC on SP via DSZC highlights that such relational advantages are further amplified when firms are able to effectively capture and exploit digital opportunities, in line with the seizing dimension of dynamic capabilities (Teece, 2007).

Second, contrary to initial expectations, SNSC does not have a direct significant effect on SP. This suggests that simply occupying a central position in the network or maintaining a large number of diverse partners may not directly translate into improved sustainability outcomes. One possible explanation is that structural advantages, such as network centrality and network size, represent potential rather than realized resources. Without the capability to process, interpret, and utilize information from multiple network ties, these structural positions may not automatically lead to performance gains. This aligns with the argument in dynamic capabilities literature that sensing opportunities alone is insufficient—firms must possess the capabilities to seize them (Kump et al., 2018).

However, SNSC significantly influences SP through DSZC, indicating that DSZC acts as a strong mediator in this relationship. This finding underscores the transformational role of digital capabilities: firms with greater

structural network advantages can leverage DSZC to integrate and exploit information from diverse sources, transforming structural potential into tangible sustainability outcomes. The strength of this mediating pathway suggests that DSZC is not merely a complementary capability but a critical mechanism that unlocks the value embedded in network structures.

Third, the magnitude of effects indicates that SNRC exerts the strongest total influence on SP, followed by DSZC and SNSC. This pattern implies that relational quality still forms the foundation of effective collaboration and knowledge flow, while structural positions play a more enabling role contingent on the firm's ability to seize opportunities digitally. This nuanced insight extends previous social network research by highlighting that in the digital transformation era, the benefits of network structures are conditional upon the development of advanced digital capabilities.

From a managerial perspective, these results suggest that firms should not only focus on expanding their network size or improving their centrality but should also invest in developing DSZC to transform these structural advantages into sustainable performance gains. For firms already possessing strong relational networks, strengthening digital seizing processes—such as data integration, cross-departmental sharing, and real-time analytics—can magnify the direct positive effects on sustainability outcomes.

5. Conclusion

This study investigated how Social Network Relational Characteristics (SNRC) and Social Network Structural Characteristics (SNSC) influence Sustainable Performance (SP) in Chinese advanced manufacturing clusters, emphasizing the mediating role of Digital Seizing Capability (DSZC). Drawing on Social Network Theory and Dynamic Capabilities Theory, we developed and tested a research model using survey data collected from eight advanced manufacturing clusters across China. The findings provide several important insights.

First, the results show that SNRC positively and directly affects SP and also enhances DSZC, which in turn further contributes to SP. This confirms that trust-based, high-quality, and stable inter-firm relationships play a critical role in facilitating the transfer of valuable knowledge and resources that improve economic, environmental, and social performance outcomes.

Second, SNSC does not directly affect SP, but it significantly influences SP through DSZC. This highlights the contingent nature of structural network advantages: occupying a central network position and maintaining a broad partner base provide access to diverse information, but without the ability to seize and apply this information digitally, such structural advantages may remain unrealized.

Third, the mediating analysis underscores the pivotal role of DSZC in transforming both relational and structural network advantages into tangible sustainability outcomes. The strength of the mediation effect for SNSC indicates that digital capability is a necessary condition for converting structural potential into performance gains.

From a theoretical perspective, this research integrates network theory and dynamic capabilities by demonstrating how different dimensions of social network characteristics interact with digital capability to shape sustainability performance. From a managerial standpoint, the findings emphasize that firms should not only cultivate strong relational ties but also invest in digital capabilities to fully leverage both relational and structural network advantages.

Overall, this study provides a nuanced understanding of the pathways linking social network characteristics and sustainable performance in digitally intensive industrial ecosystems. Future research could extend this work by adopting longitudinal designs, exploring additional digital or organizational capabilities, and testing the model in diverse industrial and cultural contexts. By doing so, scholars and practitioners can better understand and leverage the interplay between network relationships, structural positions, and digital capabilities to achieve sustainability goals.

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Appendix A

Measures

In assessing the dimension of sustainable performance, fifteen items were adapted from (Paulraj, 2011), who in turn adapted them from (Carter & Rogers, n.d.).

Economic performance

	Original Items	Adapted Items
		Our company….
1	Decrease in the cost of materials purchased	has decreased the cost of materials purchased
2	Decrease in the cost of energy consumption	has decreased the cost of energy consumption
3	Decrease in the fee for waste discharge	has decreased the fee for waste discharge
4	Improvement in return on investment	has improved its return on investment(ROI)
5	Improvement in earnings per share	has improved earnings per share (EPS)

Economic performance

	Original Items	Adapted Items
		Our company….
1	Reduction in air emissions	has reduced greenhouse gas emissions (e.g., CO_2/SO_x/NO_x)
2	Reduction in waste (water and/or solid)	has reduced resource usage (e.g., water, raw materials).
3	Decrease in the consumption of hazardous/harmful/toxic materials	has decreased the use of hazardous/harmful materials

4	Decrease in frequency of environmental accidents	has decreased the frequency of environmental incidents.
5	Increase in energy saved due to conservation and efficiency improvements	has increased energy savings

Economic performance

		Our company….
1	Improvement in overall stakeholder welfare or betterment	has improved welfare for employees, suppliers, and partners.
2	Improvement in community health and safety	has reduced workplace accident rates.
3	Improvement in the occupational health and safety of employees	has improved health and safety standards for employees.
4	Reduction in environmental impacts and risks to the general public	has reduced environmental impact on surrounding communities.
5	Improved awareness and protection of the claims and rights of people in the community served	has enhanced environmental awareness among partner enterprises in the cluster network.

Digital Seizing Capabilities

	Original Items	Adapted Items
		Our company…
1	Our company can quickly relate to new knowledge from the outside	can efficiently collect data from external partners (e.g., orders, production logs).
2	We recognize what new information can be utilized in our company	can effectively extract valuable data for internal analysis.
3	Our company is capable of turning new technological knowledge into process and product innovation	is capable of systematically collecting data from external channels such as customers and suppliers
4	Current information leads to the development of new products or services	established a cross-departmental data sharing mechanism, enabling timely access to internal operational data

Social Network Relational Characteristics

	Original Items	Adapted Items
		Our company…
1	The frequency with which our company exchanges technical/business knowledge with local suppliers	maintains frequent communication with partners.
2	The frequency with which our company exchanges technical/business knowledge with local customers Tie stability	
3	How long has our company been established technical/business knowledge exchanges with local customers	has established long-term win-win relationships with partners.
4	How long has our company been established	

	technical/business knowledge exchanges with local suppliers	
	Tie Quality	
5	When our company has technical exchanges with suppliers (or customers), both parties avoid serious harm to the other party.	and its partners have a high level of mutual trust.
6	When our company has technical exchanges with suppliers (or customers), both parties do not take advantage of the other even if opportunities to do so arise.	
7	When our company has technical/business knowledge exchanges and collaboration with other companies, we sometimes suspect the accuracy of the information these companies provide (reverse coded).	
8	our company tends to build stable relationships with more network members.	maintain stable cooperation with a broad set of partners.

Social Network Structural Characteristics

	Original Items	**Adapted Items**
1	The enterprises are dominant in the cooperation network	Our company has significant influence on the cooperation network.
2	In the innovation network, the cooperative R&D process between enterprises can only be accomplished through the participation of the enterprise.	Cooperation projects can only be completed with our company's deep involvement.
3	In the innovation network, enterprises can transfer information to other network entities without relying on additional enterprises.	We can directly transfer information to our partners without third-party assistance.
	Network Size	
4	Number of enterprises in the innovation network.	We have a large number of partner enterprises in our cooperation network.
5	Number of universities and scientific institutions in the innovation network.	Our partners are diverse in type, such as universities, financial institutions, and other organizations.
6	Number of NGOs in the innovation network.	
7	Number of financial institutions in the innovation network.	
8	Number of intermediaries, such as consulting enterprises, in the innovation network.	

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Digital Technologies and Youth Democracy: A Narrative Review of Civic Participation, Digital Citizenship and Emerging Challenges

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Abstract: The integration of digital technologies into everyday life has significantly influenced how young people engage with democratic processes, though the implications remain uneven and contested. Digital platforms offer opportunities for civic participation, activism, and political education; however, they also pose risks, including misinformation, polarization, and digital access inequalities, which raise concerns about the inclusivity of youth democracy. This study examines the role of digital technologies in shaping youth democratic engagement, with particular attention to civic participation, digital citizenship, and the challenges of digital environments. Using Scopus AI (search conducted on 11 September 2025), the review applied a narrative review approach combining a structured search string, summary and expanded summary analysis, concept mapping, topic expert profiling, and identification of emerging themes to synthesize literature across disciplines. The findings show that digital culture fosters new forms of engagement through online activism, global networks, while digital citizenship predicts both local and global participation. Nonetheless, challenges including misinformation, online harassment, and ethical concerns about technological determinism limit the democratizing potential of these tools. Emerging themes emphasize the importance of digital competence, innovations in digital democracy, youth-led digital activism, and the transformation of the public sphere. The study concludes that digital technologies present both opportunities and challenges for youth democracy, highlighting the need for educational reforms to strengthen digital literacy, policy interventions to ensure equitable access, and safeguards to protect democratic quality. These provide theoretical contributions to understanding democracy in the digital age and practical guidance for policymakers, educators, and civic organizations.

Keywords: *Digital Citizenship, Youth Democracy, Civic Participation, Digital Activism, Digital Literacy*

1. Introduction

In an increasingly digitalized world, the intersection of youth, democracy, and technology has emerged as a critical area of inquiry. The digital revolution has transformed how young people engage with society, communicate with peers, express political views, and participate in civic life. With unprecedented access to information and platforms for public discourse, today's youth, often referred to as "digital natives," are engaging with democratic processes in novel and dynamic ways. These changes raise important questions about the evolving nature of civic participation, political agency, and the future of democratic governance.

While digital technologies offer powerful tools for civic engagement, their impact is not uniform. Instead, it is shaped by a complex interplay of factors such as digital literacy, access to technology, socio-economic background, and political context. Youth, in particular, stand at the forefront of this transformation, not only as early adopters of technology but also as key actors in shaping the norms and practices of digital citizenship and democratic involvement. However, despite growing academic and policy interest in this topic, the empirical and conceptual landscape remains fragmented. While the relationship between digital technologies and youth democracy has been explored in different national and disciplinary contexts, this study adopts a global perspective by reviewing scholarly literature indexed in Scopus from 2010 to 2025. Consequently, the primary setting for this review is conceptual, encompassing the global, cross-disciplinary scholarly discourse indexed in the Scopus database, rather than focusing on a single, empirical geographic location.

Several studies have explored the positive effects of digital media on civic engagement. For instance, research indicates that high levels of digital literacy and resilience among youth enable meaningful engagement in civic spaces while mitigating exposure to online risks (Šimková & Kárníková, 2024). Similarly, disparities in digital access and competencies are shown to influence democratic participation, often reinforcing existing social inequalities (Duche-Pérez et al., 2024). Furthermore, digital citizenship is positively associated with political activism, community involvement, and youth participation in democratic movements on a global scale (Cleofas, 2025; Saud & Margono, 2021). Emerging technologies have also fostered participatory governance, transparency, and increased voter turnout among young citizens (Helbing et al., 2023; Soyipov et al., 2024).

Despite these insights, gaps remain in understanding how these multiple dimensions interrelate across diverse contexts. Existing literature often treats digital engagement, democracy, and youth participation in isolation or within narrowly defined scopes. Few studies synthesize these areas comprehensively or map the conceptual terrain using advanced tools such as Scopus AI or concept mapping. There is also limited exploration of emerging interdisciplinary themes or perspectives from topic experts.

To address this gap, this review aims to systematically analyse the evolving research landscape at the nexus of youth, democracy, and digital technology. Using Scopus AI, the study generates a concept map to visualize the intellectual structure of the field, identifies key thought leaders, and synthesizes emerging themes across disciplines. By integrating insights from diverse studies, the paper seeks to advance a more holistic understanding of how digital technologies influence youth engagement with democratic processes.

This study contributes to the academic discourse by offering a conceptual synthesis grounded in recent empirical findings, while also highlighting practical implications for policy, education, and participatory governance. Specifically, it offers: (1) a data-drive conceptual framework derived from Scopus AI that visually and systematically maps the structure of the field, defining the hierarchical relationships between key thematic clusters (civic participation, digital citizenship, and challenges); (2) an integrative synthesis that moves beyond fragmented literature to identify core theoretical mechanisms and contextual factors (e.g., digital competence, global networking) that link digital technology to youth democratic engagement; and (3) a highly focused policy and research agenda that explicitly addresses underexplored areas (e.g., Global South contexts, algorithmic bias) and provides structured guidance for future intervention design.

The remainder of this paper is organized as follows. Section 2 outlines the methodological approach, including search strategy and AI-assisted concept mapping. Section 3 outlines the results and discussion, beginning with a synthesis of the literature organized by the Scopus AI analysis, focusing on the key thematic clusters of digital technology and youth democracy, challenges, civic participation, and digital citizenship, followed by a discussion of topic experts and emerging themes. Section 4 discusses implications and areas for future inquiry. The paper concludes by emphasizing the critical role of digital technologies in shaping an inclusive, engaged, and democratic future for youth.

2. Research Methodology

This study employed a structured and data-driven narrative review methodology using Scopus AI, a cutting-edge artificial intelligence tool integrated with the Scopus database, to explore how digital technologies influence youth democratic engagement, with particular focus on civic participation, digital citizenship, and related challenges. This narrative review aims to integrate and interpret conceptual insights across diverse disciplines to provide a holistic understanding of the topic.

The literature search was conducted on 11 September 2025 and was designed to support the article's central aim: to provide an in-depth understanding of how digital technologies influence democratic engagement among youth, identify topic experts, and highlight emerging themes within the research landscape. To ensure the review was comprehensive and focused, a Boolean search string was developed to capture relevant literature across multiple domains. The final search string used in Scopus AI was:

("digital technology" OR "technology" OR "digital media" OR "online tools") AND ("youth" OR "young people" OR "adolescents" OR "teenagers") AND ("engagement" OR "participation" OR "involvement" OR "interaction") AND ("democracy" OR "politics" OR "civic" OR "governance") AND ("social media" OR "internet" OR "platforms" OR "communication").

To capture contemporary developments, the review included studies published between 2010 and 2025. The selection criteria focused on relevance to youth and democracy, conceptual richness, and the inclusion of digital participation or civic technology perspectives. This search returned a rich dataset of peer-reviewed articles,

book chapters, and conference proceedings spanning interdisciplinary fields such as political science, media studies, education, communication, and information systems. Scopus AI generated a Summary and Expanded Summary, synthesizing core findings and providing an overview of thematic trends. These summaries highlighted that digital technologies, especially social media platforms, play a transformative role in increasing civic awareness, political mobilization, and participatory governance among youth, while also introducing concerns about digital inequality, misinformation, and ethical use of online spaces (Duche-Pérez et al., 2024; Šimková & Kárníková, 2024).

The analytical process involved several stages: (1) **summary and expanded summary analysis** to identify central findings and research contexts; (2) **concept mapping** to visualize relationships among key concepts; (3) **topic expert profiling** to identify leading contributors in the field; and (4) **emerging theme identification** to synthesize consistent and rising themes. These stages collectively enabled a comprehensive narrative synthesis that connects digital technologies to youth democratic participation. This method allows for interpretive depth and conceptual integration rather than exhaustive statistical analysis, aligning with the purpose of a narrative review to generate theoretical insights and policy-relevant implications.

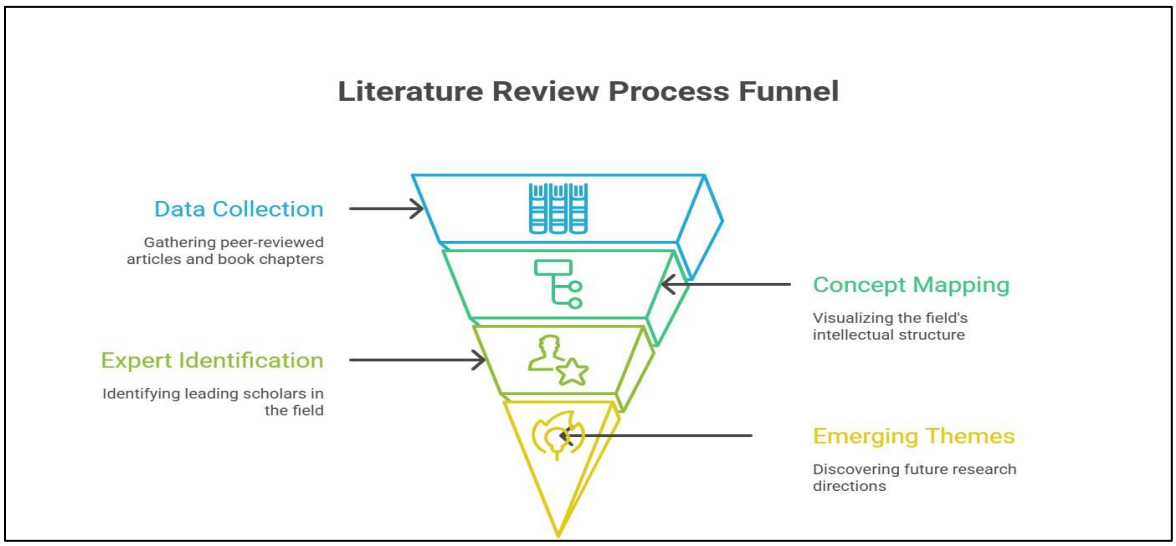
The Concept Map generated by Scopus AI offered a visual representation of the field's intellectual structure. Central nodes included "digital citizenship," "youth activism," "social media," "political participation," and "digital literacy." Peripheral but growing areas involved "algorithmic governance," "e-democracy," and "digital ethics." The mapping revealed that the research landscape is fundamentally organized around three core, interconnected thematic clusters, which structure the subsequent discussion: Challenges, Civic Participation, and Digital Citizenship (Cleofas, 2025; Helbing et al., 2023).

To further enhance the depth of this review, the Topic Experts feature in Scopus AI identified leading scholars based on citation metrics and publication volume. Notable contributors to the field included J.V. Cleofas (digital citizenship and civic engagement in Southeast Asia), D. Helbing (digital democracy and participatory design), and E. Pavan (youth social media activism and progressive politics). These scholars represent different geographical and disciplinary perspectives, strengthening the global relevance of the study (Pavan & Earl, 2025; Cleofas, 2025; Helbing et al., 2023).

Finally, the Emerging Themes generated by Scopus AI pointed to several future directions for research, such as the use of AI-driven civic platforms, gamified participation models, and critical digital pedagogy in youth civic education. These emerging trends reflect a shift from passive consumption to active creation and critique of digital content, indicating a maturing of digital democratic practices among youth (Fischli & Muldoon, 2024; Farmer, 2018).

The research funnel in Figure 1 is a visual representation of the systematic process used to narrow down a large number of articles to a final, manageable set for analysis. It illustrates the progression from a broad initial search to the final selection of highly relevant sources. In summary, the methodological use of Scopus AI enabled a rigorous, comprehensive, and multi-layered review of literature. It facilitated the identification of dominant themes, leading scholars, and promising directions for future inquiry, thereby supporting the article's aim to chart the evolving role of digital technologies in shaping youth engagement with democracy.

Figure 1: Literature Review Process Funnel



Source: Author's own construction (Generated using Napkin.Ai)

3. Results and Discussion

The findings derived from the Scopus AI analysis conducted on 11 September 2025 provide a comprehensive view of the intersection between digital technologies, youth, and democracy by highlighting summary, expanded summary, concept map, topic experts and emerging themes.

Summary and expanded summary

The analysis of the literature reveals that digital technologies play a transformative role in shaping youth engagement and democratic practices. A consistent theme emerging across studies is that digital culture has expanded how young people interact with society, cultivating broader political awareness and the development of a civic identity through digital platforms and social networks (Duche-Pérez et al., 2024; Escofet, 2020). This expansion of civic spaces highlights the ability of youth to transcend geographic and temporal barriers, positioning them as global citizens who participate in communities unrestricted by physical boundaries.

Digital technologies, particularly social media, have been found to revitalize deliberative democratic practices by providing interactive platforms for discussion, mobilization, and activism. These platforms not only allow youth to share opinions and mobilize peers but also facilitate political education and democratization by fostering accessible, user-driven forms of participation (Akmal, 2018; Helbing et al., 2023). In this sense, digital tools act as both pedagogical and political instruments that amplify the political agency of younger generations.

However, the evidence also underscores that the benefits of digital engagement are counterbalanced by significant challenges. A recurrent concern in the literature is the proliferation of misinformation, political polarization, and online harassment, all of which threaten to undermine democratic processes (Duche-Pérez et al., 2024; Asimakopoulos et al., 2025). These risks are compounded by structural inequalities, such as disparities in access to digital tools and varying levels of digital literacy, which can exclude marginalized groups from meaningful civic participation. The digital divide, therefore, remains a critical obstacle to ensuring equitable youth engagement in democracy.

The ethical implications of digital technologies further complicate this landscape. Scholars highlight the duality of digital tools as both enablers of democratic participation and mechanisms of social control. Concepts such as the "digital panopticon" point to growing concerns about surveillance, data privacy, and the potential emergence of digital authoritarianism (Baranov, 2021). These concerns necessitate stronger regulatory measures to balance technological innovation with democratic safeguards, ensuring that civic technologies are deployed in ways that enhance, rather than restrict, participatory governance (Helbing et al., 2023; Asimakopoulos et al., 2025).

Despite these risks, empirical evidence demonstrates that digital technologies continue to strengthen civic and political engagement among youth. Meta-analyses and large-scale reviews reveal that online activities such as political blogging, consuming digital news, and engaging in online political discussions have tangible offline consequences, translating into higher rates of political participation and activism (Boulianne & Theocharis, 2020). Similarly, digital media initiatives such as online voter registration systems and social media campaigns have been shown to increase youth voter turnout, illustrating the potential of technology to bridge the gap between online and offline participation (Soyipov et al., 2024).

Taken together, the findings underscore the multifaceted role of digital technologies in shaping youth and democracy. While digital platforms empower young people by creating new opportunities for civic expression, activism, and education, they also introduce ethical, political, and structural challenges that require careful consideration. Addressing issues of inequality, polarization, and digital ethics will be crucial to harnessing the full democratic potential of digital technologies for future generations.

Concept map

Figure 2: Concept map of Digital Technologies and Youth Democracy

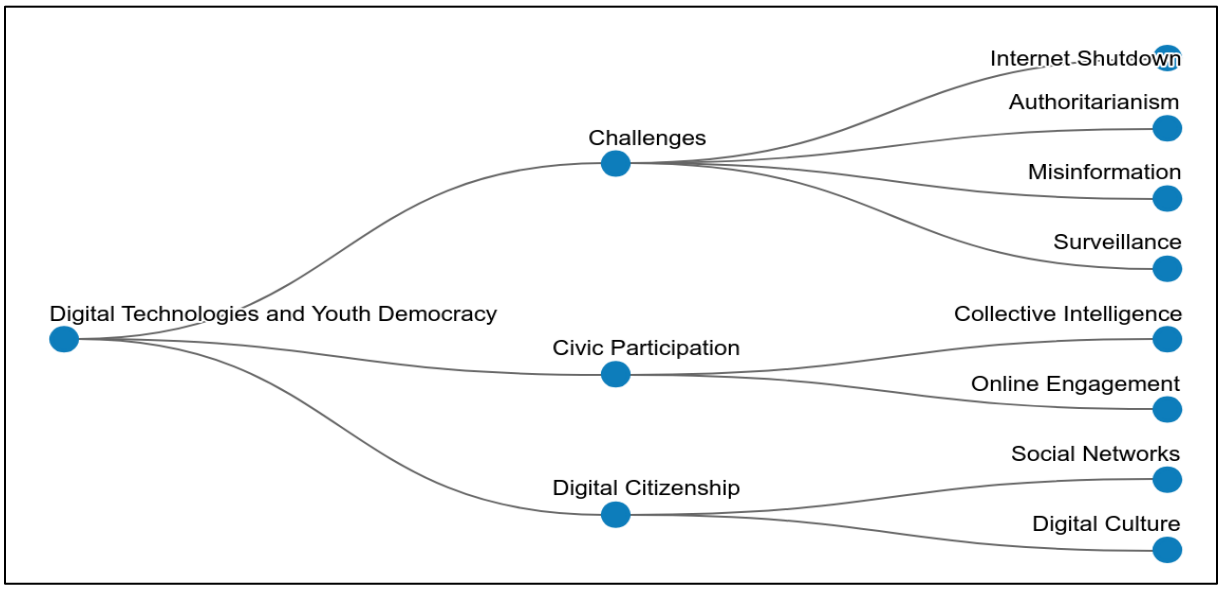


Figure 2 shows a concept map generated by Scopus AI on 11 September 2025 provides a visual representation of the thematic structure within the research domain of *digital technologies and youth democracy*. At its core, the map highlights three interconnected clusters: Challenges, Civic Participation, and Digital Citizenship, which together define the key areas of scholarly attention in this field.

Digital Technology and Youth Democracy

Digital technologies have emerged as a powerful force in shaping the democratic participation of youth, transforming how young people access information, communicate, and engage with civic life. Studies highlight that digital tools and platforms expand the scope of political participation by enabling access to real-time information, providing new spaces for activism, and fostering innovative forms of civic expression. These technologies support the development of digital literacy, online collaboration, and community participation, which together help cultivate civic identities and political awareness among young people (Arndt & Davis, 2010; Duche-Pérez et al., 2024; Escofet, 2020). By facilitating broader access to democratic processes, digital platforms act as gateways for young citizens to understand and influence societal change.

A central benefit of digital technologies lies in their capacity to enhance civic engagement and activism. Social networks and online communities allow young people to mobilize around causes, connect across geographic boundaries, and contribute to grassroots political movements. This digital engagement not only amplifies youth

voices but also promotes a sense of belonging to a larger civic community, thereby reshaping traditional boundaries of participation. Importantly, these practices demonstrate the growing role of young citizens as active contributors to democratic processes rather than passive recipients of political discourse (Duche-Pérez et al., 2024; Escofet, 2020).

However, the literature also acknowledges that digital engagement is not without its challenges. The proliferation of misinformation, political polarization, and online harassment threatens to undermine confidence in democratic institutions and erode the quality of public debate. These issues can distort political communication, leading to fragmented civic dialogue and weakened democratic outcomes. Scholars caution that such risks must be addressed to safeguard the democratic potential of digital technologies and prevent them from exacerbating existing inequalities in political participation (Duche-Pérez et al., 2024). Ensuring the ethical use of digital platforms remains a pressing concern in fostering sustainable digital democracies.

Beyond their civic and political dimensions, digital technologies also carry significant educational value. Scholars emphasize that digital platforms can support both active and passive learning experiences, fostering interaction, continuity, and purpose. These qualities align with the broader pedagogical aim of equipping young people with the capacities necessary for citizenship in what Dewey described as a "creative democracy." By integrating civic learning with digital engagement, young people develop critical thinking, digital literacy, and the reflective capacities required to act as informed and responsible digital citizens (Coulter, 2018). Such educational perspectives underscore the role of technology not just as a political tool, but as a medium for shaping long-term civic dispositions.

Finally, a global perspective reveals that the role of digital technologies in youth democracy is far from uniform. Case studies and comparative analyses demonstrate both similarities and differences in how young people engage civically through digital media across diverse cultural and political contexts. While the underlying drive for participation and activism is shared, the strategies and outcomes vary depending on local opportunities, access to technology, and socio-political environments. These findings suggest that while digital technologies have a universal capacity to empower youth, their impact must be understood in light of contextual differences, reinforcing the need for inclusive and culturally sensitive approaches to fostering digital democracy (Sampaio et al., 2024).

Challenges in Digital Technologies and Youth Democracy

The integration of digital technologies into democratic processes has raised high expectations for improving participation and inclusivity, particularly among youth. However, these expectations are often accompanied by significant challenges. One major issue is that digital platforms, while expanding access to political discourse, can also undermine democratic deliberation by fostering superficial engagement or polarizing debate. Scholars argue that the rapid adoption of digital technologies has redefined how democracy functions but has simultaneously created a fragmented public sphere where meaningful discussion is increasingly difficult to sustain (Sala, 2021). This paradox illustrates the dual role of technology as both an enabler and a disruptor of youth democracy.

Youth work in a digital society also reveals complex organizational challenges. The integration of digital technologies into youth development initiatives has transformed both interactions and institutional practices, offering new opportunities for empowerment while also complicating the roles of educators and practitioners (Zaremohzzabieh et al., 2020). The shift toward digital-first approaches requires rethinking how organizations engage young people, as over-reliance on technology risks alienating those without equal access or digital literacy. This uneven distribution of benefits underscores the persistent challenge of ensuring inclusivity within youth democracy.

The Digital Age Challenge, referring to the exponential growth in youth use of digital technologies, further complicates the democratic landscape. Young people are navigating complex transnational spaces that transcend local, national, and international boundaries, requiring educators, policymakers, and institutions to adapt rapidly to evolving digital behaviors (Armour et al., 2020). The scale and speed of these changes highlight a structural challenge; traditional governance and education systems often struggle to keep pace with the dynamism of digital youth culture, resulting in gaps in regulation, participation, and civic preparedness.

In regions such as Africa, the challenges of youth democracy intersect with broader systemic issues of governance, leadership, and development. While digital transformation offers opportunities to strengthen democratic practices, weak leadership and poor governance often limit its potential impact (Maseko, 2024). In such contexts, technology can either support democratization by facilitating civic mobilization or reinforce existing inequalities when access is uneven. Similarly, youth participatory evaluation processes often face obstacles in engaging young people meaningfully. Digital technologies can assist in overcoming these barriers by creating attractive and interactive platforms that empower youth to contribute to democratic evaluation, yet ensuring sustained engagement remains a challenge (Liu, 2022).

Finally, digital technologies have redefined youth mobility and raised new concerns for policymakers. In rural contexts, virtual mobilities allow young people to transcend physical limitations, but they also present new forms of exclusion for those unable to participate fully in digital spaces (Gwaka, 2018). Furthermore, the convergence of youth culture and digital communication technologies has heightened governance debates around online child safety, as policymakers grapple with protecting young users while ensuring their civic freedoms (Savirimuthu, 2012). Together, these findings suggest that while digital technologies hold transformative potential for youth democracy, their challenges, ranging from governance and inclusivity to polarization and safety, must be carefully addressed to secure equitable and sustainable democratic engagement.

Digital Technologies and Youth Democracy in Relation to Civic Participation

Digital technologies and social networks have fundamentally reshaped civic participation among young people, providing new avenues for interaction, identity formation, and political awareness. Research highlights that digital culture has facilitated broader and more inclusive civic engagement by allowing youth to connect across geographical and social boundaries (Duche-Pérez et al., 2024). Platforms such as Facebook, Twitter (now X), and TikTok have not only amplified youth voices but also contributed to the development of civic identities, encouraging young people to see themselves as active agents within democratic societies. This transformation reflects a shift from traditional forms of participation to hybrid modes where online engagement complements offline democratic practices.

A key finding across the literature is the link between informal online civic participation and formal offline involvement. Activities such as sharing political content, commenting on social issues, or supporting online campaigns have been positively correlated with perceptions of offline opportunities and actual participation in civic life (Dias Fonseca, 2019). This demonstrates that digital technologies act as bridges between online and offline civic spheres, reinforcing the idea that digital engagement does not replace but rather extends traditional democratic practices. For youth, this interconnectedness reduces barriers to participation by offering low-threshold entry points into civic life, which may later evolve into more formal and structured democratic involvement.

The rise of Web 2.0 technologies has been particularly influential in shaping these dynamics. Tools such as blogs, wikis, and social media platforms have provided youth with accessible and interactive spaces for political discourse, activism, and collective decision-making (Papaioannou, 2013). These tools not only foster peer-to-peer engagement but also enable grassroots organizing, thereby decentralizing civic participation and allowing young people to mobilize around issues that matter to them. In this way, digital technologies democratize access to civic spaces by empowering marginalized voices, diversifying perspectives, and challenging traditional hierarchies in political participation.

Another important dimension is the role of digital technologies in fostering critical thinking and responsible citizenship. Scholars argue that access to diverse online information and discussions enhances young people's capacity to evaluate, critique, and deliberate on social and political issues (Gonzalez-Mohino et al., 2023). Moreover, service-learning initiatives integrated with digital tools offer youth authentic opportunities to experience solidarity, responsibility, and community service, reinforcing the link between civic action and ethical responsibility (Escofet, 2020). These findings highlight the educational and developmental value of digital technologies, which go beyond facilitating engagement to shaping civic dispositions and democratic competencies among youth.

Finally, digital citizenship has emerged as a strong predictor of global civic engagement, linking local participation with broader transnational concerns. For example, research among Filipino youth shows that digital citizenship fosters involvement in civic organizations, activism, and global solidarity efforts (Cleofas, 2025). This demonstrates how digital technologies enable young people not only to engage in domestic democratic processes but also to participate in global debates on climate change, human rights, and social justice. The globalization of civic participation through digital tools underscores the evolving nature of youth democracy in the 21st century, where young people are simultaneously local and global actors.

Digital Technologies and Youth Democracy in Relation to Digital Citizenship

The rise of digital technologies has redefined youth democracy by embedding digital citizenship as a central component of civic participation. Digital culture has transformed how young people interact with their communities, encouraging them to form broader identities and heightened political awareness through online platforms and social networks (Duche-Pérez et al., 2024). Social media, online forums, and collaborative digital tools allow youth not only to consume information but also to contribute to public discourse. This has resulted in new forms of civic engagement, such as online activism and participation in community-based digital projects, which extend traditional democratic practices into digital spaces.

One of the most significant contributions of digital technologies to youth democracy is the facilitation of global civic engagement. Evidence from the Philippines shows that digital citizenship strongly predicts global civic activism, suggesting that digital tools empower young people to see themselves as part of a transnational civic community (Cleofas, 2025). By connecting local experiences with global concerns, digital platforms have enabled youth to participate in movements on climate change, social justice, and human rights, reinforcing the dual role of youth as both local and global democratic actors. This shift illustrates the growing potential of digital citizenship to transcend geographic boundaries and reshape democratic participation on a global scale.

The foundation of effective digital citizenship lies in digital literacy and civic skills. Scholars argue that without adequate skills, young people may lack the capacity to critically evaluate information, engage responsibly in online discussions, or protect themselves against misinformation and manipulation (Duche-Pérez et al., 2024). Research further shows that the development of digital and socio-civic skills is strongly tied to participatory profiles, meaning that the more literate and skilled youth are in digital contexts, the more likely they are to actively and responsibly engage in civic life (Peart et al., 2022). Thus, education systems must prioritize equipping young people with these competencies to prepare them for active digital citizenship.

Despite these opportunities, challenges persist in integrating digital citizenship within youth democracy. Political polarization, the spread of misinformation, and exposure to online harassment pose significant risks that can undermine confidence in democratic institutions and degrade the quality of civic dialogue (Duche-Pérez et al., 2024). These challenges highlight the tension between the democratizing potential of digital platforms and the ethical, social, and political risks associated with their misuse. Addressing these issues requires stronger policies that promote media literacy, regulate online environments, and ensure equitable access to digital resources.

In conclusion, digital technologies have fundamentally shaped youth democracy by advancing the concept of digital citizenship. They enable broader civic engagement, enhance global solidarity, and empower youth to act as informed and responsible democratic participants. However, the benefits of digital citizenship are contingent upon access to digital resources, the cultivation of literacy and civic skills, and the mitigation of online risks. As such, digital citizenship represents both an opportunity and a responsibility, offering pathways to strengthen youth democracy while demanding careful navigation of its inherent challenges.

Insights from Topic Experts

The role of digital technologies in shaping youth democracy can be better understood by examining the contributions of key experts in the field. Ellen Middaugh has significantly advanced scholarship on youth civic engagement through her exploration of participatory politics in the digital era. Her work emphasizes how digital platforms, particularly social media, provide young people with unprecedented opportunities to express political opinions, mobilize peers, and participate in democratic processes. At the same time, Middaugh underscores the importance of civic media literacy, the ability to critically evaluate information online as a

safeguard against misinformation and manipulation. This dual focus on empowerment and critical literacy highlights both the opportunities and responsibilities inherent in digital citizenship, suggesting that digital engagement is most effective when paired with educational strategies that equip youth to navigate the complexities of civic life online (Kahne & Middaugh, 2015).

Emerging voices such as Gabriel G. Malli extend this dialogue by examining the educational potential of social media for political learning. Malli's recent work highlights how social media journalism functions as a tool for civic education, helping youth contextualize political events and form independent judgments. Moreover, Malli's use of participatory research methods, such as visual autoethnographies, provides an innovative approach to centering youth perspectives in democratic scholarship. By amplifying young people's voices and experiences, Malli's research underscores the importance of designing civic education initiatives that are not only informed by but also co-created with youth, ensuring their active agency in shaping democratic practices (Pavan & Earl, 2025).

In contrast, Lynn Schofield Clark offers a more established perspective with extensive contributions to the study of youth, social media, and democracy. Clark's research emphasizes how digital platforms can foster counterpublics, or alternative spaces where marginalized groups of youth develop civic voices that challenge dominant narratives. These counterpublics are critical for understanding the transformative potential of digital democracy, as they demonstrate how social media enables the amplification of youth perspectives often excluded from mainstream political discourse. Importantly, Clark also highlights the challenges associated with these spaces, including online hostility and the need for inclusivity, which reflect broader tensions between empowerment and exclusion in digital civic participation (Marchi & Clark, 2021).

Taken together, these experts highlight a continuum of insights that enrich the understanding of digital technologies and youth democracy. Middaugh emphasizes the intersection of engagement and literacy, Malli focuses on the educational role of social media and youth-centered methodologies, while Clark explores the transformative potential of counterpublics and inclusive digital practices. Their combined perspectives reveal that digital citizenship is not merely about online presence but about cultivating informed, empowered, and inclusive democratic actors capable of leveraging technology for civic change.

The synthesis of these expert contributions underscores that the relationship between digital technologies and youth democracy is multifaceted, combining empowerment, education, and inclusivity with challenges of misinformation, polarization, and access. These insights are crucial for policymakers, educators, and practitioners seeking to design initiatives that not only integrate digital tools into democratic practices but also address the ethical and structural challenges facing young people in digital environments.

Emerging theme

A consistent theme in the literature is the critical role of digital competence and youth engagement in shaping youth democracy. Digital competence, defined as the ability to effectively use, evaluate, and create digital content, has become a foundational requirement for civic participation in the digital era. Research highlights that young people with higher levels of digital literacy are more likely to engage in online activism, participate in civic discussions, and contribute to democratic processes (Duche-Pérez et al., 2024; Peart et al., 2022). This consistent emphasis on digital literacy underscores the need for comprehensive educational initiatives that not only provide technical skills but also foster critical media literacy and socio-civic awareness. In this way, equipping youth with digital competence strengthens both individual empowerment and collective democratic engagement.

Another consistent theme relates to digital democracy innovations, which highlight how technology is reshaping governance and participation. Innovations such as online voting systems, digital deliberation platforms, and the integration of artificial intelligence into civic engagement are consistently cited as tools with the potential to improve transparency and inclusivity (Helbing et al., 2023). These innovations are especially significant for younger generations who are more likely to adopt and adapt to digital tools in democratic contexts. While the literature suggests that digital platforms can increase voter turnout and civic participation, scholars caution that these innovations must be accompanied by robust ethical frameworks to prevent issues such as exclusion, privacy breaches, and algorithmic bias.

Emerging as a rising theme is youth digital activism, which reflects the increasing agency of young people in leveraging digital platforms for advocacy and social change. Scholars document how social media enables young activists to organize protests, raise awareness, and mobilize transnational movements with unprecedented speed and scope (Pavan & Earl, 2025; Caron et al., 2019). Unlike traditional activism, digital activism allows for decentralized and networked forms of mobilization, amplifying marginalized voices and expanding the reach of youth-led movements. This rising theme emphasizes the power of digital tools not only to engage youth in existing democratic frameworks but also to push the boundaries of what democratic participation looks like in the 21st century.

A parallel rising theme concerns the digital public sphere and democracy, reflecting growing scholarly attention to how digital platforms are reshaping public discourse. Digital spaces create opportunities for more inclusive dialogue, enabling diverse groups of young people to engage in political debates that transcend geographic boundaries (Asimakopoulos et al., 2025; Clark & Marchi, 2017). However, this transformation also raises concerns about technological determinism, algorithmic manipulation, and the concentration of power in the hands of major platform owners. These issues can undermine democratic quality by distorting attention, spreading misinformation, and reinforcing echo chambers. Thus, while digital public spheres enhance accessibility, they also present challenges that demand regulatory and civic interventions.

Taken together, the consistent and rising themes illustrate both the stability and evolution of scholarly attention to digital technologies and youth democracy. Digital competence and democracy innovations remain enduring priorities, reflecting the long-term importance of equipping youth with skills and tools for civic engagement. At the same time, rising themes such as youth digital activism and the digital public sphere signal emerging areas where young people are actively reshaping democratic participation. These themes collectively suggest that the future of youth democracy will be defined not only by access to technology but also by how effectively young people, educators, policymakers, and platform designers address the opportunities and challenges of digital civic life.

4. Conclusion

This review has examined the complex relationship between digital technologies, youth, and democracy, with a particular focus on civic participation, challenges, and digital citizenship. The findings underscore that digital technologies play a pivotal role in reshaping how young people engage in democratic processes. Consistent evidence shows that digital culture expands civic spaces, enabling youth to develop broader political awareness, participate in online activism, and engage in transnational movements. At the same time, persistent challenges such as misinformation, political polarization, online harassment, and digital inequalities remain significant barriers to achieving inclusive and equitable democratic engagement.

From a theoretical perspective, this study significantly advances the discourse by leveraging an AI-assisted systematic methodology to clarify the field's structure, a step often lacking in traditional reviews. It contributes by offering a cohesive conceptual synthesis that validates and visualizes the core mechanisms linking digital technology to democratic engagement. Specifically, the findings confirm that the field is fundamentally structured around three intersecting pillars, which are Civic Participation, Digital Citizenship, and Challenges, thereby providing a validated conceptual framework for scholars to use when developing and testing future theoretical models of youth political behavior in the digital era. This framework reinforces the theoretical shift from viewing youth as passive citizens to active, networked agents of democratic change.

The practical implications of this review are equally significant. Policymakers, educators, and civic organizations must recognize the necessity of integrating digital literacy and socio-civic skills into education systems to prepare youth for responsible and informed participation. Additionally, innovations in digital democracy, such as online voting and AI-assisted civic platforms, hold potential to increase inclusivity and engagement if implemented with ethical safeguards. For practitioners, supporting youth-led digital activism and fostering safe, equitable online environments are critical steps toward harnessing the democratic potential of technology.

However, the study also acknowledges important limitations. First, much of the available literature remains fragmented across disciplines, limiting the integration of findings into a cohesive framework. Second, most

research is concentrated in Western or urban contexts, which restricts understanding of how digital technologies function in rural or Global South settings. Third, emerging technologies such as artificial intelligence and algorithm-driven participation are still underexplored in relation to youth democracy, creating gaps in both theory and practice.

Building on these limitations, future research should pursue several directions. Comparative studies across cultural and political contexts are essential to capture the diverse experiences of youth with digital democracy. Longitudinal research could shed light on how digital civic engagement evolves, particularly as younger generations mature into lifelong democratic participants. Further, interdisciplinary research integrating political science, education, and media studies will be vital to address the challenges of misinformation, algorithmic bias, and digital inequalities. Finally, future work should explore how emerging technologies such as AI, gamification, and immersive media can be designed to support ethical, inclusive, and sustainable democratic participation among youth.

In conclusion, digital technologies represent both opportunities and challenges for youth democracy. By fostering digital competence, addressing structural inequalities, and ensuring ethical governance of digital platforms, societies can support a generation of informed, empowered, and globally connected youth who are prepared to shape the future of democracy.

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Enhancing Financial Reporting Quality: The Association between Alternative Data, Information Timeliness and Analytics Capabilities

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Abstract: Financial reports have traditionally relied on historical data, but this approach is increasingly inadequate in today's fast-moving and data-rich financial environment. While prior studies have examined individual types of alternative data, such as social media sentiment or web traffic, there has been a limited comprehensive evaluation of how these heterogeneous sources can be integrated with conventional reporting frameworks to enhance financial reporting quality (FRQ). This study, therefore, investigates the role and potential of alternative data, for example, social media sentiment, satellite imagery, geolocation traces, and ESG-related indicators. A narrative review of the literature suggests that alternative data can improve forecasting accuracy, strengthen risk management, and enhance corporate governance; in particular, prior studies document gains in the predictive accuracy of earnings forecasts and a more granular understanding of market behaviour. At the same time, there are significant challenges related to data quality, ethical and lawful use, and the fragmented legal and regulatory environment for alternative data, especially in developing economies. Synthesising these insights, the paper develops a conceptual framework in which alternative data affect FRQ both directly and indirectly via information timeliness, with analytics capabilities acting as a boundary condition that shapes the magnitude of these effects. The study concludes that realising the potential of alternative data will require clearer regulatory guidance, robust data-governance practices and cross-disciplinary collaboration so that these new data sources can be integrated responsibly with existing reporting systems and used to support more transparent and accountable financial decision-making.

Keywords: *Alternative Data, Financial Reporting, Analytic Capabilities, Risk Management, Corporate Governance*

1. Introduction

Conventional financial reporting, which consists of financial position, income statements, and cash flow statements, provides a record of a company's past performance and financial position. However, these reports are lacking in providing predictions on future outcomes or adaptation to sudden market changes (Brown et al., 2023). There is a greater demand for timely information that can provide forward-looking insights as business environments become more complex and technology advances. Stakeholders such as investors, regulators, and analysts are currently acquiring alternative data to assess performance and risks as it happens (Johnson & Liu, 2022). This demand has encouraged the need for alternative data, which provides support to conventional reporting and provides a broader view of both current conditions and future possibilities.

Alternative data refers to information obtained from non-conventional sources rather than standard financial statements. This alternative data is typically unstructured and generated across various platforms and activities. This data can provide insights that conventional records cannot capture, which include social media activity, satellite imagery, website traffic, geolocation data, and transaction records such as credit card or online purchases (Smith & Jackson, 2023). These sources provide real-time insights; for instance, social media sentiment reflects consumer opinions immediately, while satellite imagery can reveal trends in retail activity or supply chain disruptions. Advances in big data analytics and artificial intelligence have enhanced the capacity to process these large and complex datasets, increasing the practical utility of alternative data for financial analysis (Thompson, 2022). By complementing conventional financial reports, which often focus on past performance and are released with delays, alternative data enables companies and investors to have more accurate, timely, and informed decisions (Williams & Chen, 2023).

Conventional financial reporting continues to provide pertinent information regarding current economic activity—particularly in contexts where value is generated by software, data, and other intangibles—thereby

decreasing decision usefulness at times when users require prompt and accurate signals (Duțescu, Stănilă, & Hoinaru, 2019; Giuseppe & Maccarrone, 2007). Alternative data provide high-frequency external signals that may suggest underlying conditions and enhance relevance beyond conventional indicators (Cumming & Glatzer, 2024; Sun, Liu, Xu, & Abraham, 2024; Green & Zhang, 2024), with empirical evidence of anticipated improvements in credit and risk contexts highlighting practical potential (Bai & Ma, 2024; Lu, Zhang, & Li, 2019). However, these advantages do not appear voluntarily: delays in audit and disclosure remain as significant challenges (Asmara & Situanti, 2018), and tangible enhancements depend on the analytics capabilities at the company level—managed processes, model validation, and lifecycle controls—to transform unverified inputs into assurance-ready evidence (Ekster & Kolm, 2021; Mitra, Hoang, Gladilin, & Mani, 2023). Furthermore, the accessibility, legality, and cost-effectiveness of alternative data vary significantly among countries, particularly in emerging economies where issues of privacy, origin, and access are more significant, hence complicating the generalisation of suggested methods (Zhang, 2024). The fundamental issue is to elucidate how alternative data enhances the quality of financial reporting via timeliness and to determine when such improvements are attainable considering capacity and contextual limitations (Duțescu et al., 2019; Sun et al., 2024).

Therefore, this study examines how alternative data can improve the accuracy, timeliness, and quality of financial reporting. Miller and Green (2023) revealed that alternative data provides real-time insights often missing from conventional financial sources, while Taylor et al. (2022) proved that social media sentiment, consumer behaviour, and satellite imagery enhance forecasting, strengthen risk management, and support more informed investment decisions. However, gaps remain, as only a few studies explore how to integrate alternative data into existing reporting systems or address regulatory compliance (Anderson & Wang, 2023). Although there are concerns in terms of data quality, ethical adherence and technological capacity, specifically in processing large volumes of unstructured information, as highlighted by Davis (2023), the use of alternative data significantly revolutionises financial reporting and investment analysis, enabling these financial metrics to provide more comprehensive, more timely and more actionable insights compared to conventional reporting.

There is a crucial need to explore the alternative data potential and practical application of alternative data integration for its significant benefits. To exemplify, Johnson and Kim (2023) only highlighted the use of individual data types, such as social media sentiment or web traffic in financial reporting, while Smith (2022) reported a limited number of studies on regulatory and ethical issues concerning data privacy and transparency in relation to the integration of alternative data into financial reporting. Therefore, this study aims to review current relevant literature on alternative data in financial reporting to further explore its impact on conventional metrics and the challenges, as well as trends about the integration of alternative data into financial reporting. With such insightful information, this study offers a deeper understanding of the practical benefits and limitations of alternative data integration, in addition to providing future research with potential directions.

2. Literature Review

Understanding Alternative Data

Conventional data is commonly structured accordingly to a standardised format, as seen in financial position and income statements. In comparison, alternative data is often unstructured with no fixed format, high in frequency, and derived from diverse forms and sources, such as social media, satellite imagery, and website traffic (Smith & Jackson, 2023). These features of alternative data necessitate the utilisation of advanced technological tools to optimise its usage. For example, machine learning and AI are required to process the high volume of information produced by alternative data. Correspondingly, this real-time high-frequency information also helps organisations and investors monitor market changes and make more strategic decisions (Taylor et al., 2022). Produced in various formats and forms, such as text, images, and transaction records, alternative data also provides more comprehensive insights into a company's performance as well as market conditions. Nevertheless, there is concern about the standardisation and integration of the data into conventional financial reporting due to its unformatted and diverse forms (Miller & Green, 2023). Overall, these features make alternative data both valuable and challenging in modern financial analysis.

Alternative data is typically categorized into two types: publicly available and proprietary data. Publicly available data includes freely accessible sources such as government databases, social media and open-source websites, offering insights into consumer behaviour and market trends without extra cost (Thompson, 2022). Proprietary data, by contrast, is collected by commercial providers who sell specialised datasets. These are usually more structured and detailed, including aggregated consumer spending records, advanced geolocation analytics, and high-resolution satellite imagery (Anderson & Wang, 2023). Major providers like Bloomberg, FactSet, and PitchBook supply both data and analytical tools that enhance their use in financial analysis (Davis, 2023). Choosing between publicly available and proprietary data depends on analytical goals and resources, as each type offers unique opportunities and challenges.

The Role of Alternative Data in Financial Reporting

In comparison to conventional financial data, one key advantage of employing alternative data is that it provides a more comprehensive and detailed understanding of factors affecting financial performance, therefore improving forecasting, risk management, and market analysis of companies, as evidenced by a number of studies. To exemplify, a study by Johnson and Liu (2022) revealed that foot traffic data gathered using geolocation data allows companies to predict their quarterly earnings compared to relying only on past sales data. Also, companies can strategically identify market trends that enable them to adjust their strategies before official reports by instrumenting consumer opinions on social media as the data source (Miller & Green, 2023). In the field of agriculture, investors rely on the real-time performance of agricultural yields gained from satellite imagery instead of official statistics to make any significant financial decision (Taylor et al., 2022). In risk management, companies and investors instrument Environmental, Social, and Governance (ESG) metrics to identify sustainability-related risks, such as regulatory penalties or reputational harm (Williams & Chen, 2023).

Conventionally, structured financial data is used to only record past performance, but integrating alternative data, such as social media sentiment, geolocation patterns, and satellite imagery, enables analysts to gain a better understanding of a company's performance and market dynamics, thereby strategically responding to these circumstances (Smith & Jackson, 2023). Specifically, big data analytics and artificial intelligence (AI) can be optimised by organisations to efficiently process and interpret large, complex datasets. A study by Davis (2023) demonstrated the use of machine learning algorithms to identify patterns and correlations in massive datasets in the effort to improve prediction accuracy. According to Anderson and Wang (2023), a company's risk assessment models and decision-making process can be significantly improved by leveraging AI-driven analytics. Similarly, Thompson (2022) also noted the positive impact of technology integration in producing more accurate forecasts and strategic plans.

Williams & Chen (2023) asserted that timely and relevant information on consumer behaviour, market movements, and company performance gained from unstructured sources significantly helps investors in making strategic financial decisions, as they reflect current market trends. Miller & Green (2023) further exemplified the significance of alternative data compared to conventional financial reports in assessing market sentiment and potential risks before they appear in quarterly earnings reports through social media feedback and web traffic. This real-time information significantly reduces the delay caused by conventional financial metrics and allows for quicker investment decisions. Moreover, with such comprehensive information, market transparency can be improved, thereby reducing information gaps and promoting fairer markets (Thompson, 2022).

Challenges in Utilizing Alternative Data for Financial Reporting

A key challenge of using alternative data is ensuring it is accurate, complete and reliable. Unlike audited and standardised financial data, alternative data comes from unstructured sources without formal validation, raising trust concerns (Smith & Jackson, 2023). Missing or inconsistent data can reduce analysis accuracy and lead to wrong forecasts (Davis, 2023). It also contains noise, such as spam in social media posts, which can obscure real consumer sentiment (Miller & Green, 2023). Advanced analytics, including machine learning and AI, help filter out noise and improve insight quality (Thompson, 2022).

Privacy and regulatory compliance are also critical. Alternative data often includes personal information from social media, geolocation, or transactions (Smith, 2022). Laws like the GDPR and CCPA require informed consent and responsible, transparent use (Johnson & Kim, 2023). Financial institutions must balance

compliance with using alternative data for competitive advantage (Anderson & Wang, 2023). Failure to comply can result in fines and reputational damage, making strong compliance measures essential (Taylor et al., 2022).

Combining alternative and conventional data is complex because they differ in structure, frequency, and format. Conventional financial data is structured and reported regularly, while alternative data is often unstructured, high-frequency, and comes from sources like social media, satellite images, or geolocation data (Smith & Jackson, 2023). Integrating them requires advanced technology to process and analyse large volumes of information in real time. A major challenge is storing and managing data, as systems designed for structured data may struggle with the scale and unstructured nature of alternative data (Taylor et al., 2022). Advanced analytics, including machine learning and AI, are needed to extract useful insights, which demands investment in high-performance computing and cloud storage (Davis, 2023). Strong data governance is also essential to ensure accuracy, consistency, and security. Without proper infrastructure, analytics, and governance, the benefits of integrating these data sources cannot be fully realised (Miller & Green, 2023).

Current Trends in Literature

Key findings indicate that alternative data enhances financial decision-making, forecasting accuracy, and risk management. Studies show that combining alternative data with conventional financial models improves predictions. For example, companies using social media sentiment data forecast stock price movements more accurately than those relying only on conventional reports (Johnson & Liu, 2022). Similarly, satellite imagery and geolocation data help analysts predict retail performance and supply chain trends, especially in volatile markets (Miller & Green, 2023). Incorporating Environmental, Social, and Governance (ESG) metrics also allows investors to identify sustainability and regulatory risks that conventional data may miss (Taylor et al., 2022). Despite these benefits, gaps remain in understanding how to integrate alternative data into financial reporting and manage its regulatory implications (Anderson & Wang, 2023).

Recent literature has examined hybrid financial reporting models that integrate alternative data with conventional metrics to provide a fuller view of company performance. These models address the limits of conventional reporting, which relies on historical, structured data and may miss real-time market changes (Brown et al., 2023). High-frequency alternative data, including social media sentiment, geolocation, and ESG metrics, can enhance the timeliness and detail of forecasts (Smith & Jackson, 2023). For example, combining quarterly earnings reports with daily alternative data allows companies to update investors more frequently on performance and risks (Johnson & Kim, 2023). Miller & Green (2023) revealed that machine learning algorithms help process large volumes of unstructured data and detect trends not visible in conventional statements. These models improve transparency and forecasting, but Taylor et al. (2022) cautioned about the challenges in terms of data standardisation, integration, and regulatory compliance. As they evolve, hybrid models have the potential to transform financial reporting by providing a more dynamic and comprehensive view of corporate health.

Alternative data provides deeper insights into company performance through ESG reporting and earnings forecasting. In corporate governance, data such as social media sentiment and employee reviews offer real-time feedback on reputation and organisational culture, helping boards and executives make better leadership and risk management decisions (Williams & Chen, 2023). Alternative data also improves ESG reporting; satellite imagery monitors environmental impacts, and geolocation data tracks supply chain sustainability, enabling faster and more accurate risk assessment than conventional reports (Johnson & Liu, 2022). In earnings forecasting, combining alternative data with conventional financial metrics increases accuracy—for example, social media and online transaction data better predict sales trends (Thompson, 2022). Overall, alternative data enhances decision-making by providing detailed, real-time insights, though challenges remain regarding data quality, ethics, and regulatory compliance (Smith & Jackson, 2023). As these sources expand, they are expected to play an even larger role in governance and forecasting, offering more timely and forward-looking information.

Below is a table summarising empirical evidence on alternative data sources in financial reporting from 2020-2024:

Table 1: Representative empirical evidence on alternative data and financial reporting (2020-2024)

Author(s)	Year	Title	Method	Main Findings
Johnson & Liu	2022	Leveraging Social Media Sentiment for Earnings Forecasting	Empirical analysis using social media sentiment data	Integrating social media sentiment improves earnings forecasts by providing real-time insights into consumer behaviour.
Smith & Jackson	2023	The Role of Alternative Data in Enhancing Financial Transparency	Case study analysis with geolocation and web traffic data	Alternative data, such as geolocation and web traffic, offers valuable insights that enhance market transparency and forecasting.
Miller & Green	2023	The Impact of Satellite Imagery on Retail and Supply Chain Forecasting	Satellite data analysis applied to the retail sector	Satellite imagery significantly improves supply chain analysis by providing real-time data on inventory levels and logistics.
Anderson & Wang	2023	Integrating ESG Metrics and Alternative Data in Financial Reporting	Mixed-methods study involving ESG metrics and financial performance	ESG metrics, when combined with alternative data like social media and satellite imagery, provide more comprehensive risk assessments.
Thompson	2022	Big Data Analytics in Financial Markets: A Review of Alternative Data Applications	Literature review of big data analytics applied to financial markets	Big data analytics, particularly AI-driven methods, enhance the accuracy of market analysis and financial decision-making when using alternative data.
Williams & Chen	2023	Real-Time Data for Corporate Governance and Investor Decision-Making	Quantitative analysis of social media and corporate reputation	Social media data helps companies and investors better assess corporate governance and reputational risks in real time.

Recent studies show that integrating alternative data into financial reporting improves transparency, forecasting, and risk management. Including real-time social media sentiment in earnings forecasts enhances accuracy by providing immediate insights into consumer behaviour (Johnson & Liu, 2022). Geolocation and web traffic data add detailed insights that complement conventional financial metrics, increasing market transparency (Smith & Jackson, 2023). Satellite imagery helps track inventory and logistics in fast-changing markets, improving retail and supply chain forecasts (Miller & Green, 2023). Combining ESG metrics with alternative data such as social media sentiment and satellite imagery provides a more complete assessment of corporate risks, particularly in sustainability and governance (Anderson & Wang, 2023). AI analytics can process large volumes of alternative data to enhance market analysis and financial decisions (Thompson, 2022). Real-time alternative data also enables companies and investors to evaluate reputational risks and make timely decisions (Williams & Chen, 2023). Overall, combining alternative and conventional data enhances the timeliness, accuracy, and comprehensiveness of financial reporting and forecasting.

The studies discussed in Table 1 demonstrate that alternative data are not only beneficial for trading or forecasting independently, but they also directly relate to the components of financial reporting quality. Social media sentiment and site traffic metrics enhance earnings projections and risk evaluations, hence facilitating more accurate estimations and narrative disclosures. Satellite imaging and geolocation data provide earlier and more comprehensive evidence of operational circumstances in retail and supply chains, facilitating more prompt recognition of revenues, expenses, and associated risks. ESG-focused alternative data enhances the scope of non-financial exposures that are becoming increasingly crucial to users' decision-making processes. From the perspective of the IASB, these contributions align with relevance, faithful representation, and timeliness, indicating that alternative data can improve financial reporting quality both directly, by broadening the evidential foundation of reports, and indirectly, by reducing the information cycle during which preparers and auditors make their assessments.

Opportunities and Future Directions

Current research on alternative data in financial reporting identifies areas needing further study. One key gap is how to integrate alternative data effectively into existing financial reporting systems. Although alternative data can improve forecasting and risk assessment (Johnson & Liu, 2022; Smith & Jackson, 2023), few models show how companies can systematically combine structured financial data with unstructured, high-frequency alternative data. Future research could develop standardised methods and best practices for merging these data types, improving consistency, reliability, and practical use in financial reporting.

Another important area is the regulatory and ethical use of alternative data, especially regarding privacy and potential misuse. Laws such as the GDPR and CCPA provide guidance on personal data, but their application to alternative data in financial decisions remains unclear (Anderson & Wang, 2023). Future studies integrating law, technology, and finance could clarify regulatory issues and guide ethical practices. Research could also examine how financial institutions ensure that alternative data from third-party vendors complies with legal requirements, remains accurate, and maintains transparency and accountability.

Another promising area for future research is the technology needed to manage alternative data. While advanced analytics, machine learning, and AI play a key role in processing large volumes of unstructured data (Thompson, 2022), few studies address the practical challenges companies face in adopting these technologies. Small and mid-sized companies may struggle to implement advanced systems. Future research could explore scalable solutions that allow organisations of different sizes to use alternative data effectively without overloading existing operations and IT systems.

Policymakers, industry professionals, and researchers should collaborate to develop frameworks that maximise the benefits of alternative data, as such frameworks can further foster transparency, standardisation, and ethical use in financial reporting. Noteworthy, such frameworks can also involve cross-disciplinary research in finance, data science, and law, making them more strategic and comprehensive. Also to be recommended are policies addressing data governance, quality control, and privacy protection to ensure efficient and responsible usage of alternative data.

3. Methodology

This study adopts a narrative review to theorise how alternative data shape financial reporting quality (FRQ) through the mediating role of information timeliness and moderated by analytics capabilities. A narrative approach is appropriate to a question that cuts across heterogeneous evidence, such as accounting, finance, information systems, and practitioner guidance, where the goal is integrative sense-making rather than meta-analytic estimation. The design is concept-driven; alternative data operate as the independent input, information timeliness serves as the mediating mechanism, analytics capabilities act as the moderator, and FRQ is the outcome. To maintain transparency and replicability, this review is based on a Scopus database, with a written protocol covering the search string, search date, inclusion and exclusion criteria, a two-stage screening workflow by independent reviewers, and a structured coding plan. Although the synthesis is narrative, the procedure retains systematic elements—decision logs, a standardised extraction template, and inter-coder reliability checks—so that the propositions emerge from a disciplined reading of the field and remain testable in subsequent empirical work.

The review begins by framing the problem and aligning constructs, establishing working definitions and operational boundaries for alternative data, information timeliness, analytics capabilities, and FRQ, and mapping their theorised interrelations. A protocol is then finalised, specifying Scopus as the main source, Title–Abstract–Keyword fields as the search domain, the search date of 17 July 2025, eligibility rules, and the coding and synthesis approach. The comprehensive search is executed as specified; all records are exported with complete bibliographic metadata. Screening proceeds in two stages—titles and abstracts, followed by full texts—conducted independently by two reviewers, with disagreements resolved through discussion and reasons for exclusion recorded in a decision log.

For each included item, data extraction captures study design, context, the nature and provenance of alternative data, timeliness proxies, such as audit delay or disclosure lag, indicators of analytics capabilities, such as data

governance arrangements, business intelligence or machine-learning use, and model lifecycle controls, and FRQ indicators aligned to the conceptual framework. Integrative thematic analysis then combines a deductive codebook rooted in the four constructs with inductive coding to allow new subthemes to surface, after which themes are mapped to the mediation pathway and the moderation. Internal validity is strengthened through inter-coder agreement checks (target Cohen's $\kappa \geq 0.70$), sensitivity analyses by outlet type and time window, and reflexive consideration of publication and disciplinary biases.

All material is sourced from Scopus to take advantage of its multidisciplinary coverage and consistent metadata, which are conducive to concept-driven synthesis. The search was conducted on 17 July 2025 across Title, Abstract and Keywords using the pre-specified string:

"(alternative data" OR "non-traditional data" OR "big data" OR "external data") AND ("information timeliness" OR "data timeliness" OR "reporting speed" OR "information latency") AND ("analytics" OR "data analysis" OR "business intelligence" OR "predictive analytics") AND ("financial reporting" OR "financial statements" OR "accounting reports" OR "financial disclosure") AND ("quality" OR "accuracy" OR "reliability" OR "integrity").

No language filters are applied at the search stage to avoid premature exclusion. However, items are excluded at full-text review if adequate translation is not feasible. Inclusion criteria encompass peer-reviewed journal articles and scholarly books or chapters that examine or theorise alternative data in finance or business, address information timeliness or reporting delays, discuss analytics capabilities, and operationalise or theorise FRQ. Exclusions cover technical without reporting implications, studies confined to market microstructure with no link to reporting, non-scholarly commentary, duplicates, and records without accessible full texts. Screening begins with de-duplication, followed by title/abstract checks and then full-text assessment, with every exclusion reason recorded. Forward and backward citation chaining is undertaken within Scopus on seed papers to reduce the risk of omission; any additional records are subjected to the same screening protocol.

Data extraction follows a standard template to facilitate cross-study comparison. This study records bibliographic details, method, domain, alternative data source and structure, for instance, social media sentiment, geolocation, IoT telemetry or web traffic, the operationalisation of timeliness, such as days from year-end to report release, regulatory filing lags, or data refresh cycles, proxies for analytics capabilities, for example, the evidence of analytics infrastructure and staffing, data governance maturity, model validation practices, and FRQ outcomes, which include accruals quality, restatement incidence, readability or clarity measures, and timeliness as an enhancing characteristic. This detail enables the subsequent synthesis to tie specific evidence to the hypothesised mechanisms and contingencies.

Themes are then aggregated and arranged into a concept that explicitly links bodies of evidence to the three propositions: the direct effect of alternative data on FRQ (P1), the mediating role of timeliness in the alternative data (P2), and the moderation of analytics capabilities on the alternative data (P3), which together imply a strengthened indirect effect on FRQ. Collectively, the procedures ensure that the evidence base is assembled and synthesised to speak directly to the study aim: developing a conceptual framework with three propositions that is theoretically rigorous yet readily operationalised for empirical testing in future research.

The narrative review converges on six cross-cutting themes that explain how alternative data can enhance FRQ, why information timeliness operates as the principal mechanism, and when analytics capabilities strengthen these effects. Table 1 summarises the themes, key findings, brief descriptions, representative sources and linkages to the study propositions.

Table 2: Thematic synthesis linking alternative data, timeliness, analytics capabilities and financial reporting quality

Theme	Key Findings	Brief Description	Sources
Alternative data delivers orthogonal, decision-useful signals	Alternative data provide economically meaningful information beyond conventional indicators	Non-conventional, often unstructured signals (e.g., social media, geolocation, telemetry) add predictive and explanatory power for company fundamentals and disclosure-relevant events	Saivasan & Lokhande (2024); Sun et al. (2024); Cumming & Glatzer (2024); Green & Zhang (2024)
Timeliness as the conduit to FRQ	Information timeliness mediates the Alternative data	High-frequency Alternative data compresses information cycles; earlier visibility of conditions later recognised in reports increases decision usefulness	Duțescu et al. (2019); Giuseppe & Maccarrone (2007); Asmara & Situanti (2018)
Analytics capabilities as a boundary condition	Analytics capabilities intensify gains from Alternative data by accelerating signal extraction and quality control	Data governance, feature engineering, BI/ML tooling, and model-risk controls convert noisy Alternative data into reliable, auditable insights, thereby speeding timeliness	Mitra et al. (2023); Ekster & Kolm (2021)
Governance, privacy, and provenance risks	Weak controls over Alternative data (collection, consent, lineage) can undermine credibility and FRQ	Risks include unlawful collection, unauthorised use, leakage, and poor provenance; robust controls are necessary for decision-useful reporting	Zhang (2024)
Dynamic Alternative data landscape and alpha decay	Alternative data value is non-stationary; benefits erode without continuous monitoring and adaptation	Regulatory shifts, market learning, and technological change cause alpha decay; sustained FRQ benefits require ongoing recalibration of pipelines	Green & Zhang (2024); Ekster & Kolm (2021)
Outcome relevance in adjacent domains	Alternative data improves prediction and monitoring in credit and asset management	Field and practitioner evidence (e.g., default prediction, active management) indicates practical gains with plausible spillovers to reporting processes	Bai & Ma (2024); Green & Zhang (2024); Lu et al. (2019)

Table 1 summarises various studies and their respective contributions, whereas Table 2 synthesises these findings into general concepts that reflect the organisation of this study's conceptual framework. The initial two themes illustrate how alternative data produces supplementary, unconventional signals and, crucially, how its worth is actualised through expedited information cycles, which precisely aligns with the function characterised as information timeliness in connecting alternative data to the quality of financial reporting. The third and fifth themes emphasise that these benefits are not inherent; they rely on analytical capabilities and the capacity to modify models in response to evolving regulations, markets, and technology, so confirming our characterisation of analytical capabilities as a boundary condition. The residual themes concerning governance, privacy, and provenance highlight the prevailing institutional and data-governance landscape, emphasising that inadequately managed alternative data can compromise credibility and negate possible improvements in reporting quality. The themes in Table 2 thus serve as a foundation for transitioning from study-level evidence to the mediated and regulated links outlined in the conceptual model.

Overall, the literature indicates that alternative data yield orthogonal, decision-useful signals capable of enhancing FRQ by enriching relevance and supporting faithful representation, thereby substantiating a direct link to FRQ (Cumming & Glatzer, 2024; Green & Zhang, 2024; Saivasan & Lokhande, 2024; Sun et al., 2024). The core mechanism is information timeliness: because alternative data arrive at a higher frequency and often pre-signal economic events, they shorten the information cycle and enable users to act before information loses

value, consistent with the IASB's emphasis on timeliness and with evidence on the effects of reporting delay (Asmara & Situanti, 2018; Duțescu et al., 2019; Giuseppe & Maccarrone, 2007).

The effect of this mediated pathway depends on analytics capabilities, the routines, infrastructure, and controls that convert unverified inputs into auditable insights at speed—so that stronger capabilities compress latency and stabilise model performance, positively moderating the link (Ekster & Kolm, 2021; Mitra et al., 2023). The positive outcomes are dependent on reliable governance and provenance; privacy violations, illegal data acquisition, or inadequate lineage can undermine trust and diminish quality improvements, hence moderating the actual effects of H1–H3 (Zhang, 2024). Furthermore, due to the dynamic nature of the alternative-data ecosystem—affected by alpha decay, regulatory changes, and technological advancements—sustaining FRQ enhancements necessitates ongoing monitoring and recalibration. This assertion is supported by outcome-based evidence from credit risk and active management, which indicates the practical feasibility and external validity of the proposed model (Bai & Ma, 2024; Green & Zhang, 2024; Lu et al., 2019).

4. Development of the Theoretical Framework

The theoretical framework incorporates three interrelated perspectives: (i) the IASB Conceptual Framework for Financial Reporting, which grounds Financial Reporting Quality (FRQ) in relevance and faithful representation, enhanced by timeliness (Duțescu et al., 2019); (ii) information economics, focusing on signalling and information asymmetry, which elucidates how prior credible signals mitigate the preparer–user gap; and (iii) the resource-based view (RBV) and dynamic capabilities, which regard analytics capabilities as organisation-specific practices that convert data into decision-useful information (Ekster & Kolm, 2021; Mitra et al., 2023). In the fields of finance and data science, alternative data has demonstrated the capacity to provide distinct insights into company fundamentals, enhancing prediction and monitoring when managed responsibly (Cumming & Glatzer, 2024; Green & Zhang, 2024; Sun et al., 2024). This triangulation prompts a comprehensive explanation of how and when alternative data can improve FRQ, emphasising information timeliness as the key mechanism.

This study theorised alternative data as upstream inputs that pre-signal conditions later recognised in formal reports, thereby compressing information latency and increasing decision usefulness (Bai & Ma, 2024; Sun et al., 2024). Within the IASB frame, timeliness elevates the utility of relevant, faithfully represented information by ensuring it arrives before its value decays (Duțescu et al., 2019). Empirical evidence that audit delay impairs timeliness strengthens the case for modelling timeliness as the conduit through which alternative data influence FRQ (Asmara & Situanti, 2018; Giuseppe & Maccarrone, 2007). Because extracting reliable signals from noisy alternative data requires governance, tooling, and skilled routines, analytics capabilities are posited to condition the speed and quality of this translation (Ekster & Kolm, 2021; Mitra et al., 2023). In short, the setting is one where data velocity meets reporting discipline, and capabilities determine whether benefits materialise.

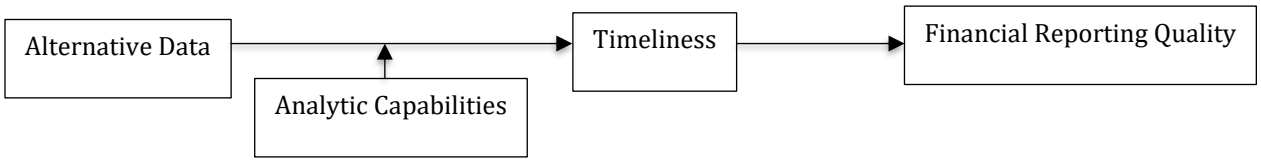
Theoretically, this synthesis contributes in three ways. It reinterprets timeliness as an active mechanism rather than a passive attribute, aligning contemporary data realities with the IASB's qualitative characteristics (Duțescu et al., 2019). It embeds signalling logic: earlier, verifiable alternative data-based insights operate as credible signals when supported by governance and model controls, reducing information asymmetry. And it operationalises both RBV and dynamic capabilities by treating analytics capabilities as the boundary condition explaining heterogeneous payoffs from alternative data (Ekster & Kolm, 2021; Mitra et al., 2023). The literature on asset management and credit risk offers external validity cues that alternative data can materially improve prediction and monitoring, strengthening the plausibility of propositions in the reporting domain (Bai & Ma, 2024; Green & Zhang, 2024). At the same time, dynamic features of alternative data imply that capability renewal is necessary to sustain benefits (Green & Zhang, 2024; Sun et al., 2024).

Practically, the framework points Chief Financial Officers, audit committees, and regulators toward investments with the highest marginal impact on FRQ: (i) (i) build governed alternative data infrastructures with documented provenance and consent; (ii) institutionalise analytics capabilities (data quality controls, feature stores, model validation, monitoring for drift); and (iii) target latency-reducing processes around close, audit, and disclosure so that AD-derived insights are reflected promptly and verifiably in narrative and

numerical reporting (Ekster & Kolm, 2021; Mitra et al., 2023). Conclusion: By specifying alternative data as the driver, Timeliness as the mediator, and analytics capabilities as the moderator, the framework offers a clear, testable pathway by which organisations can translate high-velocity external signals into higher-quality financial reporting—coherent with accounting doctrine and consistent with contemporary evidence from finance and information systems (Asmara & Situanti, 2018; Duţescu et al., 2019; Green & Zhang, 2024).

Given the preceding discussions, Figure 1 illustrates the proposed theory of the study:

Figure 1: Proposed theoretical framework



Proposition Development

Alternative data and FRQ

Drawing on the IASB's Conceptual Framework, financial reporting quality (FRQ) is anchored in relevance and faithful representation, enhanced by characteristics such as timeliness, comparability, and verifiability (Duţescu et al., 2019). The finance and information-systems literatures increasingly show that alternative data—non-conventional, often unstructured traces such as social media sentiment, geolocation, IoT telemetry, and web traffic—carry information that is orthogonal to conventional accounting and market indicators (Cumming & Glatzer, 2024; Sun et al., 2024). By enriching the evidential base available to preparers and external users, alternative data can sharpen assessments of underlying economic events (e.g., demand shifts, operational disruptions, intangible asset utilisation), thereby improving the decision usefulness of reports and supporting a more faithful representation of economic substance (Giuseppe & Maccarrone, 2007; Sun et al., 2024).

Prior studies document incremental predictive power from alternative data in active asset management and risk analytics, suggesting economically meaningful signal content that can translate—directly and not only via faster disclosure—into higher-quality reporting narratives and estimates (Green & Zhang, 2024; Saivasan & Lokhande, 2024). Field evidence from credit contexts likewise shows material performance gains when alternative data are integrated responsibly into decision workflows (Bai & Ma, 2024). While later sections theorise information timeliness as a mechanism and analytics capabilities as a boundary condition, Proposition 1 isolates the direct relationship: even holding timeliness constant, richer, corroborative evidence streams can reduce measurement error, enhance verifiability, and improve the alignment between recognised amounts/disclosures and underlying phenomena (Duţescu et al., 2019; Green & Zhang, 2024; Sun et al., 2024).

Proposition 1 (P1): Alternative data are positively associated with financial reporting quality, such that greater breadth, depth, and integration of alternative data correspond to higher levels of relevance and faithful representation in financial reports, independent of information timeliness.

Timeliness Mediated the Alternative data and FRQ.

In the IASB's Conceptual Framework, timeliness is an enhancing qualitative characteristic that increases decision usefulness by ensuring information is available before its capacity to influence decisions diminishes (Duţescu et al., 2019). Alternative data (e.g., social media sentiment, geolocation, IoT telemetry, clickstream) arrive at a higher frequency than periodic reports and often pre-signal economic events that will later be recognised in financial statements (Cumming & Glatzer, 2024; Sun et al., 2024). By compressing information latency—shortening the interval between underlying business conditions and their observability—alternative data plausibly improve the relevance and faithful representation of disclosures through more timely recognition, measurement, and narrative corroboration (Duţescu et al., 2019; Giuseppe & Maccarrone, 2007).

Evidence on reporting delays emphasizes the centrality of timeliness: audit delay materially influences the speed of financial disclosures, with slower reporting eroding the usefulness of decisions (Asmara & Situanti, 2018). Parallel literatures in asset management and credit analytics document that alternative data enhances

early detection and monitoring, yielding incremental predictive content and faster updates to priors (Bai & Ma, 2024; Green & Zhang, 2024). Transposed to the reporting domain, the same high-frequency signals can accelerate preparers' ability to substantiate estimates, triangulate fair values, and update risk narratives, thereby improving financial reporting quality because the underlying information arrives sooner and is integrated more promptly into the reporting process (Duțescu et al., 2019; Sun et al., 2024).

The mediating pathway operates as follows: alternative data reduces information latency by bringing forward externally observable traces of company activity; reduced latency increases the timeliness of internal close, audit readiness, and disclosure cycles; improved timeliness, in turn, elevates financial reporting quality via more decision-useful recognition and disclosure. While analytics capabilities strengthen this conduit (addressed in Proposition 3), the mediation logic is distinct: even without assuming capability heterogeneity, earlier visibility of economic conditions channels the effect of alternative data into higher-quality reports through timeliness (Duțescu et al., 2019; Asmara & Situanti, 2018; Sun et al., 2024).

Proposition 2 (P2): Information timeliness mediates the relationship between alternative data and financial reporting quality, such that greater availability and integration of alternative data lead to faster information cycles, which in turn improve financial reporting quality.

Analytic Capabilities Moderated between Alternative Data and Timeliness

Within resource-based and dynamic-capabilities perspectives, analytics capabilities—spanning governed data pipelines, feature engineering, model validation, and lifecycle controls—constitute company-specific routines that convert noisy, high-variety inputs into reliable, decision-useful signals (Ekster & Kolm, 2021; Mitra et al., 2023). In the context of financial reporting, these routines determine the speed and quality with which alternative data are cleaned, fused with internal records, and translated into evidence that can be audited and embedded in estimates and disclosures. Because the IASB's Conceptual Framework positions timeliness as an enhancing characteristic that elevates the usefulness of relevant, faithfully represented information, any capability that compresses latency and stabilises signal quality should strengthen the alternative data towards the timeliness conduit (Duțescu et al., 2019). In short, stronger analytics capabilities make early signals earlier and cleaner, tightening the pathway from alternative data to timeliness.

Empirical plausibility and boundary conditions. Practice-facing literature reports that alternative data deliver incremental predictive content but also highlight non-stationarity and model-risk hazards that can quickly erode value without active monitoring and recalibration (Green & Zhang, 2024; Ekster & Kolm, 2021). Organisations with mature analytics capabilities are better placed to sustain signal integrity and throughput, thereby realising faster close, review, and disclosure cycles. Conversely, weak capability environments face privacy risks and operational frictions that slow ingestion and raise assurance hurdles, blunting the timeliness gains that alternative data could otherwise deliver (Mitra et al., 2023; Zhang, 2024). The moderation logic is asymmetric; capabilities enhance positive outcomes and mitigate adverse effects, resulting in a higher trend for alternative data regarding timeliness when capabilities are robust and an easier route when they are constrained.

Proposition 3 (P3): Analytics capabilities positively moderate the relationship between alternative data and information timeliness, such that the association between alternative data integration and timeliness is stronger at higher levels of analytics capabilities, thereby amplifying the indirect effect of alternative data on financial reporting quality.

5. Conclusion

This review paper began with a straightforward question: how, in practical terms, can alternative data improve the quality of financial reporting, and through what mechanisms do these effects operate inside the firm? The review suggests that the answer lies less in the mere availability of new data sources than in how organisations mobilise them to accelerate and enrich information flows. Real-time traces from social media activity, satellite imagery, geolocation and other non-traditional sources provide signals that sit alongside, rather than replace, conventional accounting inputs (Johnson & Liu, 2022; Smith & Jackson, 2023; Miller & Green, 2023). When these signals are processed through robust analytical pipelines, they sharpen assessments of economic

conditions, support more granular forecasting, and give both preparers and users of financial reports a clearer view of emerging risks and opportunities.

A central message of the review is that timeliness should be treated as an active mechanism rather than a passive reporting attribute. Alternative data matters because it can shorten the distance between underlying economic events and their appearance in decision-relevant information. The narrative synthesis highlighted six recurring ideas: alternative data provide incremental, decision-useful information; timeliness is the main channel through which that information becomes valuable for reporting; analytics capabilities help to accelerate and de-risk that channel; governance and provenance determine whether external traces are perceived as credible; the alternative-data ecosystem is fluid and subject to rapid alpha decay; and there is already strong evidence of outcome relevance in areas such as credit risk modelling and active asset management. These strands are brought together in a mediated–moderated framework in which alternative data affect reporting quality both directly and, more strongly, through faster information cycles that are particularly effective in organisations with more mature analytics capabilities.

The theoretical contribution follows from this reframing. By positioning timeliness as something that can be engineered through organisational design and technology choices, the paper extends conventional decision-usefulness arguments. It connects signalling theory—where earlier, verifiable external traces narrow information asymmetry between insiders and outsiders—with a resource-based view that treats analytics as a firm-specific capability for transforming noisy, heterogeneous inputs into auditable evidence. This perspective helps to explain why the same alternative data can generate very different reporting outcomes across firms: what matters is not only what data are available, but also how quickly they are processed, how models are governed, and how provenance, consent and data lineage are documented. The three propositions advanced in the paper are intended as a bridge between these conceptual ideas and empirically testable claims about financial reporting quality.

From a practical standpoint, the proposed framework has clear implications for preparers, auditors and regulators. For preparers, the priority is to build governed data pipelines that combine structured and unstructured sources, record provenance and permissions, and embed feature engineering and model validation within routine finance processes. Closing, review and disclosure timetables should be redesigned so that latency reduction is treated as a deliberate objective rather than a by-product. Audit committees can strengthen their oversight by linking measures of analytics capability to reporting quality indicators, insisting on model-risk controls and drift monitoring, and requiring reproducible data lineages for key estimates. Regulators, for their part, can lower uncertainty by issuing guidance on the use of external data in financial reporting, specifying minimum governance and transparency standards, and considering safe-harbour arrangements for timely, data-supported narrative disclosures. For the audit profession, the framework points towards assurance approaches that use external traces as corroborative evidence while upholding existing expectations around independence, quality control and ethics.

At the same time, there are clear boundaries to what this study can claim. The evidence base rests on a narrative review drawn from a single scholarly index, which inevitably leaves out some relevant work from adjacent disciplines, professional outlets and grey literature. Without meta-analytic effect-size estimates, it is not possible to speak with confidence about the magnitude of the relationships described. Although screening and coding procedures were designed to be transparent and to minimise bias, they remain subject to judgement. The constructs themselves—such as breadth and depth of alternative-data integration, timeliness beyond traditional audit-delay measures, and analytics-capability maturity—are still evolving in the literature, which complicates comparison across studies. Finally, the paper develops a set of mechanisms and propositions but does not directly estimate them, so causal claims remain, by design, provisional.

These limitations suggest several lines for future inquiry. One priority is the development of reliable and widely usable measures for alternative-data integration (for example, coverage, refresh frequency and provenance quality) and for analytics capabilities (including governance arrangements, technical tooling, staffing profiles and lifecycle controls). A second is to move beyond coarse timeliness indicators and examine finer-grained measures such as intra-period disclosure patterns, update frequencies, and machine-readable time stamps on key announcements. Third, the mediated–moderated framework would benefit from testing through a

combination of archival designs, field experiments embedded in reporting workflows, and longitudinal case studies of "close-to-disclosure" processes. Fourth, researchers could explore sectoral and jurisdictional variation, especially where external traces differ in sensitivity and availability and where data protection, confidentiality and assurance norms vary. A fifth avenue lies in examining how alternative data interact with integrated reporting, ESG and sustainability narratives, and the recognition and communication of intangible assets, building on prior discussions of how integrated reporting frameworks reshape national reporting systems (Ignatova & Shmarova, 2025).

Overall, the review and the proposed framework offer both an interpretive lens and a practical orientation. They suggest that organisations should approach alternative data as credible upstream evidence rather than as a peripheral add-on; invest in analytics capabilities that shorten information cycles without sacrificing robustness; and reconfigure reporting processes so that timely, well-corroborated insights are reflected transparently, and with appropriate safeguards, in financial communication. By making explicit where the gains are likely to be largest and by setting out propositions that can be taken forward in empirical work, the study aims to inform emerging standards and internal policies. The broader ambition is to support reporting practices that are not only faster and more comprehensive but also more faithful to underlying economic reality and more useful to the wide range of stakeholders who rely on them.

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The Sustainable Water Management Through Waqf: An Islamic Perspective in Malaysia and ASEAN

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Abstract: Throughout history, human societies have emerged and flourished around river valleys, which were essential for their survival. However, contemporary challenges like global climate change, conflicts, water pollution, poverty, and difficult geographical conditions have impacted both the availability and quality of water resources. In Malaysia, water-related challenges have become particularly pressing in several states, especially rural ones. The combination of low population density in these areas and the high costs of building sanitized water supply systems has caused delays in water infrastructure projects. Since 2020, the water waqf has emerged as a promising initiative in Malaysia, spearheaded by Yayasan Wakaf Malaysia (YWM) in partnership with the Ministry of Energy Transition and Water Transformation (PETRA). This approach is also gaining traction in ASEAN countries, such as Indonesia, Cambodia, and Brunei. Although the concept of water waqf is not new, there remains limited research, both theoretical and empirical, on this topic. Therefore, this study aims to examine the role of water waqf as an alternative instrument for sustainable water management in Malaysia and selected ASEAN countries. Using a qualitative, library-based methodology, the study conducts a document analysis of primary source materials from YWM. This analysis includes reviewing annual reports, project documentation, and financial distribution records related to water waqf projects by state, up until December 2023. The findings emphasize the significant potential of water waqf development in addressing water resource challenges, ultimately benefiting society by broadening access to clean water as the concept of water waqf becomes more widely understood.

Keywords: *Transformation, Water and sanitation, Water waqf, Sustainability, Quality of life*

1. Introduction

Early human civilizations emerged near river valleys, which served as crucial lifelines supporting multiple sectors and fostering urban development that attracted populations and social groups. From an Islamic standpoint, water holds fundamental significance for the practice of purification (*thoharoh*) in daily religious rituals, making the availability of clean water essential not only for physical needs but also for spiritual observances. Indeed, Islam regards water as a divine trust **(***amanah***)** that must be managed responsibly, aligning human benefit with environmental stewardship.

However, recent global and local transformations have adversely affected both the quantity and quality of water resources. Md. Khalid et al. (2021) emphasized that factors such as global climate change, conflict, water pollution, socioeconomic struggles in impoverished nations, and geographic constraints threaten the sustainability of water supplies. Further, research by Syed Abdullah et al. (2024) identified agricultural runoff, sewage discharge, industrial pollution, soil erosion, and saltwater intrusion as major contributors to water degradation. Additionally, inefficiencies in water distribution and pricing remain persistent challenges, as noted by Sukereman (2017).

In Malaysia, water-related challenges vary across states and regions. Key concerns include river pollution, rising water demand, and over-dependence on surface water sources, as highlighted by Bakar and Rahman (2021). Rivers provide 97% of Malaysia's water supply, while only 3% is sourced from groundwater (Md. Khalid et al., 2021). Despite multiple treatment processes, pollution remains prevalent, aggravated by inadequate enforcement and fragmented water governance. This situation underscores the need for a holistic and sustainable approach that integrates environmental, economic, and spiritual dimensions of water management.

Malaysia's water governance framework has evolved through several national policies and strategic action plans, such as the 15th Strategic Action Plan under the National Water Resources Policy (2012), which seeks to strengthen water resilience against climate change and natural disasters. However, implementation gaps, financial constraints, and public awareness remain major obstacles. These challenges parallel the global call under Sustainable Development Goal (SDG) 6**,** which emphasizes ensuring the availability and sustainable management of clean water and sanitation for all.

Against this backdrop, there is a growing need to explore innovative mechanisms beyond conventional state-funded systems. One emerging Islamic approach is the application of waqf (endowment) as a sustainable financing tool for water access and management. The integration of waqf principles provides not only financial support but also a moral and communal framework that encourages collective responsibility.

One promising model is the establishment of waqf-based water wells, which have demonstrated effectiveness in supporting communities in underprivileged nations such as Cambodia, Sudan, Uganda, Ethiopia, and Nigeria. In conflict-affected countries such as Yemen, Syria, and Palestine, these wells serve as critical lifelines. Geographic constraints further complicate water accessibility, as observed in the Middle East and Sub-Saharan Africa (Md. Khalid et al., 2021). In some African regions, communities travel up to 30 minutes to access water, with wealthier households enjoying direct connections while poorer communities remain underserved (Magugudi Makgatho & Elias Musitha, 2024).

Bakar and Rahman (2021) recommend the adoption of waqf water wells due to the unique advantages of underground water sources. Natural filtration through soil, sand, and rock layers results in cleaner water, while groundwater is less affected by inconsistent rainfall, ensuring supply stability even during droughts. In Indonesia, the use of waqf wells has been proposed as a solution for rural areas. Hinsari (2020) examined waqf wells in Dusun Pucung, Kecamatan Janapria, Kabupaten Lombok Tengah, revealing that high demand during drought seasons led to partial commercialization, contradicting Islamic principles that prohibit personal profit from communal waqf assets. Such cases highlight the importance of governance and regulatory mechanisms in maintaining the sanctity and sustainability of waqf resources.

In Malaysia, the adoption of waqf-based water initiatives remains limited but shows increasing potential. Collaborative projects led by Yayasan Wakaf Malaysia (YWM) in partnership with the Ministry of Energy Transition and Water Transformation (PETRA) since 2020 have laid early foundations for waqf-driven water solutions. Therefore, this study aims to analyze the potential of water waqf as an alternative mechanism for sustainable water management and sanitation improvement in Malaysia and selected ASEAN countries. Specifically, it seeks to (i) examine the governance structure and implementation of water waqf projects, (ii) identify challenges and success factors, and (iii) assess its contribution to achieving SDG 6.

By addressing these objectives, this paper contributes to the academic discourse on Islamic-based sustainability, offering practical implications for policymakers, waqf institutions, and local communities. It also seeks to enhance awareness of the socio-economic and environmental value of water waqf as a viable model for collective action toward sustainable water security.

2. Literature Review

The Importance of Water in the Sustainability of Quality of Life

Water is essential for sustaining life and plays a critical role in ensuring a good quality of life. In Islam, water is especially significant because of its centrality to rituals involving cleanliness and worship. In Islamic

jurisprudence (fiqh), discussions about water are prioritised, as purity is fundamental for the validity of several acts of worship, including prayer (salat), fasting (sawm) and pilgrimage (hajj and umrah). Islamic teachings recognize seven types of water suitable for purification: rainwater, snow, dew (originating from the sky), spring water, well water, river water, and seawater (originating from the earth) (Syed Abdullah et al., 2024).

A study by Mokhtar & Abdullah (2012) explored the significance of water as reflected in various verses of the Qur'an. Key findings from their research emphasize the divine blessing of water, its role in creation, and its necessity for sustaining life. Qur'anic verses highlight the importance of water in supporting all living beings and stress humanity's responsibility to safeguard this precious resource.

This research presents data and findings that address the challenges and solutions related to water management. Visual aids such as images, charts, and tables will be incorporated to illustrate the results effectively, ensuring the information is clearly presented. These visuals are described and discussed within the paper to provide a comprehensive understanding of the analyzed data, emphasizing the proposed solutions to the identified problems.

This emphasis on the importance of water underscores the need for sustainable water management practices, as maintaining water purity is not only essential for physical well-being but also for spiritual observance in the Islamic context. The findings contribute to a broader understanding of how religious values can intersect with sustainable practices, advocating for responsible water usage and management to improve overall quality of life.

Table 1: The Uses of Water from the Perspective of the Qur'an

The Uses of Water	Surah/ Chapter of the Quran
As a drink for humans and animals, it also nourishes plants	Al-Nahl (16): 10 Al-Wahibah (56): 17-21
A physical cleansing agent (for the body, clothing, and living space) and a spiritual cleanser (from the disturbances of evil entities)	al-Muddathir(74): 4 Al-Anfal(9): 11
Nourishing the environment, greening the landscape, and balancing the ecosystem	al-Nahl (16): 65 al-Rum (30): 24 al-Hajj (22): 63
The sources of sustenance through economic activities such as agriculture, livestock farming, and fisheries	al-Baqarah (2): 22 al-Jathiyah (45): 12 al-Ma'idah (5): 96
The medium of communication between regions and internationally	al-Luqman (31):31
The development of knowledge	al-Mulk (67): 30

Source: Mokhtar & Abdullah (2012)

The table above highlights the importance of water sustainability for the maintenance of life. Water is not only essential for drinking by humans, animals, and plants, but also serves as a critical element for sanitation, economic development, human interaction, and the advancement of knowledge. In Islam, proper water management is strongly emphasized to ensure that other aspects of life proceed smoothly. The issue of clean water for a sustainable quality of life has garnered both global and local attention. The United Nations has declared the Sustainable Development Goals (SDGs) as a global initiative to eradicate poverty, protect the planet, and improve human life (https://www.undp.org/sustainable-development-goals).

There are 17 SDGs, with the 6th goal focused on clean water and sanitation. This goal includes eight specific targets: (6.1) ensuring safe and affordable drinking water, (6.2) ending open defecation, (6.3) improving water quality, treating wastewater, and promoting safe reuse, (6.4) increasing water-use efficiency and ensuring freshwater supply, (6.5) implementing Integrated Water Resources Management (IWRM), (6.6) protecting and restoring water-related ecosystems, (6a) expanding water and sanitation support to developing countries, and (6b) supporting local participation in water and sanitation management. The diagram below illustrates SDG 6.

Figure 1: Goal 6 Clean Water and Sanitation



To strengthen the theoretical foundation of this study, a conceptual model is proposed to illustrate how waqf can contribute to achieving SDG 6 (Clean Water and Sanitation). The model integrates three core elements: (1) Islamic moral governance, (2) sustainable resource management, and (3) community empowerment.

In this model, waqf functions as an Islamic social finance instrument that mobilizes endowment funds for the development, maintenance, and equitable distribution of water resources. By pooling charitable resources, waqf projects can finance the construction of wells, water filtration systems, and sanitation infrastructure in underserved areas. These initiatives directly support SDG targets 6.1 (safe drinking water), 6.3 (improved water quality), and 6b (community participation).

Furthermore, the model emphasizes maqasid al-shariah, the higher objectives of Islamic law, which include the protection of life (*hifz al-nafs*) and the preservation of the environment (*hifz al-bi'ah*). Embedding these objectives within water management practices ensures a balance between physical sustainability and spiritual accountability (Ismail, 2022).

Thus, the proposed conceptual framework, termed the "Waqf-SDG6 Synergy Model," demonstrates the pathway linking Islamic philanthropy (waqf) with global sustainable development goals. It highlights how Islamic ethical principles can provide an alternative governance mechanism to complement national policies on water sustainability (Hasan et al., 2021).

One of Malaysia's primary objectives involves transforming the water sector. As reported in the "Water Transformation 2040 Final Report" (2022), it was revealed that progress on target 6.5, which addresses integrated water resource management, has remained limited. Similarly, target 6.4, focusing on alleviating water scarcity and securing a stable freshwater supply, and target 6b, aimed at enhancing local community participation in water and sanitation management, continue to require substantial advancement. Consequently, this article underscores the importance of exploring an alternative approach through the implementation of waqf water initiatives. This method emphasizes collaboration between local communities and relevant authorities in managing water resources. The findings are anticipated to support governmental efforts in advancing the Water Transformation agenda set for 2024.

Water, Sanitation, Management and Legislation In Malaysia

The Malaysian government places considerable emphasis on water and sanitation management and regulatory measures. The system encompasses various essential elements, such as legislation, technical guidelines, oversight by governmental agencies, and strategic policies. Water sanitation management and legislation in Malaysia represent a coordinated endeavor involving stakeholders from the government, private sector, and community. From a legal standpoint, water and sanitation laws are vital to safeguard public health, protect the environment, and ensure the sustainable use of water resources. Three key laws governing water resources in Malaysia include the Environmental Quality Act 1974, the Water Services Industry Act 2006, and the Local Government Act 1976.

The Environmental Quality Act 1974 was specifically enacted to address environmental pollution in Malaysia, covering water, air, and land pollution. In terms of water and sanitation, the act primarily regulates the discharge of hazardous waste into water bodies, such as rivers, lakes, and seas, to prevent contamination. Stringent guidelines are outlined for industrial waste disposal into these sources, with penalties such as factory closures and legal action imposed on violators. Under this act, it is mandated that industries submit an Environmental Impact Assessment (EIA) report for any development projects that might potentially harm the environment (Department of Environment Malaysia, 1974).

The Water Services Industry Act 2006 governs the provision of water services and sanitation, including clean water supply and sewage treatment. The act ensures the delivery of high-quality, safe, and uninterrupted water services to Malaysian consumers. Regulations pertaining to the water services industry, which encompass water supply and wastewater treatment, are established to maintain public health standards. Furthermore, the act authorizes the National Water Services Commission (SPAN) to oversee and enforce these regulations, ensuring that water supply and sanitation services are safe and reliable (National Water Services Commission, 2006).

Under the Local Government Act 1976, local authorities are empowered to manage both domestic and industrial waste within their jurisdictions. Responsibilities include wastewater management, sewage system upkeep, and enforcement of health and safety regulations. The act grants local governments the authority to establish rules and guidelines for water and sanitation management at the district and urban levels. Additionally, a collaborative framework with other government agencies is established to improve the management of water resources. The act also authorizes local authorities to enforce cleanliness laws, such as regulating waste disposal into public drainage and water bodies (Attorney General's Chambers of Malaysia, 1976).

Development of Water Waqf In Islamic History

Waqf has been a pivotal instrument in the economic development of Islamic societies. Numerous studies have demonstrated its positive impact as a catalyst for local economic growth. The historical development of Islamic civilization shows that waqf has significantly benefited society in education, healthcare, social welfare, and economic development. The term "waqf" originates from the Arabic word "waqafa," meaning to stop or restrain. Imam al-Shafi'i defined waqf as the act of withholding a portion of assets for public benefit (Purwaningsih & Susilowati, 2020). Sabiq (2008) noted that in the Shafi'i school of thought, ownership of waqf property is transferred to Allah SWT, and cannot be sold or gifted.

Various forms of waqf exist, one of which is water waqf. Water waqf has played a vital role in ensuring a continuous water supply for communities, particularly in areas with limited access to clean water (Kahf, 1998). The practice of water waqf dates to the Prophet Muhammad's (PBUH) time. A notable instance occurred in Madinah, where a water crisis led to difficulties for the Muhajirin. They struggled to access clean water, as the Well of Raumah was privately owned by a Jewish man who sold water at high prices. Uthman ibn Affan (RA), one of the Prophet's companions, negotiated to purchase the well for public benefit. Initially, the Jewish owner resisted selling, but eventually, Uthman acquired half of the well, allowing the people of Madinah to draw water for free. Ultimately, Uthman purchased the entire well and donated it as a waqf for public use (Aziz et al., 2022; Ramli & Sulaiman, 2006).

The water waqf was also implemented extensively during the Ottoman Empire (1299–1922). Public fountains

(sabil) were funded by both government waqf institutions and private donations from the wealthy, such as sultans and nobles. The Fountain of Sultan Ahmed III in Istanbul, constructed in 1728, and the fountain at Sinan Pasha Mosque are notable examples of Ottoman water waqf projects (Shaw & Shaw, 1976). Similarly, during the Mamluk period in Egypt (1250–1517), public fountains and water channels were constructed and maintained through waqf institutions. These projects were vital for ensuring public access to clean water and were funded by charitable donations from the elite (Behrens-Abouseif, 1994).

In Andalusia, Islamic rulers from the 8th to the 15th centuries developed advanced water management systems supported by waqf. Innovations such as water channels and wheels were essential for agricultural irrigation, and their maintenance was overseen by waqf institutions. Public fountains, funded by waqf, were established to provide water for both urban and rural areas (Fierro, 1992).

In recent years, the concept of water waqf has been revitalized in Muslim-majority countries to address contemporary water scarcity issues. Countries like Indonesia, Cambodia, and Malaysia have implemented water waqf projects, constructing wells and rainwater harvesting systems to provide clean water, particularly in rural areas. Collaboration between governments and NGOs in Indonesia has facilitated the development of sustainable water solutions (Kahf, 1998). In Malaysia, the integration of waqf into national water management strategies has emphasized sustainability and equitable access. Efforts include rehabilitating traditional water systems and adopting new technologies (Abdul Karim & Murad, 2010).

3. Methodology

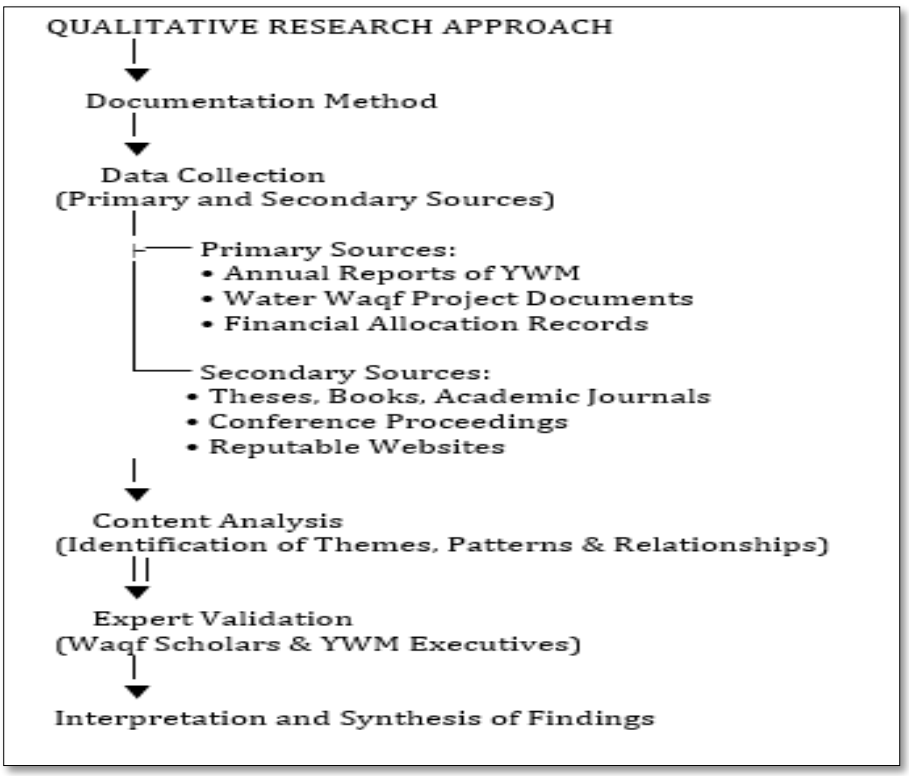
This study adopts a qualitative research approach, utilizing the documentation method to collect and interpret data. This method involves gathering, analyzing, and explaining patterns or themes relevant to the research from primary document sources, as described by Bowen (2009). The analysis focuses on annual reports, project documents, and budget allocation records related to waqf water projects across various states up to December 2023. The primary data comes from Yayasan Wakaf Malaysia (YWM), a key institution overseeing waqf management in the country, with an emphasis on water-related initiatives.

The documentation method also accommodates the use of secondary data (Lebar, 2015). In conducting content analysis, both primary and secondary data must align to ensure the findings are relevant and accurate (Talib, 2013). This research incorporates a broad range of sources, including both local and international materials, examining similar waqf water projects implemented in countries like Indonesia, Cambodia, and Thailand. Secondary sources include theses, books, academic journals, conference proceedings, and reputable websites, enriching the study's foundation.

Data analysis was carried out using content analysis, a method that systematically examines the collected information to uncover patterns, themes, and significant messages within the documents (Krippendorff, 2018). This approach provides an objective understanding of the data, allowing for an in-depth interpretation of the content and its implications.

To ensure the credibility of the findings, expert validation was conducted. Specialists in waqf studies, along with executive officers from YWM, reviewed the research findings to confirm their accuracy. This validation process is essential for maintaining the reliability of the study, as experts assess and provide feedback on the quality (Mayring, 2000). The involvement of field specialists ensures that the research outcomes are accurate, meaningful, and relevant, contributing to the broader knowledge base of waqf water initiatives (Yegidis et al., 2018).

Figure 2: Research Process



4. Results and Discussion

Development of Water Waqf in ASEAN

The Association of Southeast Asian Nations (ASEAN) is a regional organization established on 8 August 1967 through the Bangkok Declaration by five founding countries: Indonesia, Malaysia, the Philippines, Singapore, and Thailand. ASEAN currently has ten member countries, including Brunei, Vietnam, Laos, Myanmar, and Cambodia. ASEAN aims to strengthen cooperation in the political, economic, and security fields and promote peace, stability, and prosperity in Southeast Asia. ASEAN also aims to build the ASEAN Community based on three main pillars: the Political-Security Community, the Economic Community, and the Socio-Cultural Community (ASEAN Secretariat, 2022).

In ASEAN countries, the concept of water waqf was introduced as one of the measures to ensure access to clean water for underserved communities. Water waqf is an initiative where waqf funds are used to provide water infrastructure or build clean water supply systems for communities in need. In Indonesia, for example, organizations such as Dompet Dhuafa and Badan Wakaf Indonesia (BWI) are active in water waqf programs, providing access to clean water in rural areas (Dompet Dhuafa, 2022). In Malaysia, the Yayasan Wakaf Malaysia (YWM) also implements similar programs to increase water access for marginalized communities (Yayasan Wakaf Malaysia, 2023). These efforts not only help the local community but also promote the practice of waqf as a social support mechanism in Islam.

Research by Bakar & Rahman (2021) identified significant water-related challenges in Malaysia, such as river pollution, high water demand, and reliance on surface water sources. Contributors to water quality degradation, including agricultural runoff, sewage discharge, and saltwater intrusion, were highlighted by Syed Abdullah et al. (2024). Issues like inefficiency in water distribution have also been documented (Sukereman, 2017).

Alternative water supply solutions, such as harim, have been proposed to ensure sustainable water resources. Harim areas, encompassing wells and rivers, should be preserved from development to maintain their ecological quality. Bakar & Rahman (2021) advocated for water well waqf, emphasizing groundwater's

resilience during dry seasons. Groundwater wells, often found in rural areas, can be established through waqf initiatives to address water crises (Md. Khalid et al., 2021).

Rainwater harvesting has also been identified as a viable alternative, as Malaysia's high rainfall can be effectively utilized. According to Azmi et al. (2023), rainwater harvesting systems, such as backyard or underground storage, have shown promise. These systems collect rainwater, which is stored and treated for use. The estimated cost of such a system is RM2200 per project. While cost-effective, challenges such as water pressure and storage must be managed (Asmuni et al., 2016).

From 2020 to 2022, Yayasan Wakaf Malaysia (YWM) initiated ten water waqf projects across several Malaysian states, significantly benefiting communities by providing clean water. These initiatives have also served as platforms for da'wah and ongoing rewards for donors. The water waqf initiative, launched in collaboration with the Ministry of Energy Transition and Water Transformation (PETRA), aligns with national strategic plans to ensure water resource resilience (Aziz et al., 2022; National Water Resources Policy Document, 2012). As of the end of 2023, YWM has expanded its efforts, focusing on rural areas where access to clean water remains limited.

Figure 3: Distribution of Water Waqf in Malaysia Until December 2023



Source : Portal Rasmi Yayasan Wakaf Malaysia, https://www.ywm.gov.my/wakaf-air, 13 Mac 2024

The chart above illustrates the distribution of water waqf among the states in Malaysia up to December 2023. The infographic highlights three states with the highest number of water waqf assistance: Kedah (21 projects, RM877,464), followed by Kelantan (16 projects, RM736,081), and Pahang (11 projects, RM571,805). The total amount of waqf funds collected stands at RM4,560,738.61, indicating a high level of awareness among Malaysians regarding charitable contributions and social welfare efforts.

There are two main components of the water waqf fund distribution: the cash waqf received (Taslim) and the waqf benefits fund (Tauzi). The cash waqf received refers to the funds that have been expended and are necessary for maintaining the 'Ayn or the waqf water assets. In contrast, the waqf benefits fund encompasses other expenditures needed to sustain the objectives of establishing a water waqf (Application Form for Waqf Fund for Water Waqf Project Implementation, YWM Portal).

Water waqf is also implemented in several countries within the Nusantara region. For instance, Indonesia implements water waqf even though it is not primarily aimed at economic enhancement, but rather for daily use and religious practices (Nawwaf & Saifulloh, 2023). The issues and trends in Indonesia are similar, with challenges in accessing clean water in certain areas, particularly during dry seasons, due to the depletion of clean water sources (Kaslam & Mubarak, 2021). This situation is concerning, as water shortages are occurring

even in major cities and regions like Pamekasan (Mustajab, 2022). A World Bank study conducted in 2006 found that half of Indonesia's population had lost access to clean water, adversely affecting health and community activities. This led to the spearheading of programs providing clean water assistance managed by the government, companies, and non-profit organizations. Water resources are believed to serve as an object of charity and waqf, as they can significantly aid community livelihoods (Mustajab, 2022). Research by Thajudeen (2018) indicates that waqf has played a crucial role in financing numerous water infrastructure projects that have benefited communities for years.

One prominent waqf organization in Indonesia is Dompet Dhuafa. Dompet Dhuafa is a non-profit entity in Indonesia dedicated to advancing social and humanitarian development through ZISWAF funds (Zakat, Infaq, Shodaqoh, Waqf). According to Indonesia's Law No. 38 of 1999 concerning the management of zakat, Dompet Dhuafa is an institution established by the community to manage zakat. On October 8, 2001, the Minister of Religious Affairs of the Republic of Indonesia issued Decree No. 439 of 2001, which established Dompet Dhuafa Republika as a national zakat management institution sourced from the Dompet Dhuafa website https://ntt.dompetdhuafa.org/sejarah/.

According to Indonesian law, particularly Law No. 41 of 2004 concerning Waqf, water sources have not yet been explicitly stated as one of the waqf objects. The implementation of Law No. 41 of 2004, in Article 19, paragraph 3, mentions that water sources can be designated as waqf objects. However, detailed guidelines for implementation have not yet been specified (https://www.bwi.go.id/wp-content/uploads/2019/09/Undang-undang-No.-41-2004-Tentang-Wakaf.pdf).

This initiative spans several provinces in Indonesia, including Jabodetabek, West Java, Central Java, East Java, Yogyakarta, South Sulawesi, Riau, East Flores, North Sumatra, and East Kalimantan. There are also plans for waqf well development in various locations such as Pulau Buano and Pasir Panjang-Ambon; Kota Waringin Timur in South Kalimantan; Dusun Leboyo in Lamongan; Desa Kasihan in Pacitan; Pondok Pesantren Hasan Munadi in Ponorogo; Dusun Soroyati in Papua; Kampung Wisata Ciomas in Serang; Dusun Polay in Situbondo; Kendari and Konawe Selatan in South Sulawesi (https://donasi.dompetdhuafa.org/wakafsumur/)

In Cambodia, water waqf through wells is also used as an initiative for water sourcing, particularly in rural areas where access to clean water is limited. Organizations involved in well waqf projects in Cambodia include Al Ridzuan Haramain Sdn Bhd, Koperasi Kohannan, Al-Ameen Serve Holdings Sdn Bhd, and Pertubuhan Amal Kebajikan Ar Rasyid. According to Suja (2022), waqf wells not only address water issues but also enhance public health by reducing waterborne diseases. A piped water delivery system is also a popular form of water waqf development, allowing communities to receive a direct water supply to their homes.

Research by Aminah & Khairul (2021) indicates that this system has saved time in obtaining water, thereby increasing the daily productivity of residents. The construction of water tanks to store rainwater and clean water has been introduced as an alternative solution. Research by Farah (2023) found that these water tank projects improve water availability during dry seasons and alleviate pressure on natural water sources. Initiatives to introduce water filtration technology through water waqf have also received attention. Several projects have integrated filtration systems with water sources, ensuring cleaner and safer water for use. Field studies by the Mekong Institute (2023) have shown positive health impacts in communities after implementing these systems. The types of water waqf development in Cambodia have successfully addressed water issues, water delivery systems, water storage tanks, and water filtration technology. Research by Mustapa (2022) also indicates a decrease in infectious disease incidents in areas that have received water waqf projects.

In Brunei, water waqf practices and challenges vary based on local contexts, despite being rooted in the Islamic society. Water waqf practices are not formally documented as a system because waqf contributions do not require registration and are entrusted solely to the receiving parties (Mohiddin, 2021). However, the country boasts advanced water management infrastructure overseen by the Brunei Islamic Religious Council (MUIB) and other government bodies, in line with sustainability principles and public welfare. Although there are charitable water-related initiatives, they do not meet the criteria to be recognized as a water waqf under Islamic law (Water Action Hub, 2024). Water supply infrastructure, including dams and reservoirs, plays a crucial role in ensuring water security, with efforts to protect water quality being a priority due to Brunei's reliance on surface water sources.

Conversely, Thailand faces challenges in managing waqf assets due to less comprehensive legislation and traditional practices that require modernization. Water waqf has received less attention compared to land waqf, building waqf, and cash waqf. In Thailand, all religious affairs, including waqf, zakat, and fitrah, are managed collectively by the Chularajmontri, the State Committee for Islamic Affairs, and the Mosque Committee (Saputra, Brilliyandra & Syahpawi, 2024). The focus in Thailand is on improving management and development of land waqf, including those related to water resources, to enhance utility and profitability for communities (Water Action Hub, 2024).

Water Waqf Projects In Malaysia

The concept of civilization development worldwide is often described as being closely linked to the establishment of settlements along river valleys, which gradually transformed into urban centers as human populations concentrated in these areas. Similarly, the development of Malay civilization in the Nusantara region has also flourished near river valleys or areas with water sources. It is customary for inhabitants to reside in areas where access to a water supply is readily available, as it is a fundamental necessity. Historically, wells, river water, and lake water have constituted vital sources for the residents of Malaya in their daily lives (Abdullah, 2017).

The water supply system that utilises piping networks to deliver water to key areas was reported to have been introduced by the British. This system facilitated the distribution of water to residential areas and main roads in certain districts (Malaysia Water Industry Report, 1995). With the passage of time and advancements in technology, the piping system has been enhanced to facilitate the delivery of treated clean water more efficiently. However, many rural areas, particularly those in the interior, continue to face challenges in accessing clean water, likely due to various factors, including the high costs associated with constructing distribution systems relative to the number of users in those areas.

Figure 4: The construction of Waqf Water Wells in several locations in Kedah and Pahang



Source: Personal collection from the researcher's site visits

Currently, there are alternatives provided by the Yayasan Wakaf Malaysia (YWM), which offers a platform for collecting water waqf funds. These funds are then allocated to specific areas based on applications submitted by community representatives.

Figure 5: Construction Works of Waqf Water by Yayasan Waqaf Malaysia



Source: Image Collection of Yayasan Waqaf Malaysia.

The waqf instrument has been recognized by many scholars as having the potential to assist and develop the economic well-being of communities. In light of this awareness, the Yayasan Wakaf Malaysia (YWM), in collaboration with the Ministry of Energy Transition and Water Transformation (PETRA), launched the water waqf initiative on December 17, 2020 (https://www.ywm.gov.my/aktiviti/126). Over the course of three years, YWM has successfully implemented 75 projects across several states in Peninsular Malaysia, Sabah, and Sarawak, generating funds through cash waqf contributions. The following table outlines the water waqf projects that were completed, categorised by year and state in Malaysia.

Table 2: Number of Waqf Water Projects and Waqf Fund Distribution (RM) until December 2023 by State in Malaysia

State	Total Projects	Distribution of Funds (RM)
Kelantan	16	RM736,081
Selangor	4	RM120,653.98
Johor	2	RM 82, 276
Perak	5	RM181,655
Kedah	21	RM877,464
Pahang	11	RM571,805
Negeri Sembilan	3	RM109,865
Sarawak	9	RM611,952
Sabah	4	RM286,109
Total Projects by Year/ Total Overall Distribution (RM)	**75**	RM 3,577,860.98

Source: Document Data from Yayasan Waqaf Malaysia

Table 2 presents the number of waqf water projects and the distribution of waqf funds (in Malaysian Ringgit) as of December 2023 by state in Malaysia. In total, 75 projects have been implemented nationwide, with an accumulated fund amounting to RM3,577,860.98. The state of Kedah recorded the highest number of projects, with 21 projects and a total fund allocation of RM877,464, making it the state that benefited the most from this program. Kelantan ranked second with 16 projects and a total fund of RM736,081, followed by Pahang in third place with 11 projects and a fund allocation of RM571,805.

In contrast, Johor recorded the lowest number of projects and funds, with only two projects and a total fund of RM82,276. Sarawak, despite implementing nine projects, also demonstrated a relatively significant fund allocation of RM611,952, highlighting a strong commitment to the development of waqf water projects in the region.

Overall, the variation in the number of projects and the amount of funds distributed across states reflects the prioritization given to specific states based on their needs and the effectiveness of project implementation. This effort clearly aligns with the primary objective of the waqf water program, which is to provide access to clean water for communities while optimizing waqf resources for the overall benefit of society.

Comparative Analysis of Water Waqf Implementation between Malaysia and ASEAN Countries

A critical analysis of water waqf implementation in Malaysia compared to other ASEAN countries such as Indonesia, Cambodia, and Thailand reveals notable differences in terms of policy, governance, and project effectiveness. Malaysia appears to be more advanced in the areas of institutionalization and policy integration between government agencies and waqf institutions.

Conversely, Indonesia demonstrates significant strengths in community engagement and its extensive network of waqf institutions. Through the Badan Wakaf Indonesia (BWI), a variety of productive waqf programs have been implemented with the support of non-governmental organizations and local communities. However, the main challenge in Indonesia lies in the monitoring process and the transparency of financial reporting, which often vary across regions (Rahman, 2022). This highlights the need for a centralized data management model, similar to that practiced by Yayasan Wakaf Malaysia (YWM).

In Cambodia, the implementation of water waqf primarily focuses on meeting the basic needs of the Muslim minority communities, particularly in the regions of Kampong Cham and Phnom Penh. These initiatives are largely supported by external organizations such as the Yayasan Islam Malaysia (YIM) and several Middle Eastern NGOs (Judijanto et al., 2024). Although the projects have had a positive impact on community welfare, challenges related to human resources and monitoring systems have limited the long-term sustainability of these initiatives.

Meanwhile, in Thailand, water waqf implementation remains at an early stage and faces legal and administrative constraints. Waqf management in Thailand is collectively administered by the Chularajmontri, together with the State Islamic Affairs Committee and Mosque Committees (Saputra, Brilliyandra & Syahpawi, 2024). The current focus remains primarily on land and building waqf development rather than water-related waqf projects.

Overall, this analysis suggests that Malaysia has a distinct advantage in governance structure and policy support, while Indonesia excels in community participation and innovative financing mechanisms. Cambodia and Thailand, on the other hand, display emerging potential but require more structured institutional frameworks to ensure effective and sustainable implementation. To strengthen water waqf practices at the ASEAN level, it is essential to promote regional integration and knowledge exchange through a collaborative platform that incorporates elements of Islamic governance, sustainable development, and water resource sharing. This approach not only contributes to the realization of Sustainable Development Goal (SDG) 6: Clean Water and Sanitation, but also reinforces the role of waqf as a sustainable mechanism for socio-economic development across the region.

5. Conclusion

Water is a fundamental resource essential for human survival and well-being, encompassing economic, social, educational, and religious dimensions. However, global challenges such as climate change, environmental degradation, poverty, and the scarcity of clean water have adversely affected both the quality and accessibility of water resources worldwide. These conditions necessitate innovative and sustainable approaches to water resource management. In this context, water waqf emerges as a faith-based and community-driven mechanism that aligns with the principles of sustainability and social welfare. Its implementation can be adapted according to local needs and circumstances.

From a practical perspective, the study emphasizes that Islamic social finance instruments, particularly waqf, have the potential to play a strategic role in supporting sustainable water management. The findings carry significant implications for policymakers, practitioners, and researchers. Policymakers are encouraged to recognize waqf as an integral component of national water strategies, thereby fostering cross-sectoral collaboration between Islamic institutions, government agencies, and communities.

Future research is recommended to employ empirical methods such as interviews or surveys in Malaysia and other ASEAN countries to achieve a more comprehensive understanding. Such studies could enhance the sustainability and effectiveness of water waqf initiatives, which hold great potential in ensuring water security and promoting sustainable livelihoods. Ultimately, water waqf can serve as a transformative instrument for advancing Sustainable Development Goal 6 (Clean Water and Sanitation) while strengthening holistic human development.

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Microcredit and Poverty Alleviation: A Bibliometric Analysis of Global Research Trends and Intellectual Structure Space

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Abstract: This study conducts a comprehensive bibliometric analysis to map the global research landscape on microcredit and poverty alleviation, addressing the central question: What are the global research trends and intellectual structures within this field? The analysis follows a systematic approach guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure transparency and replicability. A total of 257 Scopus-indexed publications from 1996 to 2026 were examined. To ensure analytical robustness, the study employed Harzing's Publish or Perish (PoP) and OpenRefine to extract and refine citation metrics, facilitating the calculation of key indicators such as the h-index, g-index, citation counts, and average citations per paper (Harzing, 2007). The study also employs VOSviewer to examine publication patterns, co-authorship networks, keyword co-occurrence, and network visualization. In addition, the results reveal a steady increase in publications since 2017, aligned with the Sustainable Development Goals and digital financial inclusion initiatives. World Development, Journal of Development Studies, and Economic and Political Weekly emerged as the most active source titles. Citation analysis demonstrates a mature intellectual structure, with highly cited works such as Karlan and Zinman (2011) and Crépon et al. (2015) highlighting a methodological shift toward causal inference. Collectively, the findings underscore the field's evolution toward interdisciplinary, evidence-based inquiry that continues to shape global poverty alleviation discourse.

Keywords: *Microcredit, Poverty alleviation, Financial inclusion, Bibliometric analysis, Sustainable development*

1. Introduction

Microcredit has become both a strong tool and a contentious one in the global battle against poverty. By giving out small loans to the underserved population, mainly those excluded from traditional banking systems, microcredit has been hailed as a route to financial inclusion, entrepreneurship growth, and better living standards (Burket, 2018; Felix, 2023). Since the inception of Grameen Bank in Bangladesh, microcredit has taken center stage globally, not only as a social innovation but also as a financial mechanism that promises to transform lives. Its prominence has grown alongside global commitments toward fulfilling the United Nations' Sustainable Development Goals, particularly Goal 1 about eradicating poverty.

Over the past couple of decades, microcredit research has grown significantly, reflecting varied standpoints on its potential benefits and constraints. Bibliometric reviews identify a rapid growth of publications after the 1997 MicroCredit Summit, with the United States and South Asia as the leading contributors to the literature (Ali et al., 2023). Researchers have examined topics relating to financial inclusion, gender empowerment, and sustainable development (Akbari et al., 2025; Nogueira et al., 2020), although critical works have also pointed to concerns with high interest rates, repayment pressures, and other perverse consequences that may further heighten vulnerability among the poor (Jahiruddin et al., 2011; Phan et al., 2023). Geographically, research covers the regions of South Asia, Sub-Saharan Africa, Latin America, and the Middle East, which range across those with the largest microcredit initiatives globally (Sarkodie & Maloma, 2025; Bhuiyan et al., 2017).

In this dynamically evolving field of knowledge, bibliometric analysis provides a systemic means of mapping research output, intellectual structures, and emerging trends. Using VOSviewer and RStudio, among other tools, allows researchers to trace networks of co-authorship, keyword co-occurrence, and patterns of citation, thus revealing gaps and opportunities for future inquiry (Ali et al., 2023; Hassan et al., 2023). Building on such

approaches, this study synthesizes global research on microcredit and poverty alleviation in order to comprehensively understand the nature and direction taken by scholarly contributions. This not only captures the intellectual landscape but also identifies consensus, divergence, and innovation in the field.

Extensive scholarship notwithstanding, there are significant challenges that remain in order to reconcile the promise of microcredit with its contested realities. Though studies document positive impacts related to poverty reduction, enhanced entrepreneurial activity, and women's empowerment (Garcia et al., 2020; Kato, 2023), other findings have pointed out persistent over-indebtedness, structural limitations, and gender imbalances within program outreach (Barsoum, 2006; Jahiruddin et al., 2011). This paper specifically addresses the fragmented nature of existing understandings regarding how microcredit has been conceptualized, studied, and critiqued on a global scale. In the absence of such a bibliometric perspective, stakeholders run the risk of overlooking progress achieved and the areas needing deeper attention.
Therefore, this investigation has been informed by the following question: What are the global research trends and intellectual structures in the literature on microcredit and poverty alleviation? This central question orients the bibliometric analysis, with the aim of uncovering patterns of knowledge production, influential contributions, and research gaps.

The remainder of the paper is organized as follows. Section 2 describes the methodology, detailing the bibliometric methods and data sources used. Section 3 presents the results, focusing on historical trends, dominant themes, and intellectual structures in the literature. Section 4 discusses the findings with respect to theoretical and practical implications; Section 5 concludes by describing some suggestions for future research directions and considering related policy matters. This layout thus allows the readers to follow a logical flow from background to analysis, leading to a better understanding of the role of microcredit in poverty alleviation research.

2. Literature Review

Research in the area of microcredit and its contribution to poverty alleviation has grown significantly over the past three decades, yielding a body of literature that expresses optimism and skepticism in equal measure. The central thread running through most of these studies is the ability of microcredit to provide financial access to the most marginalized sections, particularly in contexts where formal banking remains inaccessible. Evidence from Sub-Saharan Africa shows that microcredit programs have been successful in reducing headcount poverty, although this outcome has varied according to household income, education, loan terms, and agricultural participation (Sarkodie & Maloma, 2025). Correspondingly, there are studies based on South and Southeast Asian experiences that point toward microcredit's positive effect on the enhancement of entrepreneurial activities and improvement in livelihood strategies; however, the magnitude of impacts varies according to contextual and structural factors (Phan et al., 2023).

The major intellectual structure of microcredit research reveals the balance of two predominant approaches: the poverty alleviation paradigm and the financial sustainability paradigm. According to Cairó i Céspedes & Gómez González (2015), the former conceives microcredit as basically a tool for the development of poorer classes, while the latter puts more stress on the viability and efficiency of microfinance institutions to sustain lending operations. This duality leads one to a more general debate within the science, in which scholars are constantly balancing social objectives with financial imperatives. Further, gender has been a central theme, as many programs have been designed to target women, premised on the argument that women are more likely to invest in household welfare. While the studies confirm increased access of women to financial resources, critics thus far have argued that this may indeed be an unwanted feminization of microcredit, inadvertently marginalizing poor men and reinforcing gendered inequalities (Barsoum, 2006).

Despite these positive findings, significant scholarly debates still characterize the efficacy of microcredit provisions and their inadvertent consequences. For example, research conducted in Pakistan illustrates that while microfinance increases income, perceived high costs of services and repayment burdens can nullify its poverty-reducing impacts (Khan et al., 2024). In the same vein, higher interest rates are found to offset the household income increase, weakening the long-term effects of microcredit participation. Beyond income issues, vulnerability studies show that relatively well-off households benefit more from microcredit, while

poorer households face increased financial stress, which perpetuates debt cycles (Phan et al., 2023). These divergent outcomes have led scholars to warn against looking at microcredit as a one-size-fits-all solution.
Another stream of literature critiques the structural limitations of microcredit and the conditions under which it can be successful. Accordingly, Sarkodie and Maloma (2025) explain that the unsatisfactory impact of microcredit in Sub-Saharan Africa is linked to its incapability to overcome micro-, meso-, and macro-level barriers, such as weak institutions, a lack of financial literacy, and non-complementary investments in education and infrastructure. In addition, there have been many reports of over-indebtedness and even increased poverty among poor families, especially in Bangladesh (Jahiruddin et al., 2011). These findings underpin the importance of adopting comprehensive development frameworks that embed financial services within broader social and economic interventions.

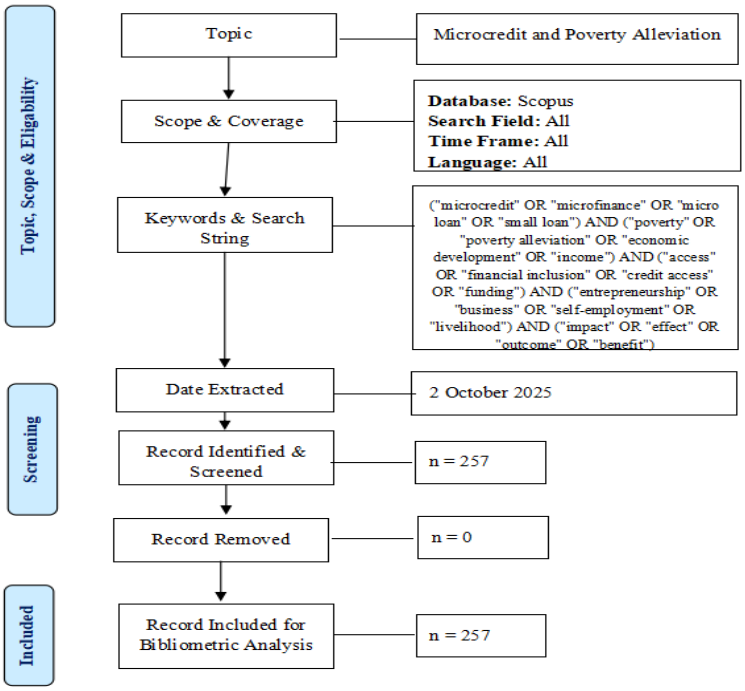
Finally, efficiency and sustainability remain a contested area in microcredit research. Though some MFIs prove to be highly efficient in terms of output maximization and input minimization, others grapple with cost inefficiencies that challenge their existence in the long term, according to Nourani, Malim, and Mia (2020). The diversity of findings exposes the gaps in understanding how institutional performance interacts with outcomes related to poverty, especially in different regional contexts. In sum, the literature reviewed above suggests progress along with fragmentation in the scholarly discourse. This study undertakes a systematic mapping of these global trends in research and intellectual structures by way of a bibliometric analysis, bringing clarity to the dominant themes, underexplored areas, and future research directions related to microcredit and poverty alleviation.

3. Methodology

Bibliometric Analysis Approach

Bibliometric analysis has become an essential methodology for the systematic examination of scholarly output, identification of intellectual structures, and the discovery of emerging trends across disciplines. In the context of microcredit and poverty alleviation, a bibliometric approach enables researchers to map quantitatively the knowledge production, evaluate citation networks, and unfold collaboration patterns among authors, institutions, and countries. This study uses Scopus as the primary data source because it provides the widest coverage of peer-reviewed journals, conference proceedings, and book chapters encompassing various disciplines. The Scopus database is generally recognized to have superior breadth and citation indexing compared to other databases, which renders it particularly suitable for mapping global research landscapes and securing reproducibility in bibliometric studies (Falagas et al., 2008; Mongeon & Paul-Hus, 2016). Apart from descriptive statistics, bibliometric mapping enables the tracing of the evolution of debates associated with microcredit, such as poverty alleviation, gender empowerment, and financial sustainability, while underlining areas that are poorly explored, like fintech integration and psychological impacts caused by microfinance. Therefore, bibliometrics provides a scientific, evidence-based overview of the development of the field at the same time as it furthers scientific knowledge through the guidance of policy-makers, practitioners, and academics toward more focused and effective research directions.

Figure 1: Flow Diagram of the Search Strategy



Data Collection

The bibliometric review on Microcredit and Poverty Alleviation was performed with the aim of transparency and replicability using the PRISMA framework. The topic scope and eligibility were then defined, limiting the review to research that studies the relationship between microcredit, microfinance, and poverty alleviation. In an effort to capture the most comprehensive dataset, Scopus was selected as the only database due to its extensive coverage of peer-reviewed journals, books, and conference proceedings across several disciplines, as well as its strong citation indexing capability (Falagas et al., 2008; Mongeon & Paul-Hus, 2016). The search strategy used included a Boolean keyword string in well-structured form, incorporating terms such as "microcredit," "microfinance," "poverty alleviation," "economic development," "entrepreneurship," "livelihood," and "impact" to ensure inclusivity of relevant studies.

The search was carried out on 2 October 2025, without restriction of publication year, subject category, or language, to allow full historical mapping of research output. This returned an initial 257 records, which were all screened for relevance. No irrelevant or duplicate records were identified, and all 257 documents were therefore included in the final dataset for bibliometric analysis. Data from Scopus were exported in BibTeX and CSV formats to capture bibliographic information including authors, titles, abstracts, keywords, affiliations, and citation counts.

Tools and Methodologies

This study employed specialized tools for the purpose of ensuring the accuracy and robustness of the bibliometric analysis: Harzing's Publish or Perish (PoP), OpenRefine, and VOSviewer. Harzing's PoP was used to extract citation metrics from the Scopus dataset in order to calculate some key indicators, such as the h-index, g-index, number of citations, and citations per paper, all critical to finding the most influential authors, journals, and articles in this field (Harzing, 2007). Because bibliographic data usually includes a lot of inconsistencies, like different ways of writing the names of authors, their institutional affiliations, and misspellings in keywords, OpenRefine has been used in this study for data cleaning and homogenization. Improving the reliability of the dataset through metadata reconciliation and duplicate detection constitutes an essential step toward network analysis (Verborgh & De Wilde, 2013). Co-authorship, co-citation, and keyword co-occurrence networks were visualized and mapped by using VOSviewer for intuitive graphical representations of the intellectual structure and the collaboration patterns within the field (Van Eck &

Waltman, 2010). These tools have guaranteed a systematic, replicable, and insightful bibliometric analysis that enhanced the quality of the data and supported the identification of emerging research fronts and global collaboration trends in the studies of microcredit and poverty alleviation.

4. Results

This section depicts the results of the bibliometric analysis on microcredit and poverty alleviation based on 257 records obtained from the Scopus database. The goal of the analysis is to map the global research trends and intellectual structure for this domain systematically. The findings are divided into four key subsections. Section 4.1 covers the year of publication, mapping the temporal evolution and growth trajectory of the research output in the field. Section 4.2 identifies the most active source titles, keyword analysis, citations by cited author, network visualization of terms in titles and abstracts (Binary Counting), highlighting the leading journals and publication outlets contributing to knowledge dissemination. Section 4.3 presents the citation analysis, emphasizing scholarly impact and citation performance. Finally, Section 4.4 discusses highly cited articles, spotlighting the seminal works of scholars constituting the theoretical and empirical basis of microcredit and poverty alleviation research. Together, these findings provide an overall understanding of the evolution, scope, and influence of scholarly work in the area.

Years of Publication

Table 1 shows that the distribution of publications in the past decade reflects a remarkable increasing trend of scholarly interest in studies of microcredit and poverty alleviation. While the highest output is in the year 2025, with 30 publications (11.67%), followed closely by 2023 with 29 publications (11.28%), 2024 comes third with 25 publications (9.73%). This reflects that microcredit is increasingly recognized as an important tool for poverty reduction in the wake of emerging global challenges such as recovery after the pandemic, climate change resilience, and the digitization of financial services (Donthu et al., 2021). Increased publication over these years may be related to heightened scholarly interest possibly due to the positioning of microcredit research within the Sustainable Development Goals and increased interest in financial inclusion for achieving social equity (Hassan et al., 2023).

Between 2017 and 2022, the publication trend illustrates constant production, with figures ranging between 12 and 21 documents annually. For example, 21 publications were recorded in 2017 (8.17%) and 20 in 2021 (7.78%), whereas 16 in 2022 (6.23%) and 14 in 2020 (5.45%) exhibit slight fluctuations. These trends reflect the maturation of the field, where researchers have started to consolidate their theoretical frameworks and explore diverse contexts, such as Sub-Saharan Africa and South Asia, where microcredit has been widely implemented (Sarkodie & Maloma, 2025; Bhuiyan et al., 2017). The relatively stable production of research during this period also points to the increasing institutionalization of microfinance studies, with contributions not only from economics and finance but also from interdisciplinary fields such as sociology, gender studies, and development policy.

In contrast, earlier years like 2016 and 2018 have relatively low rates of scholarly output, represented respectively by 8 (3.11%) and 12 (4.67%) publications. The small figures herald the actual slow build-up that has accelerated well since then. However, the single publication in 2026 stands at 0.39%, showing that for this particular year, many of its studies were still ongoing at the time of data retrieval; thus, further growth is expected once those studies get indexed. Temporally, the publication distribution underlines the historical progression of research into the modern dynamism of the field. It also reflects how global socio-economic transformations, policy priorities, and technological developments have shaped research trajectories on microcredit and poverty alleviation (Ali et al., 2023; Moed, 2017).

Table 1: Year of Publications

YEAR	TP	%
2025	30	11.67%
2024	25	9.73%
2023	29	11.28%

2022	16	6.23%
2021	20	7.78%
2020	14	5.45%
2019	18	7.00%
2018	12	4.67%
2017	21	8.17%
2016	8	3.11%
Total	257	100%

Most Active Source Title

The distribution across source titles further evidences the multidisciplinary nature of research in microcredit and poverty alleviation. Development in Practice stands out as the most prolific source, with six publications, or 2.33%. Indeed, this journal has long been at the forefront of applied development studies, combining theoretical debates with practical interventions within global poverty alleviation strategies (Nogueira et al., 2020). It tops the present ranking as a result of microcredit research's strong orientation toward policy relevance and real-world development practices. Articles published therein quite regularly explore how microfinance programs can link up with grassroots development initiatives that provide insights into sustainable and inclusive poverty reduction processes.

The second most prolific source is Sustainability (Switzerland), with five publications (1.95%), reflecting the growing interest in sustainability within the agenda of microcredit research. This corresponds to a broader understanding that microcredit, as part of financial inclusion, should be integrated into sustainable development frameworks, especially into the United Nations SDGs. Research in Sustainability often focuses on how microcredit can help empower vulnerable groups, advance gender equality, and improve resilience against economic and environmental vulnerabilities (Kato, 2023). Next to this, specialized journals such as Accounting, Finance, Sustainability, Governance and Fraud and the Journal of International Development, both 1.56%, show that financial governance and development economics perspectives remain very present in the discussion, with specific reference to efficiency, accountability, and the institutional structures framing microfinance systems (Ali et al., 2023).

High-impact journals such as World Development (1.56%) and American Economic Journal: Applied Economics (1.17%) also feature prominently, underscoring mainstream recognition of microcredit research in broader economic and policy contexts. These outlets are known for publishing rigorous empirical and theoretical analyses, thus enhancing credibility and visibility for microcredit scholarship. At the same time, specialized titles like Enterprise Development and Microfinance, and International Journal of Rural Management, demonstrate that dedicated platforms continue to play a very important role in fostering niche discussions on rural finance, community empowerment, and local-level implementation challenges. The diversity of sources, including interdisciplinary outlets like Frontiers in Public Health and Campbell Systematic Reviews, indicates that microcredit and poverty alleviation research has already gone beyond economics and finance into the domains of social sciences, health, and sustainability. This dispersion reflects the evolving intellectual structure of the field, wherein poverty alleviation is understood as a multifaceted issue requiring holistic inquiry.

Table 2: Most Active Source Title

SOURCE TITLE	TP	%
Development in Practice	6	2.33%
Sustainability Switzerland	5	1.95%
Accounting, Finance, Sustainability, Governance and Fraud	4	1.56%
Journal of International Development	4	1.56%
World Development	4	1.56%

American Economic Journal Applied Economics	3	1.17%
Cogent Business and Management	3	1.17%
Enterprise Development and Microfinance	3	1.17%
Lecture Notes in Networks and Systems	3	1.17%
A Research Agenda for Financial Inclusion and Microfinance	2	0.78%
AIDS	2	0.78%
African Journal of Food Agriculture Nutrition and Development	2	0.78%
American Journal of Applied Sciences	2	0.78%
Campbell Systematic Reviews	2	0.78%
Cogent Economics and Finance	2	0.78%
Cogent Social Sciences	2	0.78%
Frontiers in Public Health	2	0.78%
International Journal of Ethics and Systems	2	0.78%
International Journal of Financial Studies	2	0.78%
International Journal of Rural Management	2	0.78%

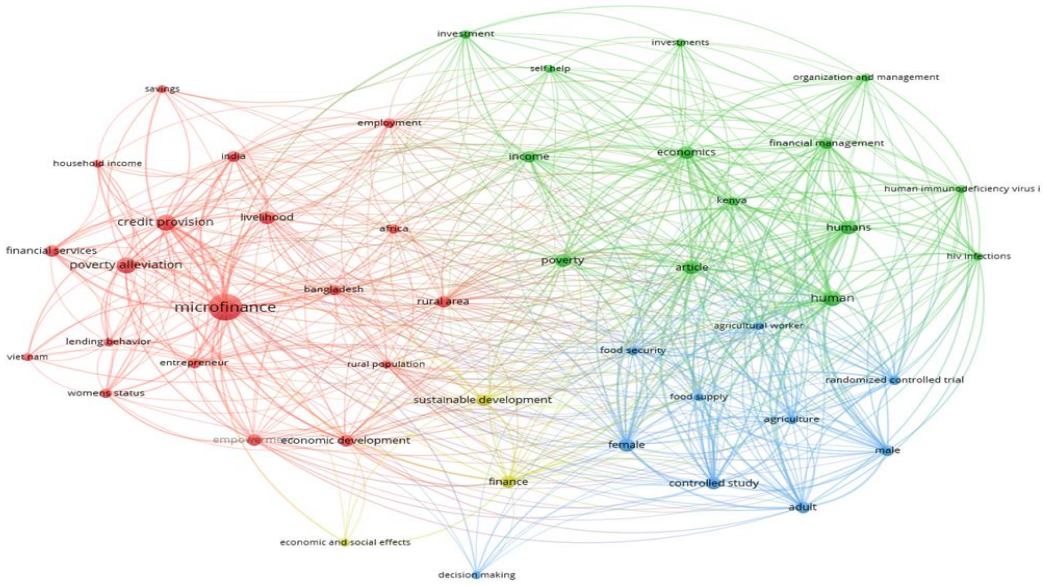
Co-Occurrence Keyword Analysis

Figure 2 indicates the intellectual and thematic structure of the literature on microcredit and poverty alleviation through its co-occurrence keyword network. Using VOSviewer, the analysis identifies four dominant keyword clusters, each representing an interconnected set of themes that shape scholarly discourse within this domain. The themes associated with the red cluster are microfinance, poverty alleviation, and entrepreneurship; hence, this represents the foundational research focus on microcredit as a development tool to improve livelihoods, promote women's empowerment, and stimulate income-generating activities in developing countries such as Bangladesh, India, and Vietnam. This cluster corresponds with early empirical studies focusing on assessing microfinance as a channel for direct poverty reduction through credit availability and entrepreneurial participation.

The green cluster identifies terms such as poverty, income, investment, and economics, resonating with the intersection between microcredit and macroeconomic outcomes. This thematic clustering would then indicate a growing scholarly attention toward the financial sustainability of microfinance institutions and the economic behavior of borrowers themselves (Armendáriz & Morduch, 2010). Co-linkage of keywords like employment or financial management shows a shift toward a perspective of microcredit's systemic contribution to sustainable economic growth and, in turn, to the attainment of the SDGs, particularly SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth) (United Nations, 2023).

Meanwhile, the blue cluster represents an emerging body of interdisciplinary research connecting microfinance to agriculture, food security, health outcomes, and gender. The co-occurrence of terms such as female, adult, and controlled study indicates a methodological evolution toward impact evaluation, including randomized controlled trials that test the impacts of microcredit on dimensions of human and social welfare (Karlan & Zinman, 2011; Crépon et al., 2015). Finally, the yellow cluster connecting sustainable development to economic and social effects and decision-making signifies the conceptual integration of microfinance within the greater sustainability frameworks. This reflects a shift from microcredit's narrow financial focus toward its role in promoting long-term social inclusion and resilience (Mader, 2018).

Figure 2: Co-occurrence Keyword Analysis



Citation by Cited Author

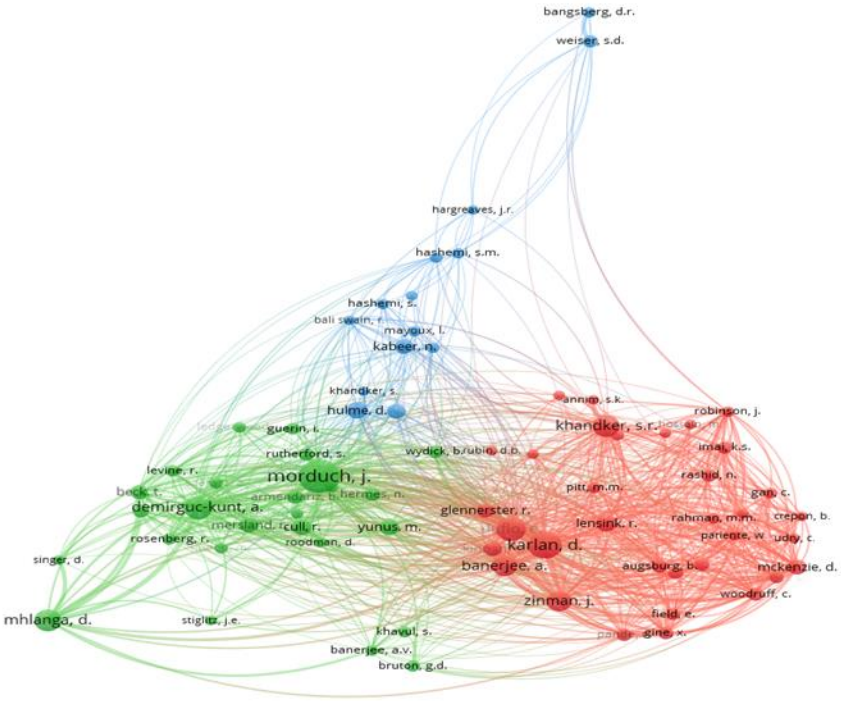
Figure 3 shows the co-citation network of cited authors, which maps the intellectual structure underlying research on microfinance and financial inclusion. Through this network visualization, it will become clear that the influential scholars who gave shape to the field via seminal theoretical and/or empirical contributions fall into three important groupings. Each color represents a distinct thematic grouping reflecting different research perspectives and disciplinary emphases.

The red cluster is dominated by influential figures such as Abhijit Banerjee, Esther Duflo, Dean Karlan, Jonathan Zinman, and Shahidur Khandker, and reflects the impact evaluation and experimental economics school of thought. These authors are central in randomized controlled trials that gauge the impacts of microfinance interventions. In particular, Banerjee and Duflo (2010) and Karlan and Zinman (2011) pioneered rigorous empirical methods for assessing whether microcredit programs really alleviate poverty. Pitt and Khandker (1998) provided foundational work using household survey data to measure welfare outcomes. Collectively, this cluster underlines evidence-based assessment of microfinance, focusing on outcomes such as income generation, women's empowerment, and entrepreneurial activity.

The green cluster represents the institutional and developmental finance perspective, Jonathan Morduch, David Hulme, and Muhammad Yunus. This cluster's work focuses on financial systems, mechanisms for poverty reduction, and sustainable financial inclusion. Demirgüç-Kunt, Klapper, Singer, Ansar, and Hess (2018) furthered the global financial inclusion agenda through the development of empirical frameworks like the Global Findex database. Morduch (1999) and Hulme and Mosley (2006) analyzed how microfinance contributes to poverty reduction while maintaining financial sustainability. Yunus (2007), founder of the Grameen Bank, emphasized the social mission of microfinance and spearheaded a global movement toward inclusive finance. This cluster thus integrates policy, social entrepreneurship, and financial innovation within the development context.

The blue cluster, which includes Naila Kabeer, Sylvia Chant, and Shah Mohammad Hashemi, focuses most on gender, empowerment, and social outcomes within microfinance research. Kabeer (1999) examined how access to credit relates to women's empowerment, especially in South Asia. Likewise, Hashemi, Schuler, and Riley (1996) evaluated microfinance participation by women in terms of its impact on household decision-making power and women's social capital. This cluster reveals how microfinance intersects with social development goals, particularly in fostering gender equity and community well-being (Mayoux, 2001).

Figure 3: Citation by Cited Author



Network Visualization of Terms in Titles and Abstracts (Binary Counting)

Figure 4 presents the network visualization of terms identified in titles and abstracts of publications related to microcredit, microfinance institutions, and poverty alleviation based on full counting. Contrary to binary counting, full counting considers the number of occurrences of terms in all documents; hence, it gives a better view of the intensity and interconnectedness of themes (Van Eck & Waltman, 2014). The map has five big clusters that are representative of distinct yet interrelated research domains within the broader discourse of microfinance and poverty reduction.

The yellow cluster is centrally positioned in the network and reflects the core research focus of the field, with high-frequency terms such as study, effect, evidence, outcome, enterprise, and intervention. This centrality indicates that empirical evaluations and impact studies dominate the literature, with a strong focus on the effectiveness of microcredit interventions in fostering enterprise performance and poverty alleviation (Banerjee et al., 2015; Pitt & Khandker, 1998). The interconnectedness of evidence, outcome, and intervention signals the methodological evolution of the field toward more robust, data-driven analyses, especially RCTs and quasi-experimental designs (Karlan & Zinman, 2011; Duvendack et al., 2011). In addition, the presence of microenterprise, financial literacy, and MSMEs suggests a growing interest in how microfinance contributes to small business sustainability and entrepreneurship development in LMICs (Cull et al., 2021).

The green cluster centers around words related to empowerment, gender, and rural development and is dominated by terms such as empowerment, woman, activity, self-help group, Bangladesh, India, and borrower. This thematic grouping highlights the gendered and community-oriented approaches characteristic of microfinance. Seminal works of Kabeer (1999) and Hashemi et al. (1996) illustrate how access to microcredit enhances not only women's access to financial resources but also strengthens their social status and decision-making capability. Other literature fortifies this story by investigating how women's participation in microcredit programs promotes household welfare and collective female empowerment (Mayoux, 2001; Al-Shami et al., 2016). Dense linkages between the concepts of rural woman, self-help group, and Bangladesh stress the impact of the Grameen Bank model, a trendsetter that remains a yardstick for inclusive financial innovation with a gender perspective (Yunus, 2007).

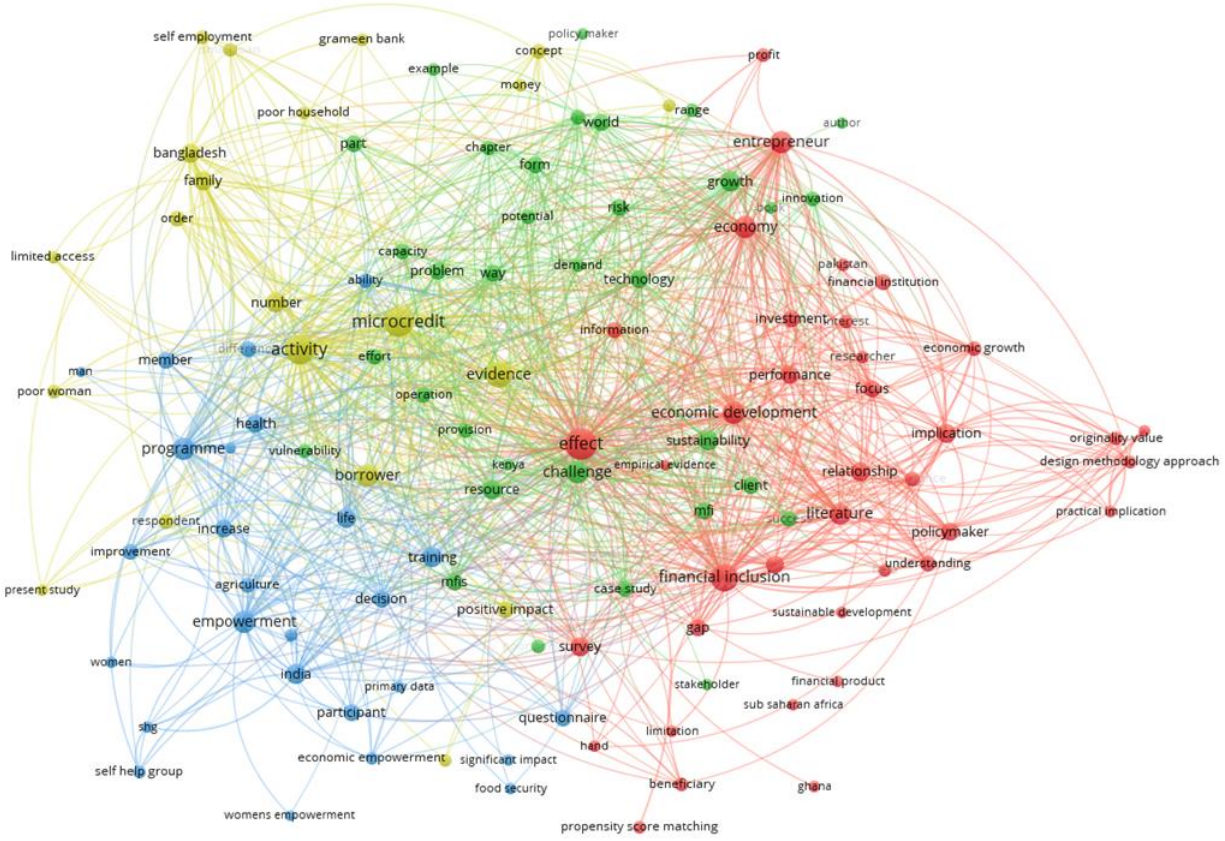
The red cluster is about the institutional structures and management practices related to the delivery of microfinance. The most common terms in this cluster are institution, participant, resource, management, and

practice. This cluster emphasizes aspects related to operational and managerial issues of MFIs, particularly in striking a balance between outreach, sustainability, and social performance (Armendáriz & Morduch, 2010; Ledgerwood et al., 2013). The co-occurrence of terms such as stakeholder, credit access, and project reflects the ongoing discourse on governance, performance assessment, and the role of social capital in an institution's success (Mersland & Strøm, 2010). Moreover, the linkage to climate change and vulnerability indicates an increasing awareness of MFIs' role in climate resilience and adaptive capacity for poor households (Chamberlin & Jayne, 2021).

The blue cluster emphasizes microfinance institutions and entrepreneurship performance. Some of the more salient terms include microfinance institution, performance, sustainability, social cohesion, and women entrepreneur, which would suggest a recent focus on the analysis of how microfinance supports small business performance and local economic resilience. Several scholars, such as Morduch (1999) and Karlan and Goldberg (2011), have stated that sustainable MFIs are important for sustaining long-term poverty alleviation effects, while more recent work has emphasized how the integration of digital financial services (FinTech) can be used to promote operational efficiency and increased financial inclusion (Demirgüç-Kunt et al., 2018).

The purple cluster represents environmental sustainability and vulnerability, with terms like climate change, agriculture, vulnerability, and resource management. This cluster reflects the new frontier of the intersection between environmental challenges and access to finance, especially in agriculture and rural settings. It shows that microfinance has transitioned from a limited financial tool to a comprehensive instrument in solving global sustainability and resilience problems.

Figure 4: Network Visualization of Terms in Titles and Abstracts (Binary Counting)



Citation Analysis

Citation analysis of the dataset covering 1996–2025 allows for a deeper exploration into the nature of scholarly influence that microcredit and poverty alleviation research have generated. In 257 papers, the dataset amassed 4,612 citations-17.95 citations per paper on average-with an average of 177.38 citations per year. This

indicates that over more than two decades, this line of inquiry has sustained its academic relevance, underpinning continuous global interest in the place of microcredit as a poverty-reducing tool. The visibility of the collected works is moderate, with 17.95 citations per paper on average, indicating that key works have shaped later scholarship and policy debates accordingly. Evidence includes Banerjee et al. (2015) and Morduch (1999). These results reveal the cumulative building of knowledge wherein foundational studies continue to provide intellectual scaffolding for modern-day inquiries.

The data indicate that the author-level productivity produced an average of 119.88 papers per author and 2,055.5 citations per author. Although this figure reflects bibliometric aggregation linked to co-authorship networks, it also points toward the collaborative nature of research in the field of microcredit studies. This is due to increased collaboration between economists, development practitioners, and regional scholars, further magnifying the reach and impact of studies on microcredit across boundaries into economics, finance, sociology, and development studies. The h-index is 33, indicating that at least 33 publications of this dataset have been cited 33 or more times. This confirms a high citation impact with continued academic recognition. The g-index of 61 reflects this effect of highly cited papers. It has indicated the presence of seminal works that contribute disproportionately to the dissemination of knowledge.

Taking all the citation metrics together, it can be said that microcredit and poverty alleviation research has grown into an established area of investigation with long-term academic impact. The balance between the breadth of citation dispersal, as reflected by the h-index, and citation concentration, as reflected by the g-index, indicates that while most papers enjoy moderate citation, a minority subset of highly cited works has driven the intellectual trajectory of the field. These results also support the presence of seminal works, including, but not limited to randomized control trials and conceptual frameworks, which continue to provide an intellectual anchor to scholarly debates about the effectiveness and limitations of microfinance. In general, citation analysis supports the dual role played by microcredit research in both pure theoretical inquiry and as a practical tool guiding poverty alleviation policies.

Table 3: Citation Analysis

METRICS	DATA
Publication years	1996-2025
Citation years	26 (1996-2025)
Papers	257
Citations	4612
Citations/year	177.38
Citations/paper	17.95
Citations/author	2055.5
Papers/author	119.88
h-index	33
g-index	61

Highly Cited Articles

The most cited article in the dataset is Karlan and Zinman (2011), with a total of 284 citations at an average of 20.29 per year. This study employs a randomized credit scoring design to assess the real-world impacts of microcredit. Indeed, it provides rigorous causal evidence of whether access to small loans improves household welfare. The methodological innovation in this paper utilizes lender practices to randomize credit access, which has become a benchmark in development economics for impact evaluation. Following closely behind, Crépon et al. (2015) come in a close second, with 264 citations or 26.4 per year. Crépon et al. present the findings from an RCT in Morocco that finds that while microcredit expands business investment and risk-taking among borrowers, it does not significantly increase average household consumption or women's empowerment. This nuanced result called into question earlier optimistic narratives about microfinance's transformative potential.

Another highly influential contribution is that of Attanasio et al. (2015), which deals with joint-liability

microfinance in Mongolia. This study, cited 229 times, reports moderate positive impacts on business creation but more limited impacts on broader welfare indicators like health or education (Attanasio, Augsburg, De Haas, Fitzsimons, & Harmgart, 2015). Highly distinctive is the critical theoretical stance of Mader (2018), cited 210 times at 30 per the highest annual rate in the list. Contesting Financial Inclusion interrogates the ideological and political dimensions of financial inclusion policies, which are often framed by the need to expand markets rather than any genuine concern for poverty alleviation as such.

Early foundational work includes Imai, Arun, and Annim (2010) and Karlan and Morduch (2010), both published in 2010 and accumulating over 200 citations each. Imai et al. (2010) use large-scale Indian data to show that microfinance access correlates with reduced poverty, especially in areas of higher program intensity. Meanwhile, Karlan and Morduch (2010) comprehensively reviewed barriers to financial access and relevant policy tools for overcoming them and thus constitute a core reference in the field of financial development. In contrast, recent work, not surprisingly, reflects the emerging interest in the interface between financial literacy and inclusive finance. Hasan, Le, and Hoque (2021) have received 189 citations in just three years from the date of publication, that is, 47.25 per year as of 2024, which indicates the growing scholarly attention being paid to the role of financial capability in enabling effective use of financial services.

Table 4: Highly Cited Articles

NO.	AUTHORS	TITLE	YEAR	CITES	CITES PER YEAR
1	D. Karlan, J. Zinman	Microcredit in theory and practice: Using randomized credit scoring for impact evaluation	2011	284	20.29
2	B. Crépon, F. Devoto, E. Duflo, W. ParientÃ©	Estimating the impact of microcredit on those who take it up: Evidence from a randomized experiment in Morocco	2015	264	26.4
3	O. Attanasio, B. Augsburg, R. De Haas, E. Fitzsimons, H. Harmgart	The impacts of microfinance: Evidence from joint-liability lending in Mongolia	2015	229	22.9
4	P. Mader	Contesting Financial Inclusion	2018	210	30
5	K.S. Imai, T. Arun, S.K. Annim	Microfinance and Household Poverty Reduction: New Evidence from India	2010	209	13.93
6	D. Karlan, J. Morduch	Access to finance	2010	196	13.07
7	M. Hasan, T. Le, A. Hoque	How does financial literacy impact inclusive finance?	2021	189	47.25
8	A. Tarozzi, J. Desai, K. Johnson	The impacts of microcredit: Evidence from Ethiopia	2015	182	18.2
9	J. Kim, P. Pronyk, T. Barnett, C. Watts	Exploring the role of economic empowerment in HIV prevention	2008	131	7.71
10	A. Asfaw, B. Simane, A. Hassen, A. Bantider	Determinants of non-farm livelihood diversification: Evidence from rainfed-dependent smallholder farmers in northcentral Ethiopia (Woleka sub-basin)	2017	99	12.38
11	M. Hudon	Should access to credit be a right?	2009	97	6.06
12	J.A. Brett	"We sacrifice and eat less": The structural complexities of microfinance participation	2006	84	4.42
13	S.D. Weiser, E.A. Bukusi, R.L. Steinfeld, E.A. Frongillo, E. Weke, S.L. Dworkin, K. Pusateri, S. Shiboski, K. Scow, L.M. Butler, C.R. Cohen	Shamba Maisha: Randomized controlled trial of an agricultural and finance intervention to improve HIV health outcomes	2015	75	7.5
14	P.W. Chirwa, S. Syampungani, C.J. Geldenhuys	The ecology and management of the Miombo woodlands for sustainable livelihoods in southern Africa: The case for non-timber forest products	2008	65	3.82
15	X. Li, C. Gan, B. Hu	The welfare impact of microcredit on rural households in China	2011	64	4.57
16	J.P.H. Poon, D.T. Thai, D. Naybor	Social capital and female entrepreneurship in rural regions: Evidence from Vietnam	2012	59	4.54

17	S. Mahmood, J. Hussain, H.Z. Matlay	Optimal microfinance loan size and poverty reduction amongst female entrepreneurs in Pakistan	2014	58	5.27
18	A. Dutta, S. Banerjee	Does microfinance impede sustainable entrepreneurial initiatives among women borrowers? Evidence from rural Bangladesh	2018	57	8.14
19	V.E. Jancenelle, R.R.G. Javalgi, E. Cavusgil	The role of economic and normative signals in international prosocial crowdfunding: An illustration using market orientation and psychological capital	2018	57	8.14
20	S.R. Halder, P. Mosley	Working with the ultra-poor: Learning from BRAC experiences	2004	55	2.62

5. Discussion and Conclusion

The bibliometric overview gives a comprehensive outlook into the global research landscape on microcredit and poverty alleviation, answering the research question on prevailing trends and intellectual structures. Publication pattern analysis indicates that scholarly attention has grown constantly from the mid-2010s, reaching a peak in three consecutive years, 2023-2025. This is an indicative trend of the greater recognition being attained by microcredit as a means to attaining United Nations SDGs, Goal 1 (No Poverty) and Goal 8 (Decent Work and Economic Growth) (Ali et al., 2023; Felix, 2023). A sustained rise in publications signifies deepening academic interest in the evolution of microcredit's contribution toward financial inclusion, gender empowerment, and entrepreneurial capacity, especially in low-income and developing economies (Bhuiyan et al. 2017; Kato 2023).

The source title analysis indicates that research outcomes in the area are concentrated within well-established journals, such as Development in Practice, Sustainability (Switzerland), and World Development, which are core outlets for the dissemination of interdisciplinary knowledge relating to development economics, sustainability, and social entrepreneurship. Indeed, Nogueira et al. (2020) and Akbari et al. (2025) bear witness to this fact. The leading position of sustainability-oriented journals indicates a conceptual shift from positioning microcredit as a tool for poverty reduction toward its positioning as a means for sustainable and inclusive development. Indeed, Cairó & Gómez (2015) build upon such a premise. This presents a larger intellectual evolution of the field, whereby there is a growing effort by scholars to embed the microfinance discourse within the frameworks of ethical finance, social justice, and environmental resilience.

Citation analysis further reinforces these findings, with an h-index of 33, 4,612 citations, and 257 publications, indicating a mature and influential body of literature. Highly cited works, including Jahiruddin et al. (2011) and Sarkodie & Maloma (2025), have framed both theoretical and empirical debates regarding the duality of impact that microcredit has to improve livelihoods, while its limitations take precedence when institutional and structural challenges prevail. The evidence underlines the paradigm shift in scholarly thinking-from optimistic narratives of microcredit success to critical assessments with emphasis on contextual factors such as governance, financial literacy, and institutional quality (Phan et al., 2023).

Network analyses further reveal three dominant thematic clusters. First, there is the cluster on financial inclusion and poverty reduction, showing the role of microcredit in bridging access gaps among marginal groups. The second cluster covers women's empowerment and entrepreneurship, a theme reflecting continuous attention to gender-sensitive approaches in processes of poverty reduction, as documented by Barsoum (2006) and Kato (2023). The third cluster stands for emerging research frontiers, especially digital finance, fintech innovation, and post-COVID resilience strategies, illustrating how the field has adapted to technological and socioeconomic changes. These clusters together reflect the intellectual structure of the discipline-that is, one which combines economics with gender studies and development policy to explore microcredit's multi-faceted contribution to sustainable livelihoods.

Even given these sound findings from the study, there is recognition of a certain methodological limitation: the source of data. The bibliometric analysis in the study was focused solely on data from the Scopus database. Even though Scopus is known for its wide international scope, this can also mean that relevant publications

indexed exclusively in WoS might be missed. This paper used Scopus because comprehensive metadata is available, citation linkage is robust, and there is greater coverage of journals dealing with development and social sciences compared to WoS factors which makes it very suitable for analyzing such highly interdisciplinary topics as microcredit and poverty alleviation. Burnham, 2006. In conclusion, the value of this paper can be seen in the mapping of the intellectual trajectory of microcredit research by surfacing the centrality and emergence of financial inclusion, gender empowerment, and technological innovation. This study can be furthered by subsequent research through the use of longitudinal and comparative bibliometric methods in tracking thematic shifts, investigating the infusion of digital microfinance in the post-COVID-19 era, and determining how regulatory transformations and those caused by fintech are impacting inclusive finance ecosystems. Mapping these trajectories will provide enhanced capability on the part of scholars and policymakers to utilize microcredit as a strategic tool for pursuing equitable and sustainable development outcomes.

It demonstrates that the intellectual landscape depicted is dominated by five thematic clusters, reflecting the emerging contours of research on microcredit and poverty alleviation. The network visualization of title and abstract terms represents the core research concepts in terms of frequency, centrality, and interlinkage based on full counting (Van Eck & Waltman, 2014). Accordingly, these clusters-yellow, green, red, blue, and purple-reflect the multicharacter evolution of the field from impact-oriented studies to sustainability-driven paradigms and technology-enabled paradigms. All these clusters outline the intellectual structure and emerging frontiers in the greater discourse of financial inclusion and development.

The yellow cluster is centrally positioned in the network and embodies the empirical and evaluative core of microcredit research. The high-frequency terms, such as study, effect, evidence, outcome, enterprise, and intervention, suggest that quantitative assessments and impact evaluations dominate scholarly attention (Banerjee et al. 2015, Pitt & Khandker, 1998). The strong co-occurrence between evidence, outcome and intervention underlines a methodological movement of the field toward rigorous designs, especially RCTs and quasi-experimental approaches (Karlan & Zinman, 2011, Duvendack et al. 2011). Related terms include microenterprise, financial literacy, and MSMEs, which reflect growing interest in the role of microcredit for entrepreneurship development and small business resilience, especially in low- and middle-income countries (Cull et al. 2021). This cluster, therefore, represents the empirical nucleus of microcredit research characterized by evidence-based assessment of its socioeconomic impact.

The green cluster centers on empowerment, gender, and rural development, reflecting the sustained academic and policy focus on women's empowerment as a central goal of microfinance. Terms such as woman, self-help group, Bangladesh, India, and borrower reveal the geographical and social specificity of this theme. Foundational studies by Kabeer (1999) and Hashemi et al. (1996) have shown that access to microcredit improves not only women's income but also their social agency and household decision-making power. Later research has taken these findings further by demonstrating how membership in self-help groups promotes collective empowerment and community solidarity (Mayoux, 2001; Al-Shami et al., 2016). The dense interlinkages among rural women, self-help groups, and Bangladesh reaffirm the lasting influence of the Grameen Bank model, which still stands as the archetype for gender-sensitive and community-based financial innovation (Yunus, 2007).

The red cluster encompasses institutional structures and management practices related to microfinance delivery. Key terms such as institution, management, participant, resource, and practice emphasize the operational and governance dimensions of MFIs. This cluster highlights research concerned with balancing outreach and sustainability, assessing social performance, and exploring the influence of institutional design on outcomes (Armendáriz & Morduch, 2010; Ledgerwood et al., 2013). These are, in turn, linked with stakeholders, credit access and the project. This hints at the performance evaluation literature, with emphasis put on social capital as a crucial vehicle toward attaining institutional sustainability (Mersland & Strøm, 2010). More interestingly, its recent co-occurrence with climate change and vulnerability shows that scholars have started paying increasing attention to the adaptive role of MFIs in building resilience amongst low-income populations facing environmental stressors (Chamberlin & Jayne, 2021).

The blue cluster is closely related but centers on microfinance institutions, entrepreneurship performance, and

sustainability. Key terms such as microfinance institution, performance, social cohesion, and women entrepreneur reflect the interaction of financial systems with enterprise outcomes. Classical work by Morduch (1999) and Karlan and Goldberg (2011) focused on the necessity of MFIs to achieve financial sustainability so that there could be long-term poverty reduction impacts. More recent work pushes this argument out toward digital financial services and FinTech integration that promotes efficiency, outreach, and inclusion (Demirgüç-Kunt et al., 2018). The interrelation between entrepreneurial outcomes and institutional innovation in this cluster reflects the way the sector is evolving adaptively to technologically enabled and socially driven business models.

Finally, the purple cluster illustrates an emerging frontier linking environmental sustainability with financial inclusion. The co-occurrence of terms like climate change, agriculture, vulnerability, and resource management reflects a conceptual shift toward recognizing microcredit's role in promoting ecological resilience and supporting sustainable livelihoods. This development marks the fact that microfinance is increasingly framed not just as an economic empowerment tool but also as a tool of environmental adaptation and climate risk mitigation (Chamberlin & Jayne, 2021). This kind of research chimes with global narratives of sustainability under the United Nations Sustainable Development Goals, particularly SDG 1 (No Poverty), SDG 5 (Gender Equality), and SDG 13 (Climate Action) (Ali et al., 2023; Felix, 2023).

Synthesizing insights from these five clusters, the field of microcredit and poverty alleviation demonstrates a distinct intellectual trajectory—shifting from isolated program evaluations toward a multidimensional framework that integrates gender, technology, institutional governance, and environmental sustainability. These interconnected themes reflect both theoretical maturation and methodological diversification. While the current analysis relied exclusively on the Scopus database, which may exclude relevant records indexed in Web of Science or regional repositories, Scopus was selected for its extensive coverage of social sciences and development economics and its compatibility with bibliometric visualization tools such as VOSviewer (Falagas et al., 2008; Martín-Martín et al., 2018). Future research could enhance robustness by triangulating databases to capture non-English or regionally focused studies that contribute to the evolving microfinance discourse. From a theoretical standpoint, these thematic clusters reveal an evolving intellectual structure anchored in three complementary paradigms: capability theory which frames microcredit as a means to expand human freedoms; institutional theory, which examines how organizational and policy environments shape microcredit outcomes; and innovation diffusion theory, which underpins recent studies on fintech-enabled financial access. Together, these frameworks enrich the understanding of how microcredit interacts with socio-economic systems to produce differentiated impacts.

Overall, findings indicate a turn in microcredit research from its early philanthropic narratives to a data-driven, contextually embedded, and technology-driven research agenda. Cross-regional comparative analyses between South Asia, Sub-Saharan Africa, and Southeast Asia might be further pursued in future studies to understand how regulatory, cultural, and digital infrastructures mediate the success of microcredit interventions. Furthermore, the incorporation of social networks and content analysis into future bibliometric studies could facilitate the identification of emergent research groups and cross-disciplinary collaborations, deepening insight into how the field continues to change in the digital era.

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Impact of Director Networks on Strategic Decision-Making: The Mediating Role of Information Flow

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Abstract: Strategic decision-making at the board level is increasingly shaped by directors' interorganisational networks. However, the mechanisms by which these structural positions translate into strategic influence remain underexplored. While existing scholarship acknowledges the value of director network centrality in enhancing resource access and legitimacy, the mediating role of information flow in converting this structural advantage into high-quality strategic decisions has received limited conceptual attention. Addressing this gap, the present study aims to develop a theoretical framework that explains how director network centrality influences strategic decision-making through board-level information flow. Using a narrative review methodology, this study synthesises 26 peer-reviewed articles sourced from the Scopus database. An integrative thematic analysis reveals three critical propositions: (1) director network centrality positively influences information flow; (2) information flow enhances strategic decision-making quality; and (3) information flow mediates the relationship between network centrality and strategic decision outcomes. The framework draws upon Resource Dependency Theory, Social Capital Theory, and the Knowledge-Based View of the Firm, offering a multi-level understanding of how network embeddedness, trust-based exchanges, and cognitive integration shape strategic governance. Theoretically, the study advances governance literature by positioning information flow as a cognitive mechanism within networked boards. Practically, it encourages organisations to reassess board effectiveness by considering directors' network positions and internal information-sharing capabilities. The paper concludes by identifying conceptual limitations and proposing directions for future empirical validation. This framework offers a fresh perspective on how boardroom dynamics can be leveraged to enhance strategic agility and decision quality in complex environments.

Keywords: *Director Network Centrality*, *Information Flow*, *Strategic Decision-Making*, *Corporate Governance*, *Board Dynamics*

1. Introduction

In the modern corporate landscape, strategic decision-making is no longer a function confined solely within organisational boundaries—it is increasingly shaped by complex inter-organisational relationships, particularly at the board level. Director interlocks and network centrality have emerged as critical conduits for resource exchange, reputation building, and, crucially, information flow. As boards evolve from traditional oversight bodies into strategic knowledge platforms, the structural positioning of directors within wider networks becomes essential in shaping not just what decisions are made, but how they are made. In an era defined by volatility, ambiguity, and disruption, understanding the mechanisms through which board-level networks influence firm-level strategy is both timely and consequential.

The extant literature on board governance has extensively examined the role of board composition, independence, and diversity in shaping strategic outcomes (McClane & Nili, 2021). However, a more nuanced body of research now suggests that it is not merely who sits on the board, but how they are embedded within broader networks that matters. Network centrality—an actor's prominence within the boardroom web—has been associated with superior access to external information, resource control, and increased legitimacy (Nicholson et al., 2004). Moreover, studies such as Bilgili and Bilgili (2024) underscore the importance of internal knowledge sharing and informal flows of information within board structures, highlighting how

network ties shape cognition, consensus-building, and ultimately, the strategic choices undertaken by firms. Yet, while this body of work has established important links, few studies have clarified the mechanisms—particularly the mediating role of information flow—that bridge the director network and strategic decision-making nexus.

This leads to a critical problem: despite increasing scholarly recognition of director networks as vehicles of influence, there remains limited conceptual clarity regarding how information circulates within these networks to affect strategy formulation. Most empirical models treat director centrality as a direct predictor of strategic outcomes, omitting the crucial mediating construct of information flow—a form of social capital that channels actionable intelligence, risk signals, and market cues. This study addresses this conceptual blind spot by proposing a framework where information flow functions as the mediating pathway through which director network centrality influences strategic decisions. By articulating this relationship, we offer a more precise understanding of why some firms consistently outperform others in strategic agility and foresight, despite similar formal governance structures.

The aim of this study, therefore, is to develop a conceptual framework that captures the mediating role of board-level information flow in the relationship between director network centrality and strategic decision-making. This fills a critical research gap at the intersection of social capital theory, strategic management, and corporate governance. In doing so, we respond to the call for more integrative models that capture the dynamic interplay between board structure and cognition (Pignatel, 2008). Our model synthesises insights from resource dependency theory, social capital theory, and knowledge-based views of the firm to offer a richer theorisation of how board connectivity translates into strategic foresight and firm competitiveness.

This paper is structured as follows. The next section reviews relevant literature on director network centrality, information flow, and strategic decision-making. We then outline the theoretical underpinnings and conceptual propositions that inform our model. This is followed by a discussion on the implications for governance practice and strategic management. The final section offers concluding remarks and suggestions for future empirical validation. Through this work, we aim to open new scholarly conversations about network-aware governance and provide practitioners with a more granular understanding of how board dynamics can be leveraged for superior strategic outcomes.

2. Literature Review

Director networks have long been recognised as a crucial dimension of corporate governance, shaping how firms access resources, legitimise actions, and make strategic decisions (McClane & Nili, 2021). At the heart of this discourse is the notion that directors are not isolated agents but rather embedded actors within a web of formal and informal relationships that extend beyond the firm. These interlocking directorships foster avenues for social capital, influence boardroom deliberations, and shape strategic trajectories. The study of director networks thus moves beyond individual qualifications or board structure, focusing instead on the strategic position of directors within wider governance ecosystems.

The structural position of a director within a network—commonly measured through centrality metrics such as degree, betweenness, or eigenvector centrality—serves as a proxy for their potential influence over informational access and diffusion (Nicholson et al., 2004). Central directors are likely to serve on multiple boards, possess rich interfirm linkages, and act as bridges between otherwise disconnected corporate actors. This embeddedness allows them to gather critical knowledge, develop normative legitimacy, and catalyse strategic change. Network centrality, therefore, is not merely about connectedness—it reflects strategic power, which can be mobilised to shape firm direction and performance.

Recent literature has started to unpack how this power operates. Fang, Pittman and Zhao (2021) found that directors with high external network centrality were instrumental in reducing stock price crash risks by enhancing firms' information environments. This effect, however, was not direct—it hinged on the capacity of directors to transmit timely and relevant information into the firm. This finding supports the notion that information flow, rather than structural ties alone, mediates the impact of network centrality on strategic

outcomes. Information becomes a strategic asset only when it is mobilised, interpreted, and integrated into decision-making.

The role of information flow is further theorised through the lens of the knowledge-based view (KBV) of the firm. Bilgili and Bilgili (2024) propose that boards function as intra-firm knowledge networks, whereby the strategic value of directors lies in their capacity to interpret, filter, and disseminate knowledge across organisational silos. In this framing, director network centrality enhances the board's absorptive capacity, allowing firms to better scan the environment, interpret weak signals, and respond to threats and opportunities. This is particularly salient in dynamic or crisis environments, where decision-making agility becomes paramount.

Empirical support for this knowledge-centric perspective is also seen in the work of Chen et al. (2025), who found that independent director networks positively influenced carbon disclosure practices in China. Their findings suggest that directors do not merely react to policy or market pressures—they proactively shape corporate governance outcomes through knowledge sharing and strategic signalling. This reinforces the mediating role of information flow, as it is through these shared networks that new norms, expectations, and practices are internalised by firms.

Moreover, the influence of director networks is not unidimensional—it is shaped by institutional, cultural, and contextual variables. Wright (2023), in examining Australian directorates from 1910 to 2018, illustrated how interlocks were influenced by political, industrial, and regulatory forces. These contextual layers can either facilitate or constrain information flows within networks, affecting how knowledge is interpreted and used in decision-making. Thus, any conceptual model must be sensitive to both structure (centrality) and agency (how information is mobilised and acted upon).

The impact of director networks on strategic decision-making is especially evident in high-stakes scenarios, such as during financial crises or major corporate transformations. Nandy et al. (2020) demonstrated that directors with stronger networks tended to steer firms towards more responsible CSR practices during turbulent periods. This suggests that strategic decisions, particularly those requiring ethical or long-term considerations, are deeply influenced by the normative pressures and information embedded within director networks. Board-level strategic cognition is, therefore, not entirely endogenous—it is shaped by exogenous ties and the information they carry.

Furthermore, dissent behaviour among directors is increasingly linked to their network position. Zhang, Liu, and Zhong (2024) showed that more centrally positioned directors were significantly more likely to issue dissenting votes, indicating greater confidence, access to information, and independence in board deliberations. This underscores the influence of networked cognition in shaping strategic alternatives, questioning consensus, and preventing groupthink—an essential attribute of robust strategic decision-making.

However, while the positive dimensions of director networks are well-documented, researchers have cautioned against overlooking ethical considerations. Cronin et al. (2021) emphasise the challenges of network data in business settings, including power imbalances and potential stakeholder harm. Similarly, Maya-Jariego et al. (2021) highlight how confidentiality, coercion, and relational ethics must be carefully managed when analysing organisational networks. These issues must inform both the theoretical framing and empirical investigation of director networks, particularly when exploring sensitive domains like strategic decisions.

In sum, while substantial work has documented the relevance of director network centrality to organisational performance, a coherent conceptual framework that explicitly models information flow as a mediating construct remains underdeveloped. This study aims to fill that gap by integrating insights from social capital theory, knowledge-based views, and network governance literature to propose a model where network centrality influences strategic decisions through the mediating role of information flow. In doing so, it contributes to a more dynamic understanding of how power, knowledge, and connectivity shape firm strategy.

3. Methodology

Research Design

This study adopts a narrative review methodology, which is particularly appropriate for synthesising fragmented literature, developing conceptual clarity, and proposing new theoretical frameworks. Unlike systematic reviews that aim to exhaustively map all literature based on strict inclusion/exclusion protocols, narrative reviews offer a more flexible, integrative, and theory-generating approach. They are well-suited to research areas characterised by multidisciplinary perspectives, evolving definitions, and conceptual overlaps—such as board networks, strategic decision-making, and information flow. Given the conceptual nature of this paper, the narrative review allows for deeper critical engagement with existing scholarly debates, enabling the identification of gaps and the construction of new theoretical linkages.

The narrative review process adopted in this study follows established guidelines for conceptual theory development and knowledge synthesis, as outlined in scholarly guidance (Baumeister & Leary, 1997; Webster & Watson, 2002). Through this methodology, the review aims not only to describe extant studies but also to interpret, evaluate, and reconceptualise the existing literature on director network centrality, board-level information flow, and strategic decision-making. This design supports the construction of an integrative conceptual framework grounded in current research while addressing theoretical fragmentation across disciplines such as corporate governance, management, sociology, and network science.

Key Steps in Conducting the Narrative Review

The narrative review process in this study followed a structured yet flexible approach to ensure rigour, transparency, and conceptual depth. This systematic process was designed to uncover emerging themes, theoretical linkages, and practical implications from a broad and multidisciplinary body of literature. The first step involved clarifying the review's purpose, which was to explore how director network centrality influences strategic decision-making through the mediating role of board-level information flow. This clear objective guided the formulation of the search string and the conceptual boundaries of the review.

Next, the Scopus database was selected as the primary source due to its comprehensive coverage of peer-reviewed journals across multiple disciplines, including management, finance, economics, organisational behaviour, and information systems. Scopus also provided robust keyword-based and Boolean search capabilities, ensuring that the literature search was both comprehensive and precise. A tailored search strategy was then developed to retrieve relevant studies that captured the interdisciplinary nature of director networks and strategic decision-making.

Data collection was conducted between August and September 2025, focusing exclusively on peer-reviewed journal articles written in English. To ensure inclusivity and depth, no temporal limitation was applied, allowing the review to incorporate both foundational and contemporary works. The initial search results were screened by reviewing titles and abstracts to ensure relevance to the study's core themes. Articles were included if they explicitly addressed director networks, board-level information flow, or strategic decision-making.

Finally, the selected articles were analysed using integrative thematic analysis, a qualitative synthesis method that facilitates the identification of recurring patterns, theoretical perspectives, and conceptual gaps across diverse studies. The extracted themes were subsequently compared, clustered, and interpreted to form the theoretical foundation for the conceptual framework proposed in this study. This synthesis ensured that the resulting framework was grounded in both theoretical insight and empirical evidence.

Data Collection and Review Strategy

The core of this review was shaped by an extensive search and selection strategy using Scopus as the primary database. A Boolean search string was constructed to cast a wide but focused net over the literature, intersecting five critical domains: director roles, network ties, strategic behaviour, decision-making, and impact. The final search string used was:

("director" OR "board member" OR "executive" OR "leadership") AND ("network" OR "connections" OR "relationships" OR "collaboration") AND ("strategic" OR "tactical" OR "decision" OR "planning") AND ("decision-making" OR "choices" OR "judgment" OR "policy") AND ("impact" OR "effect" OR "influence" OR "outcome")

This query yielded an initial set of 3806 articles from 2020 to 2025. After removing duplicates and filtering by peer-reviewed status and topic relevance, 845 articles were retained for abstract screening. Following an in-depth review of titles, abstracts, and keywords, 18 articles were deemed to meet the inclusion criteria, while an additional 8 were added through backward citation searching, resulting in a final sample of 26 articles.

The review strategy was guided by the principles of integrative thematic analysis (Braun & Clarke, 2006), which supports the systematic categorisation of literature into distinct but interconnected themes. Each article was read in full and coded using NVivo software, focusing on three layers of abstraction: (i) core concepts (e.g., network centrality, information asymmetry, strategic cognition), (ii) theoretical foundations (e.g., resource dependence theory, social capital theory, institutional theory), and (iii) empirical patterns (e.g., crisis responses, dissent voting, innovation outcomes). This iterative coding process allowed the researchers to identify key thematic clusters, which were then used to inform the construction of the conceptual framework.

The emerging thematic map revealed four dominant themes that underpin the relationship between director networks and strategic decision-making. The first theme, Structural Embeddedness and Centrality of Directors, highlights how directors' positions within interlocking networks shape their influence and access to resources. The second theme, Board-Level Information Access and Diffusion Mechanisms, focuses on how information flows across interconnected boards, enhancing the quality and timeliness of decision-making. The third theme, Strategic Cognition and Sensemaking Processes, emphasizes how directors interpret and integrate diverse knowledge gained through network ties to inform strategic choices. Finally, the fourth theme, Governance Outcomes and Performance Impacts, reflects how these network dynamics and cognitive processes translate into tangible governance effectiveness and improved firm performance.

These themes not only underpin the conceptual framework developed in this paper but also highlight the mediating role of information flow as the mechanism through which director networks exert influence on strategic choices. The use of an integrative thematic analysis ensured that the proposed framework was grounded in literature while allowing space for conceptual innovation. Furthermore, insights from qualitative, quantitative, and mixed-methods studies were integrated to ensure methodological triangulation and theoretical richness.

As with any narrative review, this study is interpretive rather than exhaustive. Although the Scopus search strategy was structured and guided by explicit inclusion criteria, the reliance on a single database and peer-reviewed English-language articles means that some relevant studies indexed elsewhere, or using alternative terminology for director networks and information flow, may not have been captured (Baumeister & Leary, 1997; Webster & Watson, 2002). In addition, the integrative thematic analysis is based on the authors' reading and coding of the selected articles and does not employ a formal quality appraisal checklist; consequently, the prominence of findings reflects their conceptual relevance rather than a standardised assessment of methodological rigour (Braun & Clarke, 2006).

A further methodological limitation arises from the strong conceptual relatedness of the constructs in the proposed framework: director network centrality, information flow, and strategic decision-making are treated as analytically distinct, yet they are likely to be empirically correlated. While this paper does not estimate statistical models or conduct multicollinearity diagnostics, any subsequent quantitative validation of the framework should explicitly test for multicollinearity and adopt modelling strategies—such as latent-variable or structural equation approaches—that can accommodate overlapping constructs and shared variance.

4. Key Findings from the Narrative Review

The narrative review of 26 curated articles revealed several recurring yet under-theorised themes connecting director network centrality, information flow, and strategic decision-making. These themes were distilled through integrative thematic analysis and are summarised in the table below.

Table 1: Key Findings from the Narrative Review

Theme	Description	Key Sources
Director Network Centrality Enhances Strategic Influence	Directors with high network centrality possess greater access to strategic resources, legitimacy, and influence, enabling them to shape strategic direction.	Nicholson et al. (2004), Wright (2023), Zhang et al. (2024)
Network Embeddedness Shapes Boardroom Cognition	Directors embedded in multiple boards influence groupthink, dissent, and board-level cognition, impacting how strategic options are evaluated.	Stevenson & Radin (2015), Zhang et al. (2024)
Information Flow as Strategic Resource	Information that flows through interlocks enhances the board's ability to anticipate risk, navigate uncertainty, and improve strategic planning.	Bilgili & Bilgili (2024), Fang et al. (2021)
Mediating Role of Information Flow	Information flow mediates the relationship between network centrality and strategic decision outcomes, but this mechanism is under-theorised in existing studies.	Fang et al. (2021), Hudson & Morgan (2024)
Network-Driven Ethical and CSR Outcomes	Well-connected directors tend to promote CSR and long-term sustainability, particularly during periods of crisis.	Nandy et al. (2020), Chen et al. (2025)
Institutional Context Shapes Network Effects	Cultural, legal, and institutional contexts moderate how director networks influence decisions, especially across global governance settings.	Wright (2023), McClane & Nili (2021)
Information Asymmetry Reduction through Networks	Central directors help reduce asymmetries in knowledge, mitigating risks such as stock price crashes and decision bias.	Fang et al. (2021), Hudson & Morgan (2024)
Conceptual Fragmentation in Literature	Studies often examine director networks, decision-making, and information flow in isolation, limiting integrative theorisation.	Ford-Eickhoff et al. (2011), Liao & Chen (2009)

Narrative Summary of Key Findings

The review uncovered a robust yet fragmented body of literature that collectively affirms the growing influence of director networks in shaping strategic outcomes. At the heart of this dynamic lies network centrality, which grants directors superior access to privileged information, reputation capital, and strategic foresight. Studies by Nicholson et al. (2004) and Zhang et al. (2024) highlight how centrally-positioned directors are not passive participants but strategic actors with disproportionate influence over boardroom decisions.

Furthermore, the cognitive dynamics of boards are increasingly influenced by the embeddedness of directors in external networks. Stevenson and Radin (2015) demonstrate how informal network ties shape not only the content but the process of strategic deliberation—driving group norms, consensus, or dissent. This shows that the board is not a neutral decision arena but a socially constructed space influenced by external network logic.

A central contribution of this review is the identification of information flow as the critical mediating mechanism. The findings from Bilgili and Bilgili (2024), along with Fang et al. (2021), converge on the idea that director networks are only impactful when the information they access is interpreted, translated, and transmitted effectively into strategic insights. Yet, most prior studies either treat information flow as a black box or conflate it with structural connectedness. This presents an important theoretical gap.

Another emerging insight is the relationship between network-driven ethics and CSR orientation. Directors with expansive networks are more likely to push for environmentally and socially responsible strategies,

especially during institutional turbulence (Nandy et al., 2020; Chen et al., 2025). These actions are influenced by normative pressures within elite networks, as well as reputational considerations.

However, the effect of director networks is not universal; it is shaped by institutional and cultural contexts. Wright (2023) demonstrated how governance practices evolve differently in Anglo-Saxon versus Asian contexts, requiring scholars to contextualise findings accordingly. Moreover, the reduction of information asymmetries through director networks emerges as another overlooked area. Studies such as Hudson and Morgan (2024) suggest that diverse board interlocks may reduce risk by facilitating more accurate, timely information dissemination.

Lastly, a critical meta-observation is the theoretical fragmentation of the literature. The constructs of network centrality, information flow, and strategic decision-making are often studied in isolation, resulting in siloed models with limited cross-fertilisation. There is a clear need for integrated frameworks that bring these elements into a unified conceptual narrative—precisely what this study aims to contribute.

Theoretical Framework Development

The theoretical framework serves as the scaffolding for understanding the mechanisms through which director network centrality influences strategic decision-making, with information flow posited as a mediating variable. It provides a conceptual lens that integrates multiple theories to explain how social structures, cognitive dynamics, and governance mechanisms interact within boardrooms. As boards evolve beyond oversight bodies into strategic actors embedded in dynamic inter-organisational ecosystems, the need to theorise how information circulates through these networks becomes critical. This framework is grounded in Resource Dependency Theory (RDT), Social Capital Theory (SCT), and the Knowledge-Based View (KBV) of the firm—each contributing distinct but complementary insights into how strategic influence is acquired and exercised in corporate governance.

In the context of this study, Resource Dependency Theory underscores the board's function as a boundary-spanning unit that accesses critical resources—both tangible and intangible—through external networks (Pfeffer & Salancik, 2015). Director network centrality enhances a board's ability to manage dependencies by positioning firms within influential inter-organisational arenas. Meanwhile, Social Capital Theory emphasises that these networks do not merely provide resources but facilitate the flow of trust-based information, norms, and cognitive frames (Nahapiet & Ghoshal, 1998). This relational capital allows directors to channel strategic knowledge into the firm, acting as conduits of tacit and timely insights. Lastly, the Knowledge-Based View frames the board as an internal knowledge integration platform, where information is absorbed, filtered, and transformed into strategic action (Bilgili & Bilgili, 2024). In this model, the flow of information is not passive—it must be actively managed, interpreted, and internalised.

The conceptual framework developed in this study positions director network centrality as the independent variable, information flow as the mediating mechanism, and strategic decision-making as the dependent variable. It theorises that directors who occupy central positions within interlocking networks are more likely to access a broad array of strategic information, ranging from market intelligence to regulatory cues and competitor behaviour. However, centrality alone does not guarantee influence—its effect is contingent on the board's ability to translate external signals into coherent internal discourse. Information flow, therefore, is the mechanism through which centrality is operationalised into cognitive advantage and ultimately, decision quality. This mediating role positions information not merely as a by-product of connectivity but as a form of intangible capital that shapes strategic direction.

The integration of literature supports this theoretical architecture. For example, Fang et al. (2021) illustrated how directors with extensive external connections help firms mitigate information asymmetry, thereby reducing stock price crash risks. Bilgili and Bilgili (2024) emphasised that intrafirm knowledge networks enhance the strategic foresight of boards. Nandy et al. (2020) and Zhang et al. (2024) further demonstrated how networked directors influence strategic behaviour during crises and dissent voting patterns, respectively. These findings, while not always explicitly linked, converge on a central theme: the strategic potency of director networks lies in their informational leverage, not merely their structural configuration. By synthesising these

perspectives, this framework fills a conceptual gap in the literature where network centrality and information dynamics intersect with strategic outcomes.

Practically, this framework has several implications for corporate governance. First, it shifts the focus from board composition (e.g., gender, independence) to board connectivity and cognitive capacity—highlighting the need for more nuanced board evaluations. Regulators and investors should recognise that boards with diverse and centralised networks may be better equipped to navigate uncertainty and complex decision-making environments. Second, it provides a basis for executive recruitment strategies that prioritise relational capital and cognitive brokerage roles. Finally, this model supports the development of network-aware governance tools—where the quality of information flow, rather than board formality, becomes a key performance indicator in strategic governance assessments.

In applying this framework, future empirical studies can test the mediating effect of information flow using structural equation modelling or multi-level path analysis. Measurement of director network centrality can be operationalised through network metrics such as betweenness or eigenvector centrality, while information flow can be proxied through board communication patterns, decision speed, or dissent frequency. This will allow scholars to validate the hypothesised relationships and provide empirical support for the conceptual linkages proposed here. Moreover, qualitative approaches such as boardroom ethnography or in-depth interviews with directors can uncover the cognitive and discursive mechanisms underpinning information flow—providing rich contextual insights.

In conclusion, the theoretical framework proposed here contributes to the evolving discourse on networked governance by bridging structural embeddedness with strategic cognition. It advances theory by positioning information flow as a mediating mechanism, thereby addressing the black box between director centrality and strategic decision outcomes. Through this integration of RDT, SCT, and KBV, the framework offers both theoretical sophistication and practical relevance—inviting scholars and practitioners alike to reconsider how boards govern not only through structures and processes but through networks, cognition, and flows of meaning.

To visualise the theoretical architecture underpinning this study, Figure 1 presents the conceptual model linking Director Network Centrality, Information Flow, and Strategic Decision-Making. This framework integrates perspectives from Resource Dependency Theory (RDT), Social Capital Theory (SCT), and the Knowledge-Based View (KBV) of the firm to explain how directors' structural positions within networks translate into strategic influence via enhanced informational access and processing. The model positions information flow as the core mediating mechanism, highlighting its pivotal role in transforming structural advantage into cognitive and strategic outcomes at the board level. Given the preceding discussions, Figure 1 illustrates the proposed theory of the study:

Figure 1: Conceptual Framework Linking Director Network Centrality, Information Flow and Strategic Decision-Making



Figure 1 illustrates the proposed mediating relationship between director network centrality, information flow, and strategic decision-making, grounded in Resource Dependency Theory, Social Capital Theory, and Knowledge-Based View (KBV).

The proposed framework is grounded in three key theoretical foundations: Resource Dependence Theory (RDT), Social Capital Theory (SCT), and the Knowledge-Based View (KBV). RDT posits that network centrality enhances a firm's access to external resources and strengthens its legitimacy within the broader business environment. SCT emphasizes that trust-based relationships within director networks facilitate the exchange of tacit knowledge and the development of shared interpretative schemas, which are crucial for effective collaboration and strategic insight. Meanwhile, the KBV suggests that information acquired through these

networks must be absorbed, interpreted, and utilized as a valuable knowledge asset within the board to enhance decision-making capacity.

Building on these theoretical perspectives, the framework enables future empirical research to test several propositions and key relationships: (P1) director network centrality positively influences information flow; (P2) information flow positively influences the quality of strategic decision-making; and (P3) information flow mediates the relationship between network centrality and strategic decision-making. By integrating structural, relational, and cognitive dimensions, this model offers a comprehensive, multi-level understanding of how board connectivity shapes strategic governance processes beyond the limits of formal board composition.

Proposition Development

Director Network Centrality Positively Influences Information Flow

Director network centrality refers to the structural position and connectedness of directors within a network of interlocking boards. Directors who are more central in these networks have superior access to external knowledge, resources, and strategic intelligence, which are not readily available to more peripheral members. These central directors act as information brokers, linking disparate firms and industries, thereby enabling faster and broader acquisition of relevant knowledge (Nicholson, Alexander, & Kiel, 2004). As such, their embeddedness in multiple organisational boards increases their capacity to gather, interpret, and relay critical information into the focal firm's strategic discourse. The more central a director is, the higher their exposure to external developments, peer learning, and regulatory signals—assets that are crucial in a volatile decision-making environment.

The literature supports the notion that network centrality plays a vital role in enhancing board-level information flow, both in terms of volume and diversity. For instance, Fang, Pittman, and Zhao (2021) empirically demonstrated that directors with well-established external ties help mitigate information asymmetry within the firm, thereby improving the firm's internal decision quality. Similarly, Bilgili and Bilgili (2024) argue that boards with central members are better positioned to engage in knowledge integration and organisational learning. These directors not only act as knowledge conduits but also serve as cognitive filters who interpret and prioritise information based on their cross-firm experiences. Importantly, Stevenson and Radin (2015) noted that directors who possess extensive informal networks shape the shared cognition of the board, influencing how information is processed and which issues receive strategic attention.

Thus, network centrality does not merely represent access—it enables the flow of relevant, timely, and strategic information into the boardroom. This information flow forms the basis of sensemaking, foresight, and adaptive decision-making processes. When directors are structurally positioned at the intersection of multiple boardrooms, they are more likely to transfer new ideas, best practices, and insights from one context to another. As such, their influence on internal information environments becomes disproportionately impactful. Therefore, we propose the following:

Proposition 1: *Director network centrality positively influences the flow of strategic information within the board.*

Information Flow Positively Influences Strategic Decision-Making Quality

In the context of corporate governance, information flow refers to the transmission, exchange, and interpretation of relevant knowledge within the boardroom that supports decision-making processes. Strategic decision-making, particularly at the board level, is highly dependent on timely, diverse, and contextually rich information. Without it, decision-makers may suffer from bounded rationality, groupthink, or over-reliance on heuristics. Information flow serves as the cognitive infrastructure upon which boards develop strategic foresight, evaluate alternatives, and manage complexity. Bilgili and Bilgili (2024) propose that the board functions as an internal knowledge network, where information does not merely accumulate but is actively shared, filtered, and contextualised—ultimately improving the robustness of strategic choices.

Empirical and conceptual studies reinforce the critical role of information flow in enhancing strategic decision-making quality. For instance, Fang et al. (2021) demonstrated how improved information environments—facilitated by director networks—reduce stock price crash risks by minimising information hoarding and signalling failures. In the healthcare sector, Ford-Eickhoff, Plowman, and McDaniel Jr. (2011) found that boards

actively involved in strategic information exchanges contributed to sharper strategic focus and better alignment with long-term goals. Similarly, Hudson and Morgan (2024) showed that heterogeneous board interlocks enhance firm adaptability and reduce idiosyncratic risk, largely due to improved strategic information flow. In each case, the common thread is clear: strategic quality improves when boards have access to relevant, diverse, and cognitively integrated information streams.

Furthermore, information flow enhances not just what decisions are made, but how they are made. It supports inclusive deliberation, critical challenge, and real-time adaptation—all hallmarks of high-quality strategic decision-making (Stevenson & Radin, 2015). When information flows effectively across board members—whether through formal channels or informal ties—it enables a diversity of perspectives, reduces decision biases, and creates a foundation for proactive strategy formation. As such, organisations with effective internal information flows are more likely to make decisions that are forward-looking, risk-aware, and value-generative. Based on this synthesis, we propose:
Proposition 2: *Information flow positively influences the quality of strategic decision-making within the board.*

Information Flow Mediates the Relationship Between Director Network Centrality and Strategic Decision-Making
While director network centrality provides structural advantages, its influence on strategic decision-making is rarely direct or automatic. Instead, it operates through intervening mechanisms that convert positional power into cognitive or behavioural outcomes. Among these, information flow plays a pivotal mediating role. Directors who are centrally positioned in interlocking board networks often have access to richer, timelier, and more diverse information—but that access must translate into actionable insights to shape board decisions effectively (Nicholson, Alexander, & Kiel, 2004). It is through the flow and diffusion of this information that centrality manifests as strategic influence, making information flow the crucial conduit between structure and outcome.

Several studies lend empirical support to this mediating dynamic. Fang et al. (2021) demonstrated that firms with directors who hold central positions across boards experienced fewer stock price crashes due to improved information transparency and flow. Similarly, Hudson and Morgan (2024) found that board network heterogeneity—an aspect of centrality—reduced firm-specific risk by facilitating strategic foresight through informational access. These studies imply that it is not centrality alone, but rather the board's ability to mobilise and internalise information, that determines strategic effectiveness. In healthcare governance, Ford-Eickhoff et al. (2011) observed that board involvement in strategy only translated into results when informed by sufficient, high-quality data flow—reinforcing the mediating role of information access in turning network position into decision capacity.

Conceptually, this mediation aligns with both Social Capital Theory, which posits that networks yield value through the exchange of information and trust (Nahapiet & Ghoshal, 1998), and the Knowledge-Based View of the Firm, which sees information as a strategic resource that must be integrated and leveraged internally (Bilgili & Bilgili, 2024). When boards fail to facilitate open, multidirectional information flows—even if well-connected—the structural advantage remains underutilised. In contrast, boards that cultivate deliberate, trust-rich communication patterns allow central directors to import external insights into internal deliberations, enhancing decision quality. Therefore, we propose the following:
Proposition 3: *Information flow mediates the relationship between director network centrality and strategic decision-making quality.*

5. Conclusion

This conceptual paper set out to explain how director network centrality shapes strategic decision-making through the mediating role of information flow at the board level. By drawing on a narrative review of 26 peer-reviewed articles and integrating insights from Resource Dependency Theory, Social Capital Theory, and the Knowledge-Based View of the firm, the study advances a framework that links structural position, information dynamics, and strategic cognition coherently. The core argument is that network centrality, by itself, does not automatically translate into superior strategic outcomes; its value depends on how effectively information is channelled, interpreted, and embedded within board deliberations.

The study makes three interrelated theoretical contributions. First, it refines board governance models by positioning director network centrality as a key antecedent of board-level information environments, highlighting how centrally placed directors broaden the range and depth of strategic signals available to the board. Second, it elevates information flow from a background condition to an explicit mediating construct that links network structure to decision quality, thereby opening the "black box" between board connectivity and strategic outcomes. Third, by combining RDT, SCT, and KBV, the paper reconceptualises the board as a knowledge-driven decision platform rather than a purely structural or compliance-oriented mechanism, emphasising cognition, sensemaking, and learning as central to contemporary governance.

From a practical standpoint, the framework offers several implications for corporate governance practice and policy. For firms, it suggests that board effectiveness should be assessed not only in terms of demographic diversity, independence, or committee structures, but also in terms of directors' embeddedness in external networks and their capacity to act as cognitive brokers. Nomination and governance committees may therefore need to give greater weight to candidates' network positions, cross-board experience, and ability to translate external knowledge into actionable strategic insight. For regulators, investors, and stewardship actors, the model underscores the importance of monitoring both who is connected to whom and how information flows within and across boards when evaluating governance quality.

The framework also carries specific implications for regional ESG governance, particularly in emerging markets and ASEAN-type contexts where institutional environments are evolving. Well-connected directors can serve as conduits for global ESG norms, best practices, and disclosure standards, helping firms to interpret regulatory changes, stakeholder expectations, and sustainability risks more effectively. Strengthening information flow within boards—through transparent reporting, structured discussion of ESG issues, and cross-committee coordination—can improve the quality of strategic decisions related to climate risk, social responsibility, and ethical conduct. Policymakers and stock exchange authorities may therefore consider incorporating network-aware and information-centric indicators into governance codes, ESG guidelines, and board evaluation frameworks.

At the same time, the study has several limitations. As a conceptual paper based on a narrative review, it does not empirically test the proposed relationships, and the selection and interpretation of literature are inevitably shaped by the authors' judgment. The framework may also operate differently across industries, institutional settings, and ownership structures, which limits its direct generalisability. These constraints, however, also open a clear agenda for further empirical work.

Future research can build on this framework in several ways. Quantitative studies using social network analysis and structural equation modelling could test the mediating role of information flow and compare the effects of different centrality measures (such as degree, betweenness, and eigenvector centrality) on various dimensions of strategic decision quality. Longitudinal designs could examine how changes in board networks over time influence firms' strategic responses to shocks, such as crises or regulatory reforms. Qualitative approaches—including boardroom ethnographies and in-depth interviews with directors—could provide richer insight into the informal, relational, and cognitive aspects of information exchange that are difficult to capture quantitatively. Finally, cross-country comparative studies would help to clarify how institutional logics, regulatory regimes, and cultural norms condition the influence of director networks on strategy and ESG-related decisions.

In summary, the paper contributes to the governance literature by showing that the strategic impact of director networks lies not solely in who sits at the centre of the network, but in how information circulates through and within the boardroom. By foregrounding information flow as a mediating mechanism, the framework encourages scholars and practitioners to adopt a more nuanced, network-aware, and cognitively informed view of board-level strategic decision-making.

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Challenges in Maintaining Halal Integrity in the Logistics Industry: A Case Study of Kokubu Food Logistics Malaysia Sdn. Bhd

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Abstract: Halal logistics has become an increasingly important component of Malaysia's supply chain ecosystem, reflecting both religious obligations and growing consumer expectations for transparency and integrity. Although Malaysia is recognized for its robust halal certification framework, maintaining halal integrity in logistics operations remains a challenging task, particularly for multinational firms navigating diverse regulatory environments and customer demands. The study aims to (1) examine halal logistics from an Islamic perspective, (2) analyze the processes of maintaining halal certification, and (3) identify the challenges faced by logistics operators in sustaining compliance. This study examines how Kokubu Food Logistics Malaysia Sdn. Bhd. (KFLM), a subsidiary of Japan's Kokubu Group, manages the complexity of sustaining halal compliance in daily operations. Using a qualitative case-study approach, data were collected through semi-structured interviews with three key personnel directly involved in halal logistics management. Thematic analysis was applied to identify major themes related to research objectives. The findings show that while KFLM has established a strong Halal Assurance System supported by clear SOPs, regular audits, and departmental coordination, the company continues to face financial pressures, varying levels of staff awareness, and inconsistent customer compliance. External regulatory changes further compound these issues, particularly when global halal standards do not align with JAKIM's guidelines. Despite these challenges, the study highlights KFLM's resilience through continuous training, structured documentation practices, and close engagement with certification authorities. The research contributes to the theoretical understanding of halal logistics as an operational expression of *Maqasid al-Shariah* and offers practical insights for policymakers seeking to strengthen standard harmonization, traceability, and industry support mechanisms. Overall, the study underscores that halal logistics is not merely a technical process but a reflection of ethical responsibility, organizational discipline, and the broader principles of *amanah* and *halalan toyyiban.*

Keywords: *Halal logistics, halal certification, maintaining halal integrity, halal compliance, Kokubu Food Logistics Malaysia Sdn. Bhd*

1. Introduction

Halal is a term that refers to anything acceptable or allowed by law, which is derived from the Arabic language and is the central theme of Islamic law that determines what can be eaten, used, and produced (Abdullah et al., 2021). In Malaysia, where most of the population is Muslim, observing halal principles is not only a religious commitment but also an economic requirement. The halal industry in the country has expanded at a fast pace to keep up with the rising Muslim population, which makes up 63.5% (Population and Housing Census 2020) of the total population of 34.2 million people in 2025 (Department of Statistics Malaysia [DOSM], 2025). So consumer requests for halal goods and services, especially in the logistics sector, have gone up significantly.

Halal logistics is one of the essential components of the halal supply chain. The main role of these systems is to ensure that products do not get contaminated or mixed with impurity (*najs*) or non-halal elements in all stages of transportation, warehousing, and distribution. In this way, logistics operations help to maintain the concept of *halalan toyyiban* from a religious point of view. This concept not only requires that goods be permissible but also that they be pure, safe, and healthy for humans to consume. According to the Halal Malaysia Portal (2025), over a hundred logistics companies in Malaysia have registered with JAKIM to offer halal-compliant services. This positive trend indicates that industry players are becoming

more and more aware of the necessity of following Shariah principles in their operational practices.

Maintaining halal certification, however, continues to be a complicated procedure riddled with various problems. To this end, enterprises should guarantee the absolute separation of halal and non-halal products, carry out regular checks on Halal Control Points (HCPs), and keep their records in accordance with the Malaysian Standard MS2400:2019. These stipulations usually cause higher expenses of operations and the necessity for the training of staff in new skills. On top of that, a slip in compliance may lead to a certificate suspension, a decrease in customer trust and a tarnished image of the company (Harun et al., 2023).

Halal certification, although it enables logistics firms to gain a competitive advantage, is usually difficult to maintain over the long term. The certification procedure, overseen by JAKIM, is very detailed as it requires a lot of documentation, is subject to frequent audits, and must be renewed in a timely manner. This activity calls for a high level of organizational discipline and a financial investment of considerable size. Logistics providers are often confronted with obstacles both inside and outside their organizations. Among these obstacles are the lack of sufficient knowledge of halal requirements by the staff, non-uniform implementation of Standard Operating Procedures (SOPs), and an increase in operational costs due to compliance (Husna et al., 2024). On top of that, there are external factors like changing regulatory requirements and the evolution of customer expectations that make it even harder.

The complexity of maintaining halal integrity in logistics is further compounded by the inconsistencies that exist among global halal certification standards. Variations between JAKIM's regulatory framework in Malaysia and the guidelines of other international halal authorities often create practical barriers for companies operating across borders. These differences can lead to confusion, duplication of certification efforts, and operational inefficiencies, particularly for firms engaged in international trade (Mahidin & Saifudin, 2017). Without consistent adherence to Shariah principles and transparent monitoring systems, the risk of contamination, non-conformance, or even suspension of halal certification becomes a serious concern.

Against this backdrop, it becomes essential to understand how logistics companies navigate these multifaceted challenges to preserve halal integrity while remaining operationally competitive. This study, therefore, focuses on Kokubu Food Logistics Malaysia Sdn. Bhd. (KFLM), a subsidiary of Japan's Kokubu Group, which offers an exemplary case of how an international logistics provider integrates Japanese management discipline with Malaysia's halal certification framework. This intersection between global business practices and Islamic ethical governance presents unique managerial and cultural dynamics that have yet to be extensively explored in halal logistics literature. Hence, this research aims to investigate the mechanisms and challenges involved in maintaining halal compliance and operational integrity within a real-world corporate setting. Specifically, the objectives of the study are to:

- explain the concept of halal logistics from an Islamic perspective,
- analyze the processes involved in maintaining halal certification for logistics operations, and
- identify the challenges faced by KFLM in implementing and sustaining halal logistics standards.

From a theoretical standpoint, the study enriches the understanding of halal logistics as an operational system that embodies the higher objectives of Islamic law (*Maqasid al-Shariah*). It highlights how the protection of faith (*hifz al-din*), life (*hifz al-nafs*), and wealth (*hifz al-mal*) can be realized through ethical and transparent logistics practices (Majid et al., 2023). From a practical perspective, this research provides valuable insights for logistics operators seeking to strengthen their halal assurance frameworks, enhance staff competency, and foster stronger collaboration with certification authorities. For policymakers and regulators, the findings emphasize the importance of harmonizing global halal standards, improving traceability mechanisms, and expanding capacity-building initiatives within the logistics sector.

In sum, halal logistics plays a central role in Malaysia's halal supply chain ecosystem by ensuring that all stages of storage, transportation, and distribution comply with Islamic principles. Although the nation's halal certification system under JAKIM is well established, empirical studies on how multinational

logistics companies sustain compliance in practice remain limited. By examining KFLM's experiences, this study sheds light on the real-world application of halal governance across cultural and regulatory contexts, bridging the gap between theory and practice in the evolving landscape of global halal logistics.

2. Literature Review

The concept of halal logistics has been a major focus of the attention of scholars and industry players, in the last few years, as the global halal market keeps expanding, and consumer awareness rises. Halal logistics is about the management of supply chain processes such as transportation, storage, and product handling which must be carried out according to Islamic law (*Shariah*). According to Ridhwan et al. (2020), halal logistics is about tracing the chain from the source of raw materials to the final delivery of the product in such a way that the chain is free from contamination by non-halal substances or impure (*najs*). It derives from the Quranic principle *of halalan toyyiban*, which requires that allowed goods should not only be pure but also safe and wholesome.

In Islam, the management of logistics goes beyond mere operational efficiency and is also morally and spiritually accountable. Halal logistics is one of the examples of implementing *Maqasid al Shariah*, the higher objectives of Islamic law, which in turn support the idea of protection of the most fundamental human values, such as faith (hifz al din), life (hifz al nafs), intellect (hifz al 'aql), lineage (hifz al nasl), and wealth (hifz al mal). Once these goals are met, logistics activities become a means not only of economic sustainability but also of ethical and social harmony. As an example, cleanliness (*taharah*) and avoidance of contamination are related to life and health preservation, whereas business transparency is justice and the protection of wealth.

On top of that, Malaysia's halal logistics system, governed by the Malaysian Standard MS2400:2019, is very clear about the requirements that are necessary to ensure that every logistical step is in accordance with Shariah. It is based on the idea that the halal and non-halal products should be kept in different places, all the operations handling should be documented, and Halal Control Points (HCPs) should be identified and checked for any breach that would cause halal integrity to be violated. By implementing these measures, halal logistics are not only a religious requirement but also a systematic quality assurance model that supports both domestic and international trade (Safian et al., 2020).

A person who wants to maintain a halal certificate must always comply with the Manual Procedure for Malaysia Halal Certification (MPPHM), which is prepared by the Department of Islamic Development Malaysia (JAKIM, 2022). It is definitely not a single occurrence but rather the entire procedure comprises cycles of filing, monitoring, and renewal which guarantees that the operations are in accordance with Shariah and the regulatory standards. A logistics company as an organization should establish a Halal internal assurance system that includes an Internal Halal Committee (IHC) formation. This committee is the implementation of halal-related policies, the internal audit organization, and operations monitoring of HCPs. The committee should have a minimum of two Muslim members who have sufficient knowledge of halal management (Shahruddin et al., 2025). Companies, moreover, should maintain comprehensive records that cover Standard Operating Procedures (SOPs), training records, supplier certificates, and audit reports. These records serve as proof of compliance and are available for JAKIM's periodic inspections.

To manage halal certification, technological innovations have removed the limitations that existed before. Rejeb et al. (2021) bring up blockchain technology and the Internet of Things (IoT) to explain how these technologies are increasingly being used for creating secure halal traceability systems. Such advanced options make it possible for the product flow to be monitored in real time, reduce the chances of human error, and pave the way for certification process transparency to the public. Similarly, Belkhatir et al. (2020) argue that digitalization equips halal logistics stakeholders with the ability to manage intricate supply chains involving cross-border trades where the accuracy and transparency of documents are of utmost importance.

Basically, halal certificate maintenance is not only about keeping the organization in line with the halal food guidelines but also about ensuring that the organization functions as a morally upright entity with characteristics such as ethical integrity, accountability, and the unceasing pursuit of self-improvement. The renewal phase, which generally occurs every two years, is a time to examine the system and deal with the non-

conformances raised by logistics companies. Failure to comply with these procedures may result in the issuance of nonconformance reports, a temporary suspension of certification, or even the loss of consumer trust.

Though Malaysia enjoys a good reputation worldwide as a leader in halal certification, logistics companies still have various problems with the implementation and maintenance of halal standards. The issues can be grouped into three major categories, namely operational, regulatory, and human resource problems. The complex nature of the halal supply chain is the main reason why logistics providers find it difficult from an operational side. Any single node in the network, i.e., suppliers, transporters, and storage facilities, needs to be halal compliant to be able to stop contamination. The risk of cross-contamination escalates if a company is involved in the handling of both halal and non-halal goods, particularly in mixed cargo operations (Faradina et al., 2018). Consequently, logistics providers are required to make investments in new facilities such as separate storage units, temperature-controlled vehicles, and sanitation systems to remain compliant.

As for the regulation, the biggest obstacle is the differences in global halal standards. Mahidin and Saifudin (2017) mention that Malaysia sets very high standards for halal regulation, but many other countries consider halal certification as a voluntary practice. The inconsistency thus created fragments international trade and forces companies to obtain several certificates to meet the different requirements of various markets. Furthermore, changes in internal regulations such as JAKIM's revised rules on cross-border halal certificates usually result in adjustments in operations that are both time-consuming and costly.

When it comes to human resources, the issues concerning the HR department further exacerbate the situation for the implementation of halal logistics. Many logistics companies face problems such as low staff awareness and insufficient training in halal management. According to Voak and Fairman (2020), staff at all levels should not only acquire the technical knowledge of halal logistics but also be aware of its ethical and spiritual aspects. Without adequate knowledge and training, employees may inadvertently violate halal procedures, thus putting the company's certificate at risk. Moreover, on the one hand, the high cost of continuous training and, on the other, the frequent occurrence of staff turnover make it difficult to establish sustainable programs for capacity building.

Besides all these, monetary restrictions overlay the issue with yet another layer of complexity. Maintaining a halal certificate means the bearer must incur quite a few costs, among which are application and renewal charges, inspection fees, pest control costs, and *sertu* cleansing procedures when there is contamination. These costs can become a real headache for operating small and medium enterprises (SMEs) so that some of them may even view halal certification as nothing more than a bureaucratic burden, thereby losing the opportunity of viewing it as a strategic business investment (Husin et al., 2021).

Maintaining halal integrity throughout the entire logistics chain is essential in order to retain consumer trust, corporate reputation as well as sustainable economic growth. From the perspective of Islamic law, the idea of integrity (*amanah*) is the fundamental moral value that underpins the conduct of business. If a halal product is mishandled or contaminated, its religious permissibility is limited; thus, it negatively affects the trustworthiness of the entire supply chain (Majid et al., 2023).

In addition, consumer perception is the vital factor that keeps halal businesses going. Muslim consumers, in particular, are becoming progressively more aware of the processes involved in halal certification and hence, they require transparency at every stage of the supply chain. The discovery of any non-compliance situation would result in loss of both reputation and money. Husna et al. (2024) believe that the success of halal logistics companies depends largely on their ability to maintain their credibility through the halal assurance system which is actually implemented and can be seen.

Furthermore, maintaining halal integrity will serve well for the global competition in the halal industry. Not only do halal logistics companies attract Muslim consumers by providing very stringent standards of cleanliness, traceability, and good conduct, but also non-Muslim markets that place a high value on quality assurance and safety are attracted. Besides that, through the merger of halal principles with international quality management systems such as ISO 9001 and HACCP, companies are not only able to streamline their

operations but also bolster their compliance mechanisms (Karim et al., 2018).

3. Research Methodology

This research utilized a qualitative research design through a single case study approach. The qualitative approach was chosen as it allows exploring in detail the experiences, perceptions, and practices of people who are directly engaged in halal logistics operations. Creswell and Poth (2018) clarified that qualitative research is the best fit when the researcher aims to delve into complex social phenomena in their natural setting and thus it helps to uncover the meanings that are not accessible through quantitative instruments.

The case study framework is an in-depth analysis of a particular organization in its real-life context. Yin (2018) states that the case study method gives an opportunity to view the researched phenomenon in its entirety, and the use of various evidence sources to understand the underlying mechanisms in detail. In this study, Kokubu Food Logistics Malaysia Sdn. Bhd. (KFLM) was chosen as the case due to its goodwill as a halal-certified logistics provider under the supervision of JAKIM. The company's journey in handling halal compliance makes it a relevant and feasible area for research the issue of maintaining halal integrity in the logistics industry.

Kokubu Food Logistics Malaysia Sdn. Bhd. is a holding company of the Kokubu Group in Japan, which is engaged in the storage, transportation, and distribution of food and beverages in a temperature-controlled environment. KFLM is situated in Shah Alam, Selangor, and offers complete logistics solutions to both local and international clients. The company has been certified halal by JAKIM and is committed to operating according to stringent halal standards to assure the integrity of its services. With its long experience and well put together halal compliance system, KFLM is a perfect place to explore the operational and managerial challenges in maintaining halal logistics practices.

This study used purposive sampling to select participants knowledgeable and directly involved in halal logistics operations. Purposive sampling enables the researcher to single out the most informative cases that provide the deepest insights into the research objectives (Palinkas et al., 2015). Three participants were chosen for this research: the Halal Executive, the Directing Manager, and the Transport Manager. These three individuals not only ensured the day-to-day operations of their departments ensured Halal compliance but also, therefore, represented different managerial views of the company's Halal assurance system.

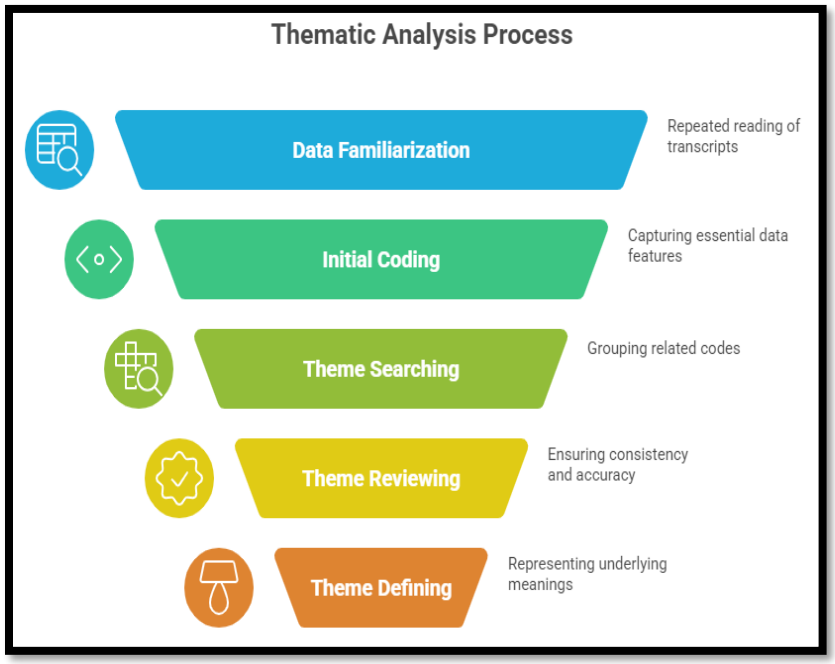
The choice of a small, targeted sample is consistent with qualitative research principles, which emphasize depth rather than breadth. As Guest et al. (2020) state, qualitative insights are best realized through smaller samples that make it possible detailed examination of participants' views and experiences rather than generalization to larger populations. Data collection involved semi-structured interviews. The main reason for this choice is that the method facilitates flexibility in probing participants' responses while at the same time keeping a clear structure in line with the research objectives. The duration of each interview was about 45 to 60 minutes and were held face-to-face at the company premises to ensure confidentiality and comfort.

The interview protocol had three main parts. The first part was about participants' understanding of halal logistics and its principles. The second part was devoted to the company's certification of halal activities. The third part of the program explored the problems encountered in the implementation and continuation of halal compliance. Depending on the participants' preferences, all the interviews were held in English and Malay. Also, they were audio-recorded with the consent of the interviewees. Notes were made to capture non-verbal cues and contextual-related observations.

The qualitative data gathered from the interviews were analyzed using thematic analysis. This methodology was selected as it offers a detailed procedure for recognizing, arranging, and explaining the interpretative patterns in the qualitative data (Braun & Clarke, 2021). It is essentially an inductive process, carried out by six significant steps:

- Familiarization with the data through repeated reading of transcripts.
- Generation of initial codes to capture essential features of the data.
- Searching for themes by grouping related codes.
- Reviewing themes to ensure consistency and accuracy.
- Defining and naming themes to represent the underlying meanings.
- Producing a coherent narrative that integrates the themes with relevant literature.

Figure 1: Thematic Analysis Process



Source: Braun & Clarke (2021)

The data were coded manually and checked using the constant comparison method to maintain the credibility and consistency of the data. The themes that emerged from the data were aligned with the research objectives and later reviewed by the academic supervisor for analytical validity. In order to confirm the trustworthiness of the findings, the present research has adopted the characteristics of credibility, dependability, transferability, and confirmability as defined by Lincoln and Guba (1985). To establish credibility, triangulation of data sources, long-term involvement with the participants, and member checking, where the participants examined and confirmed the accuracy of the interview transcripts, were employed. The researchers ensured dependability by keeping a detailed audit trail of research decisions, interview notes, and coding procedures. Transferability was facilitated through detailed, contextualized descriptions of the case, thus allowing readers to judge the relevance of the findings to different settings. Conformability was supported by the researchers' reflexivity and the effort to reduce personal bias through the clear, documented, and transparent stages of the research process. Approval of the ethical aspects of the present research was granted by the Faculty Research Ethics Committee. The participants were informed about the study's purpose, their voluntary involvement, and the option to leave the study at any time. To maintain confidentiality, pseudonyms were used, and, where it was deemed necessary, company-related data were anonymized. The researcher only had access to the audio recordings and transcripts, which were kept in a safe place.

4. Results and Discussion

This section presents and discusses the findings obtained from semi-structured interviews conducted with three key personnel at Kokubu Food Logistics Malaysia Sdn. Bhd. (KFLM), namely the Halal Executive, the Directing Manager, and the Transport Manager. The analysis of their responses resulted in

three overarching themes: (1) understanding of halal logistics and organizational awareness, (2) maintaining halal certification and operational compliance, and (3) challenges in implementing and Sustaining Halal Logistics. Each theme is discussed in detail below:

Theme 1: Understanding Of Halal Logistics And Organizational Awareness

The following table summarizes selected excerpts from the interviews, illustrating how each informant interprets understanding of Halal Logistics and Organizational Awareness based on their respective roles and departments**:**

Table 1: Interview Questions and Quotations from Informants' Responses on Understanding of Halal Logistics and Organizational Awareness

Question	Informant 1 (18 June 2025)	Informant 2 (21 June 2025)	Informant 3 (21 June 2025)
a) From your perspective, how would you define "halal logistics"?	*"According to the Halal word itself, it means what is permissible and lawful by Shariah. Meanwhile, the prohibited or unlawful according to Shariah is that there cannot be any contact, mixing or even cross-contamination with alcoholic drinks (intoxicants), porcine, dog or any substances that come from a haram source. Moreover, Halal logistics can be defined as it includes all of the logistics activities such as inbound, outbound, delivery, transportation and others. As for Kokubu itself, we focus on transportation and warehousing that must comply with Islamic law and authority regulations whereas there cannot be any mixing and contact between any materials or substances that are prohibited by Shariah"*	*"In my opinion, I think Halal logistics means all the processes that are involved like transportation, warehousing, storing goods, and others must be free from haram (unlawful or prohibited by Shariah) substances. What I mean is, the whole process of the supply chain from the raw materials, goes through the process of manufacturing until it becomes a perfect finished product to be delivered to consumers, all of the process must be free from unlawful or prohibited substances."*	*"From raw materials to finish products, all of it must be free from any non-halal or haram substances, which means the supply chain itself must be free from contamination or contact with non-halal substances at all process levels. This is what Halal logistics means".*
b) In your view, how important is Shariah compliance in the supply chain, especially in halal food logistics?	*"Shariah compliance is important to maintain halal integrity in Kokubu. In addition, by complying with Shariah requirements, Halal integrity will be more guaranteed and can gain customer trust, especially for large companies to attract customers to use our services and then gain customer trust. Some customers are more likely to choose halal logistics services because their products already have halal certificates and to maintain halal transparency for their products. When the company complies with Shariah, it is closely related to halal. For example, in terms of cleanliness and preserving product quality. If the Shariah*	*"Halal logistics is important for the supply chain for the global market because we not only focus on the domestic market but we also focus on abroad customers. Halal logistics are also crucial for the Halal global market because the Muslim population is globally increasing. With Halal certification, the chance of the business to grow even further increases because there are high demand for the Halal*	*"First, we must comply with the Shariah compliance because if not do so, it will break the Halal supply chain. Second, the supply chain must be in good condition which means that the supply chain itself must practice Halal service. The compliance with Shariah is also to prevent any cross-contamination and contact with non-halal substances. It is also important to*

	standards are not complied with, the probability of errors is high such as lorry drivers carrying non-halal goods when delivering products to customers. In addition, the halal certificate is also at risk of being withdrawn, customers lose trust in the services offered and customers will look for other logistics services. There are approximately 107 logistics companies registered in Malaysia that comply with Shariah and apply for halal certificates. Therefore, there is competition between companies that offer halal logistics services."	*global market. We at Kokubu are not only certified Halal by JAKIM but also certified by ISO where these certifications preserve the quality of the product and quality of the management."*	*ensure and preserve Halal integrity of F&B products and good condition of the product's quality."*
c) What are the key Islamic principles that should be considered in halal logistics?	*"When we talk about, the first thing is must be clean and hygiene means the handled products must be free from any najs (impurity) like najs mukhaffafah, mutawassitah and mughallazah. However, Najs Mukhaffafah is not relevant in the logistics industry. Ensuring the products are safe from cross-contamination with najs mutawassitah like mouse droppings and najs mughallazah like intoxicant drinks, porcine and dog during the storage and transportation process. Besides, segregation between halal and non-halal products is obligatory because mixing with halal and non-halal products is prohibited according to Shariah law. At KFLM, all the F&B products that are registered under this company are certified Halal by JAKIM or any foreign certificate bodies that are recognized by JAKIM. Moreover, responsibility plays a vital role. For example, I as Halal Executive at this company, need to ensure that our service complies with JAKIM requirements and regulations related to this industry. Other departments are also responsible and play vital roles to ensure Halal integrity".*	*"The only Islamic principle that I know is hygiene and cleanliness, because every religion considers hygiene to be one of the most important things in life. So, here at Kokubu, hygiene and cleanliness are our top priority aside from preserving product quality and perfect service. The methods that we use here include have schedule for cleaning every area inside this company. The schedule ensures a continuous clean area of the warehouse. Besides, we also implemented a pest control mechanism around the warehouse to prevent any breach of wild pests".*	*"I think maybe cleanliness can be one of the principles that should be considered, because hygiene is very important, not only at this company, but everywhere also hygiene must be a priority. Here, since I am responsible for transportation, every day the driver must make sure the trucks are in clean and good condition. We also have a schedule to clean the trucks by washing them. This is to preserve and maintain the quality of the products and also the Halal status of the products".*

Source: Personal Interview with Informants

The first theme highlights the participants' understanding of halal logistics and their awareness of its principles. The interviews with the three informants reveal a consistent understanding of what halal

logistics means within the operational context of Kokubu Food Logistics Malaysia (KFLM). All three informants emphasized that halal logistics is fundamentally about ensuring that every stage of the supply chain, beginning from the handling of raw materials right up to the delivery of the finished product, remains completely free from any form of contamination with non-halal substances. Although each informant described the concept in their own way, they shared the same core belief that halal logistics is not simply about moving goods; it is a responsibility to safeguard religious compliance throughout the logistics process. This includes strict segregation of halal and non-halal items, maintaining cleanliness, and ensuring that no cross-contamination occurs at any point.

The importance of Shariah compliance was also strongly highlighted across all interviews. Informant 1 explained that adherence to Shariah requirements is essential not only to protect the integrity of halal products but also to maintain customer trust. He mentioned that any failure to follow these requirements, such as a driver mistakenly transporting non-halal goods, could place the company's halal certification at risk and damage its credibility. Informant 2 supported this view by noting that halal compliance strengthens the company's position in both local and international markets, particularly with global demand for halal products increasing in line with the growing Muslim population worldwide. Informant 3 added that any disregard for Shariah principles could disrupt the entire halal supply chain, which would defeat the purpose of halal logistics altogether. Their collective responses show that Shariah compliance is regarded as both a religious obligation and a critical business strategy.

When discussing the key Islamic principles that guide halal logistics, cleanliness emerged as the most prominent theme. Informant 1 gave a detailed explanation of the different categories of *najs* and emphasized the need to prevent contamination during storage and transportation. His response reflects a strong understanding of Islamic jurisprudence and its direct relevance to logistics operations. Informants 2 and 3 echoed this focus on cleanliness by describing the practical steps taken at KFLM, such as scheduled cleaning routines, pest control measures, and daily inspections of vehicle hygiene. Their comments illustrate how Islamic principles such as *taharah* (cleanliness) and *amanah* (responsibility) are applied in daily operations, ensuring that both the quality and the halal status of the products are preserved.

Overall, the interview data demonstrate that employees across different departments at KFLM share a unified understanding of halal logistics and are committed to maintaining halal integrity in their respective roles. Their perspectives show not only technical knowledge about halal procedures but also an appreciation for the ethical and spiritual values that underpin them. This shared understanding strengthens the company's internal culture and supports its sustained efforts to uphold halal standards consistently.

Theme 2: Maintaining Halal Certification and Operational Compliance

Table 2: Interview Questions and Quotations from Informants' Responses on Maintaining Halal Certification and Operational Compliance

Question	Informant 1 (18 June 2025)	Informant 2 (21 June 2025)	Informant 3 (21 June 2025)
a) Could you explain the process your company follows to obtain and maintain halal certification?	*"The first way for Kokubu to obtain a halal certificate is to apply on the JAKIM website, MyeHalal. The application must be made as early as 6 months before the expiry date of the halal certificate. After JAKIM has reviewed the application, we will send relevant documents such as the company profile, Halal minutes meeting, HAS manual and others. After that, JAKIM will conduct a field audit at our*	*Firstly, we must make sure all of the related documents are sufficient before proceeding to make an application. After the application was made, JAKIM will conduct on field audit from documentation to*	*From the view of transportation departments, we make sure that the trucks are in a clean condition and free from any najs. If there is any contact with najs mughallazah, we will perform sertu for the truck to vanish the najs. We also make sure that there are no non-halal*

	company by conducting an audit of all documents related to halal. JAKIM will also conduct an audit of the application and handling of products in the warehouse or transportation to see if we comply with the conditions set by JAKIM and relevant laws. For example, JAKIM will check the company's SOPs such as inbound, outbound. Halal certificates for products registered in the warehouse. If there is no halal certificate, supporting documents must be included to prove that the product is free from non-halal elements. If there are any SOPs or product handling that do not follow JAKIM's conditions and regulations, then they will give an NC (non-conformance) to Kokubu. After JAKIM completes the field audit, they will hold a closing meeting. Then they will provide a list of NCs and the company must respond within 5 days to send an audit report and close the NC. After sending the corrected NC, JAKIM will bring it into the panel meeting to obtain agreement and approval from the panel. Only then will the halal certificate be issued by JAKIM."	*a site audit, like a warehouse and a truck. After the audit is done, if there are any NC given by the JAKIM, we have only 5 to 14 business days to do corrective action. After that, the follow-up audit will be conducted by JAKIM to check whether the NC has been closed or not."*	*products in the warehouse to prevent any cross-contamination with the halal products. That's how we play a role as the transportation department to maintain halal integrity in our company and services."*
b) What kind of documentation and audits are involved?	*" The documents that are obligated to be audited by JAKIM are the HAS manual because it includes many important aspects like the company's profile, Halal policy, SOP inside the warehouse, SOP of transportation, training record, sertu record, appointment letter, and IHC organization chart.*	*"Every established SOP that relates to Halal will be involved during audit, and for types of audits, we have two types which are JAKIM audit for Halal and customer audit for quality."*	*"The documents that are involved in audits are like a manifest form for the driver to fill, a delivery order, a delivery note and many others."*
c) How do you ensure halal compliance throughout the logistics chain (storage, handling, transport)?	*"Ensure all staff comply with the company's SOP such as the inbound SOP which requires a tally sheet. Ensure that the halal certificate of each product has not expired and if it is about to expire or has expired, it is necessary to request a copy of the renewed halal certificate from the customer and then update it in the halal master list. Next, during the receiving*	*"One of the methods we use to maintain Halal certification is establishing Halal Control Points throughout every process step."*	*"First step, before the customer's products enter our warehouse, the driver must hand all of the documents of the products to our staff. Our staff will then check all of the information about the products to ensure they fulfil all of the requirements, and the*

	process, the quality officer or warehouse manager must ensure that each incoming product has a valid halal certificate or supporting documents. In addition, during the transportation process, it is also necessary to ensure that each outgoing product has a valid halal certificate, and that there is no cross-contamination with non-halal materials before being sent to the customer. Then, I will also conduct random inspections in the warehouse and lorries to ensure that staff comply with halal requirements."		*most important thing is checking the halal certificates of the products. The second step is that the products will be stored in the warehouse according to the products' nature. The third step is, when the products have to be delivered to our customers, the products will first be checked to ensure they are of good quality and there is no contact or cross-contamination with non-halal substances. The fourth step is to ensure the trucks are in clean condition and free from any najs."*
d) Are there any specific SOPs (standard operating procedures) related to halal practices that your company must adhere to?	*Among the SOPs related to halal requirements are inbound, outbound, and Halal Control Point. With the existence of SOPs, halal integrity is more guaranteed and maintained to avoid any non-conformance that can reduce the company's halal integrity. Each SOP must have supporting evidence (in writing, either softcopy/hardcopy) or a form. To ensure that all staff comply with the company's SOPs, training will be provided to staff so that they understand the importance of SOPs and comply with them."*	*"SOP documents related to Halal are like receiving, picking and dispatch."*	*"All of the related SOPs that are stated in the contract."*

Source: Personal Interview with Informants

The second theme focuses on the mechanisms adopted by KFLM to maintain halal certification. Participants reported that the company strictly follows JAKIM's halal certification procedures, which involve continuous documentation, audit preparation, and staff monitoring. The Halal Executive detailed that KFLM has developed its own Halal Assurance System (HAS) that integrates Halal Control Points (HCPs) into daily operational workflows. These HCPs include vehicle inspection, loading and unloading procedures, warehouse sanitation, and personnel hygiene. Their explanations also show that halal certification at KFLM is not a one-time administrative task, but an ongoing, organization-wide effort that involves documentation, audits, and continuous monitoring across all logistics activities.

All three informants agreed that the certification process begins with a formal application submitted through JAKIM's MyeHalal system. This application must be prepared well in advance, typically six months before the expiry of the existing certificate. According to Informant 1, the application requires the company to submit various documents including the Halal Assurance System (HAS) manual, minutes of halal committee meetings, standard operating procedures (SOPs), training records, and product-related documents. Once the application is reviewed, JAKIM conducts an on-site audit to examine both

documentation and operational practices. Informant 2 confirmed that this audit covers the warehouse, transportation units, and other areas involved in product handling. If any discrepancy is detected, JAKIM issues a non-conformance (NC) notice, which the company must resolve within a specified timeframe. The corrected NCs are then reviewed in a follow-up audit before the case is brought to the JAKIM panel for approval.

Beyond the certification process, the maintenance of halal compliance is deeply embedded in KFLM's daily operations. Informant 1 explained that compliance begins with ensuring that every incoming product has a valid halal certificate. If a certificate is missing or near expiry, the company immediately contacts the customer to obtain an updated copy. Random inspections are also conducted in the warehouse and on company vehicles to ensure that handling practices align with halal requirements and that no cross-contamination occurs. Informant 2 highlighted the role of Halal Control Points (HCPs), which serve as checkpoints across the logistics chain to ensure that each process step adheres to Shariah-compliant standards. From the transportation perspective, Informant 3 described how cleanliness checks are carried out before products are received, during storage, and before delivery. He also noted the need for *sure* cleansing procedures if any contact with severe impurities (*najs mughallazah*) is suspected.

The interviews also shed light on the types of documentation and audits involved in halal certification. KFLM is required to maintain a comprehensive HAS manual that outlines the company's halal policies, procedures, and responsibilities. Informant 1 listed several key documents, including the SOP for inbound and outbound processes, appointment letters of halal committee members, and records of *sertu* procedures. Informant 2 added that the company undergoes two types of audits: halal audits by JAKIM and quality audits by customers. Meanwhile, Informant 3 pointed out the operational documents used in audits, such as delivery notes, manifests, and product movement records.

SOPs play a central role in sustaining halal integrity across the logistics chain. Informant 1 mentioned that SOPs exist for inbound and outbound activities and that adherence to these procedures is monitored through regular internal training. Informant 2 referred to SOPs for receiving, picking, and dispatch processes, while Informant 3 emphasized that all SOPs outlined in contractual agreements must be followed without exception. These SOPs ensure consistency across departments and help minimize the risk of errors that could compromise halal integrity.

Overall, the interview findings illustrate that KFLM's halal compliance is built on a structured system supported by documentation, audits, clear SOPs, and continuous monitoring. The commitment shown by staff from different departments reflects a shared understanding of the importance of halal certification, not only for regulatory purposes but also as part of the company's ethical and operational culture.

Theme 3: Challenges in Implementing and Sustaining Halal Logistics

Table 3: Interview Questions and Quotations from Informants' Responses on Challenges in Implementing and Sustaining Halal Logistics

Question	Informant 1 (18 June 2025)	Informant 2 (21 June 2025)	Informant 3 (21 June 2025)
a) What are the main challenges your company faces in implementing halal logistics?	*Among the challenges that we faced here to implement and maintain the Halal certificate is the high cost. The involved costs are application fee, processing fee, training costs like Halal Executive Training, Halal Audit Training, Halal Awareness Training and Halal compliance training. Besides, the other costs are maintenance costs like if have any contact with Najs*	*"I think the cost is the challenges that we faced because we want to maintain a Halal certificate, of course we have to incur the cost, no problem, but the thing is maintaining Halal will come with indirect costs. I mean like when we apply for Halal, of course we have to pay for the fee, but*	*"The challenges that we faced here are first the compliance of our staff with Halal requirements. This is a challenge to our company because some of the staff are not aware of the importance of Halal requirements. This might be a loophole in*

	Mughallazah, then must perform the sertu process whereas need to pay to JAIS."	*the indirect cost that I mean is the other cost like staff training cost, typhoid cost, pest control cost. All of those are indirect costs that become JAKIM requirements. So, we have to bear the cost."*	*our company's Halal because it might affect our Halal integrity."*
c) Are there external challenges, such as regulatory changes or customer demands that impact halal logistics?	*"The external challenges that we faced are customers' demand where they want the highest quality of Halal service but they pay us with cheaper price. This is not commensurate with the quality of service that we provide. Another challenge is that authorities like JAKIM make changes or additions to the requirements and regulations to renew the Halal certificate. For example, the addition of new regulations that products cannot be certified by a cross-border certificate."*	*"I think awareness from customers is really important regarding Halal requirements. Sometimes, they choose to ignore it even though they know it is important for Halal. An example like one of our customers, they have a cross-border Halal certification. This is one of the JAKIM requirements that cross-border Halal certificates are not valid. So, when this happens, we will also be the wrong deed from the customer because not comply with JAKIM requirements. This can affect our company's Halal integrity."*	*"Other challenges are that the compliance from customers themselves may be a factor of the Halal challenges in our company. If the customers are not aware of the importance of Halal requirements, we worry that the customers will not comply with the Halal requirements and that will have an impact on our company's Halal."*
d) In your opinion, do you think the period to renew a halal certificate is reasonable? If not, why?	*"The period of renewal of Halal certification is reasonable and there is no problem with our company to follow the set period."*	*"For me, there is no problem with the Halal certificate renewal period as it is also important for us."*	*"The renewal period of the Halal certificate is not a challenge for our company, and it is still reasonable."*

Source: Personal Interview with Informants

The third theme addresses the multifaceted challenges faced by KFLM in implementing and sustaining halal logistics operations. Informants reveal several important challenges faced by KFLM in implementing and sustaining halal logistics. Although the informants spoke from different departmental roles, their insights point to three main areas of concern: financial pressures, staff awareness, and external factors involving customers and regulatory authorities.

Financial Burden as a Central Challenge

All three informants acknowledged that the cost of maintaining halal certification remains one of the largest obstacles for the company. Informants 1 and 2 explained that halal certification brings not only the expected fees for application and processing but also a series of additional expenses that accumulate throughout the year. These include the cost of staff training, typhoid vaccinations, pest-control services and specialized cleansing procedures such as *sertu* when contamination with *najs mughallazah* is suspected. Their explanations show that halal certification requires continuous financial commitment, and the burden of these recurring costs cannot be ignored in long-term planning.

Internal Challenges Linked to Staff Knowledge and Compliance

While financial issues were highlighted by the first two informants, the third informant offered a different perspective by focusing on human factors within the organization. He noted that not all staff fully understand the importance of halal requirements, which creates gaps in compliance. When employees overlook or misunderstand halal procedures, the company's halal integrity becomes vulnerable. His explanation illustrates that the effectiveness of halal logistics depends not only on formal systems and SOPs but also on the awareness and discipline of those responsible for executing them.

External Pressures from Customers and Regulatory Changes

The interviews also indicate that KFLM faces external challenges that stem from customer behavior as well as evolving regulatory expectations. Informants 1 and 2 pointed out that some customers demand high-quality halal services but are unwilling to pay in accordance with the level of service they expect. In addition, there are cases where customers themselves fail to meet halal requirements, for example, by supplying products certified using cross-border halal certificates that are not recognized by JAKIM. When customers disregard these standards, KFLM risks being penalized for non-compliance even though the fault does not originate from the company.

Regulatory adjustments introduced by JAKIM also contribute to operational difficulties. Informant 1 mentioned that new rules, such as the restriction on accepting cross-border halal certificates, require companies to revise their internal processes, update documentation and conduct additional training. These changes, while necessary for improving halal governance, demand time, effort and financial resources.

Renewal Period Viewed as Reasonable

Despite the challenges discussed, all three informants agreed that the renewal period for the halal certificate is reasonable. None of them regarded the renewal timeframe as a burden. This consistency shows that KFLM has developed strong internal systems and is confident in managing the renewal process efficiently.

The findings suggest that KFLM's challenges are wide-ranging. The company must deal with financial demands associated with compliance, ensure that staff remain aware and disciplined in following halal procedures, and address external influences such as customer behavior and regulatory changes. Even so, the company demonstrates stability in managing certificate renewals, indicating a well-established halal assurance structure. These insights provide a realistic understanding of the operational complexities involved in maintaining halal logistics within a multinational business environment.

5. Conclusion

This research focuses on the methods employed by Kokubu Food Logistics Malaysia (KFLM) to sustain halal integrity in their logistics operations. Findings illustrate that halal logistics at KFLM goes beyond mere compliance as it is considered a moral obligation guided by the principles of *halalan toyyiban* and *Maqasid al-Shariah*. Staff from different departments reiterated that cleanliness, segregation, having a valid halal certificate, and compliance with Shariah are their daily routine and thus their workflow. Being grounded on these common values enables KFLM to keep a robust halal assurance system and be able to fulfill the expectations of the regulators. However, the uncovered study also pointed to several challenges that are directly linked to the operational sustainability of the company. Expenses related to training, pest control, *sertu*, and audit requirements continue to be a cause of concern. The differences in staff awareness and the gaps in customer compliance that exist create the supply chain for halal as a susceptibility. Nevertheless, KFLM is showing endurance through well-planned SOPs, internal inspections, and being ahead of the game in coordinating with JAKIM, thus demonstrating how multinational logistics providers can facilitate the implementation of halal governance in the kind of business environment that is typical nowadays.

Theoretical Implications

In essence, this research exemplifies the fact that halal logistics is an applied recitation of Islamic ethical governance and not just a set of technical standards. The activities at KFLM reveal how *taharah, amanah*, and

the *Maqasid al-Shariah* are implemented through actual processes, inspections, and decision-making. This is in line with the increasing view in the halal logistics literature that organizational culture and the internalization of values are just as important as formal regulations. Besides, the study emphasizes the necessity of perceiving halal logistics in cross-border and multinational contexts. The story of KFLM demonstrates that the differences between global halal standards and the regulatory requirements in Malaysia can make the certification and operational workflow more difficult. These revelations are indicative of the fact that theoretical issues in the future should be more attentive to the functioning of halal governance across cultural, regulatory, and organizational boundaries.

Practical Implications

The findings, in essence, highlight the need to embed halal compliance in the daily operations of a business. If companies want to reinforce their halal assurance, they should invest in having clear SOPs, conducting regular training, always monitoring at Halal Control Points, and having a well-organized documentation system. KFLM's journey reveals that when employees internalize the values of halal, they find it easier to maintain compliance and the need for supervisory enforcement becomes minimal. As for the policymakers, the findings highlight the necessity of clearer communication of the changes in regulations and more harmonization between global halal standards. Easier certification procedures, the use of technology by means of an incentive, and collaboration beyond borders can very much lessen the compliance burden for industry players. These steps will enable logistics providers to uphold halal integrity in a more efficient way without the reliability of certification systems being compromised.

Limitations and Suggestions for Upcoming Research

The scope of this research was only a single case situation with three informants which limited the capacity of the findings to be generalized. The viewpoints of the frontline staff, customers, and regulatory officers were not obtained, thus, some of the operational realities and compliance issues may not have been sufficiently represented. Research on halal logistics in different company sizes and sectors should be conducted to disclose more diverse challenges and practices. Besides, studies can also target the positive effect of these technologies revolutionizing the halal food supply chain such as blockchain, IoT-based monitoring, and AI-supported inspection systems in strengthening traceability and reducing non-compliance risks. Furthermore, probing employee attitudes and organizational culture more deeply would reveal how the employees' internalization and enactment of halal values in logistics scenarios. This would help become a more comprehensive understanding of halal logistics as the convergence of religious principles, operational demands, and human behavior.

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Drivers and Constraints of Remanufacturing: A Global Bibliometric Review

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Abstract: This study aims to provide a global bibliometric review of scholarly research concerning the drivers and constraints in the domain of remanufacturing, which also seeks to provide a blueprint of the intellectual structure and thematic evolution, along with collaboration patterns in this important area of sustainability. This study reviews 1,162 publications from Scopus's 2015–2025 database, employing bibliometric methods using VOSviewer and Harzing's Publish or Perish software. This study measures the trends in publications, authorship, subject areas, and keyword co-occurrence networks. The results show an exponential increase in research output since 2019, with Environmental Science and Engineering dominating the publications. Research output stems from the drivers which include the absence of policy and regulatory support, economic incentives and profitability, sustainability and resource efficiency, market demand and consumer behaviour, and technological improvement. The constraints of research output include consumer perception and acceptance, high initial investment and financial viability, lack of skilled workforce, product design and technical obstacles, and reverse logistics and supply chain uncertainty. Research also shows the strong interdisciplinary nature of the field. The primary focus of research is still concentrated in Europe and East Asia. By integrating ten years of worldwide research, this study aims to create a systematic evidence base for academics and practitioners. In closing, it advocates for research on remanufacturing to be more inclusive, context-sensitive, and transdisciplinary so that remanufacturing can develop as a scalable, equitable, and transformative component of the circular economy.

Keywords: *Remanufacturing, Circular Economy, Bibliometric Analysis, Sustainability Drivers, Barriers to Adoption*

1. Introduction

Remanufacturing is an efficient way of integrating ecological boundaries within the burden of industrial output, which has been largely unexplored due to the insufficiency of global alternatives. Enhancing the quality of used goods avoids waste disposal and reduces energy consumption, the extraction of primary resources, and the necessity of new materials, which underpins the circular economic models (Matsumoto et al., 2016; Yang, 2019). In economic terms, remanufacturing reduces and controls costs and risks through prolonged product lifespans, diversification of income streams, and improved market position (Ferraro et al., 2024; Eguren et al., 2018). With the political and business world being the most dynamic and active spheres pursuing the most attainable alternatives for reaching ecological objectives, it is ever more vital to understand the incentives and obstacles to the remanufacturing process.

Some current literature identifies the drivers and constraints shaping remanufacturing practices in various countries. The drivers are environmental and economic incentives (Matsumoto et al., 2016; Gunasekara et al., 2018), government regulations such as take-back mandates and fiscal incentives (Singhal et al., 2018; Li et al., 2024), technological advancements in intelligent as well as additive manufacturing (Abassi et al., 2025), greater consumer awareness (Almefelt & Rexfelt, 2017; Lastovetskaia et al., 2025), and tangible strategic business interests such as product durability and differentiation (Eguren et al., 2018). On the other hand, operational uncertainties in reverse logistics (Gunasekara et al., 2018; Mukherjee & Mondal, 2009), consumer quality perception (Diener et al., 2019; Lastovetskaia et al., 2025), economic feasibility (Ferraro et al., 2024; Sun & Wang, 2024), border regulatory asymmetry (Yang, 2019) and education deficits in the Global South (Monyaki & Cilliers, 2023) still impose significant constraints. While valuable, the remaining insights are still fragmented and lack a cohesive focus, global in nature, across disciplines, geographies, and methodologies.

This paper employs bibliometric analysis, an approach that draws on quantitative, data-based techniques to delineate the intellectual framework, thematic change, and cooperative structures within a specific area of scholarship (Abassi et al., 2025) to begin resolving this fragmentation. Positioning our analysis within the overarching domain of research on sustainable operations and the circular economy, we draw on a complete dataset of articles published in the Scopus database. While narrative and systematic reviews emphasize subjective interpretation, the bibliometric approach provides a neutral perspective and tracks the scholarly attention that has shifted over time, the prevailing themes, and the enduring gaps. This method addresses the 2019 call for evidence-based mapping of the field's qualitative sustainability transitions (Yang, 2019) and counters the predominant qualitative approach in the field by elucidating macro patterns that lie hidden at the micro level.

While the potential for remanufacturing is well established, its global uptake is uneven and stifled by context-specific obstacles. One of the main challenges is the lack of a cohesive and empirically grounded account of how drivers and constraints function across geographic, industrial, and disciplinary divides. The proliferation of knowledge in a particular area is often hindered by the narrow focus of reviews which examine only one industry, region, or type of barrier. In light of the above, this study tries to address the following issue: the literature on remanufacturing is missing a comprehensive and global account of its intellectual structure, including thematic areas and patterns of collaboration concerning drivers and constraints.

To this end, we ask, what are the key drivers and limitations of global remanufacturing research, and how have these changed over time in various regions and in different fields? The rest of the document is organized in the following way. Methodology is described in Section 2. This includes an explanation of how data were retrieved from Scopus, the PRISMA selection process, and how Harzing Publish or Perish and VOSviewer were used for data cleaning and visualization. Section 3 is devoted to the bibliometric analysis and covers the publication patterns and bibliometric results on the geographic and institutional affiliations, co-citation analysis, and thematic clusters. Section 4 describes the implications of these findings for theory, policy, and practice, including the more recent developments on intelligent remanufacturing and strategies focused on the end-user. Section 5, the last section, presents the limitations and future research agenda in the context of remanufacturing and the global sustainability agenda, which we hope will serve as an initial guide to building the remanufacturing research agenda.

2. Literature Review

Predominant Themes in Remanufacturing Drivers

One of the most prominent ideas in the literature is that remanufacturing serves as a means to implement the strategies of a circular economy while providing simultaneous advantages on the environmental and economic fronts. Most authors note the remanufacturing of products as a means of conserving resources and reducing waste, and as a mitigative measure to the emission of greenhouse gases, thereby addressing climate change, and the implications of resource exhaustion (Matsumoto et al., 2016; Zhang et al., 2020). From the economic perspective, there are savings to be gained from remanufacturing, the value of products is heightened as components of a product of a certain grade are recovered, and the product lifecycles are prolonged (Eguren et al., 2018). Operational efficiency is not the only motivator; especially in the automotive and electronics capital-intensive industries, the strategic motivators of product differentiation, brand equity, and market adaptability also play a role (Karunarathna & Gamage, 2022). The integration of the three components of sustainability; social, environmental, and economic is becoming a key topic, particularly in recent studies which are calling for the inclusion of integrated performance metrics to capture all three (Mejía-Moncayo et al., 2025).

Key Constraints and Contextual Barriers

Remanufacturing holds great potential, yet numerous structural and contextual barriers remain, and these tend to differ greatly based on geography or specific industry. Many operational bottlenecks stem from concerns over access to cores, uncertainty regarding core quality, and issues with pricing in the marketplace (Eguren et al. 2018). In developing economies, the barriers included a lack of government support, the absence of standardized regulations, issues with the perception of quality, and the overwhelming price competition with new goods (Sharma et al. 2016). Technological constraints like the absence of non-destructive testing or deconstruction methods can impede scalability, particularly with more intricate products such as medical

equipment and industrial machinery (Wang et al. 2023). The challenges observed in these examples illustrate the reality that remanufacturing involves more than just technical processes; it has to do with the systems comprising the institutions, markets, and infrastructure that can enable or hinder the potential of remanufacturing.

Scholarly Debates on Sustainability Integration

One of the most critical academic discussions concerns the focus on remanufacturing and the sustainability discourse. Initial studies on remanufacturing focused solely on the environmental and economic impacts. More recent studies, on the other hand, argue that the social impacts of remanufacturing such as labor, equity, and community concerns, need to be added to the foundational frameworks (Mejía-Moncayo et al., 2025). Some scholars affirm that the discourse is still predominantly techno-economic, paying little attention to the socio-cultural aspects of the adoption (Sharma et al., 2016). Other scholars argue that remanufacturing will become a niche practice and will not be able to serve as a systemic solution without adequate policy frameworks and inter-sectoral disengagement (Singhal et al., 2018). This is an example of the many discussions concerning the disengagement of power, governance, and socio-economic behavior on systemic issues surrounding remanufacturing and the circular economy.

Emerging Technological and Strategic Trends

There is a growing interest in the design of technology-enabled intelligent systems in remanufacturing. Innovations in non-destructive disassembly, laser cleaning, lifecycle assessment of cores, and additive restoration techniques have been advancing the technical feasibility and quality assurance of remanufactured products (Wang et al., 2023). In addition, IoT and AI technologies are being incorporated into systems designed to optimize core reverse logistics and forecast core availability (Singhal et al., 2018). From a strategic point of view, the development of industry-specific, particularly automotive and electronics, sector roadmaps is gaining attention due to the large end-of-life volumes, which is a double-edged sword (Karunarathna & Gamage, 2022). All these shifts indicate the movement in remanufacturing from non-systematic approaches to integrated, data-enhanced closed-loop supply chains designed to meet the goals of industrial decarbonization.

Gaps in Current Research and the Role of Bibliometrics

A synthesized global understanding of how drivers and constraints interrelate across areas, disciplines, and temporal scales is still lacking, even with abundant qualitative and case-based insights. Numerous analyses are limited in scope to specific countries, such as India or the Basque Country, or to specific sectors, which unfortunately restricts the findings' generalizability (Sharma et al., 2016; Eguren et al., 2018). Likewise, the cross-cultural contexts of comparative analyses on policy effectiveness or consumer behavior are scarce. This lack of cross-cultural examination restricts the formation of coherent global action plans. A bibliometric method directly takes on this challenge by systematically delineating the intellectual structure in the field, which consists of core authors, impactful journals, thematic areas, and cooperative linkages, as well as dominant paradigms, emerging areas, and neglected geographies (Matsumoto et al., 2016; Wang et al., 2023). These macro insights are critical to positioning research, influencing policy, and facilitating the international remanufacturing sector as an integrated element of sustainable industrial ecosystems.

3. Method

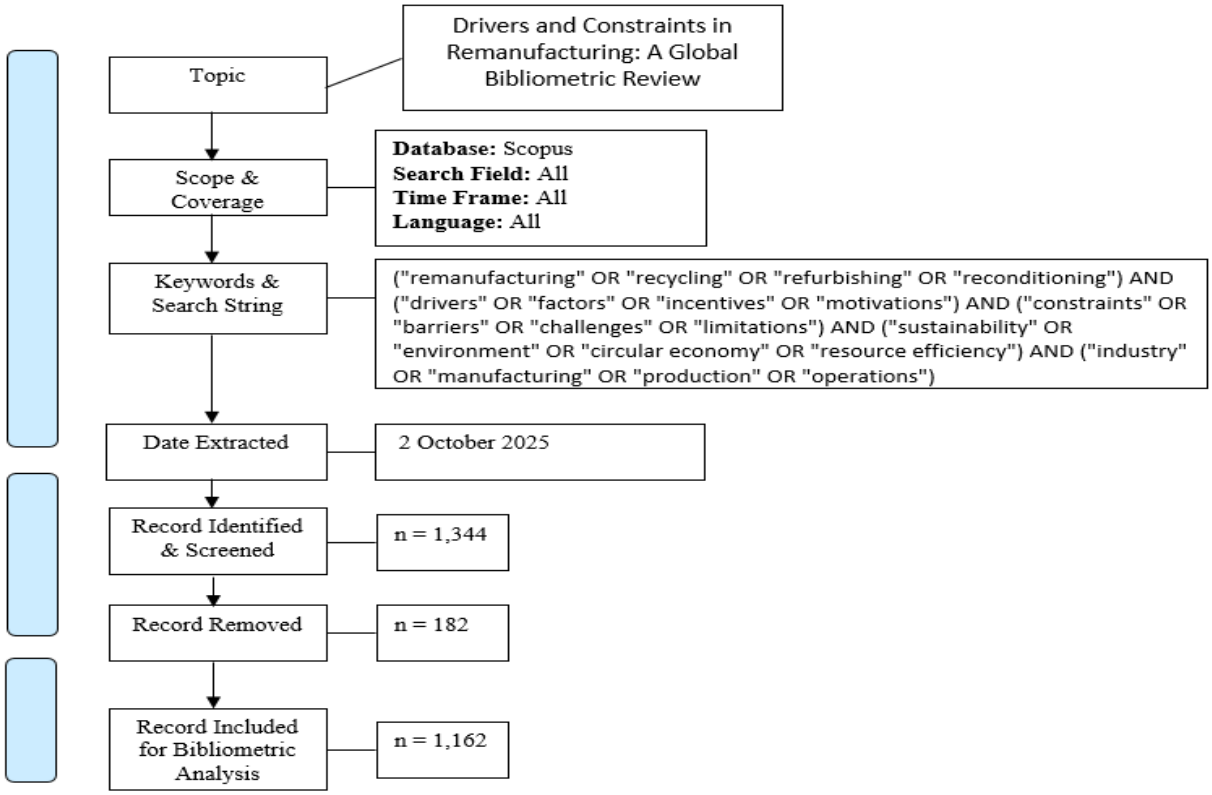
A comprehensive bibliometric analysis presents a methodical and quantitative technique to analyse the intellectual structure and research tendencies and patterns of global cooperation in a specific scientific field. For this research, the Scopus database was used as the main data source given its wide coverage of peer-reviewed journals, conference proceedings, and books in the fields of engineering, environmental science, business, and operations management, all of which lie at the core of remanufacturing research (Baas et al., 2020). The Scopus database offers high-quality metadata, including author affiliations, citation counts, keywords, and funding data that are critical for precise co-authorship, co-citation, and keyword co-occurrence analysis (Mongeon & Paul-Hus, 2016). Thus, this study focuses on a bibliometric analysis of a dedicated dataset on remanufacturing drivers and constraints to identify thematic clusters (for example, integration of circular economy, reverse logistics, and consumer perception), analyzes the dynamics of the focus areas over a specified time, and illustrates the patterns of collaboration at the geographical and institutional levels.

Through bibliometrics, scholars can condense disparate scholarship into a visual and digestible representation of a knowledge landscape, including what paradigms dominate, what trends are emerging, like intelligent remanufacturing technologies (Wang et al., 2023), and what areas or topics are still lacking attention, like the dimensions of social sustainability (Shaharudin et al., 2022). As a method of analysis, which is objective and reproducible, bibliometrics both integrates knowledge and outlines an agenda for prospective research, research-driven policies, and advocacy, which, in turn, fuel the rapid development of remanufacturing as an essential strategy for sustainable industrial ecosystems (Matsumoto et al., 2016; Yang, 2019).

The methods and processes pertaining to the data collection for this bibliometric analysis were undertaken through a PRISMA approach (as shown in Figure 1). The study was oriented with the primary research topic 'Drivers and Constraints in Remanufacturing: A Global Bibliometric Review'. This helped to define the conceptual parameters for the research. In the next step, the range of the study was defined to consist of all the literature published in the Scopus database, without any filters concerning the date of publication or the language to provide a comprehensive and global scope.

The key step was building a detailed search string with Boolean logic to account for all aspects of the topic. The query merged four thematic groups: (1) remanufacturing-related words – "remanufacturing," "recycling," "refurbishing," and "reconditioning"; (2) driver-related words – "drivers," "factors," "incentives," "motivations"; (3) constraint-related words – "constraints," "barriers," "challenges," "limitations"; and (4) context-setting words around sustainability and industry – "sustainability," "environment," "circular economy," "resource efficiency," "industry," "manufacturing," "production," "operations." This intricate search string was run on 2 October 2025 and returned 1,344 records, which were identified and screened. In the next step, 182 records were removed which were probably automated deduplication or a first pass screening by title and abstract to exclude non-research items like editorials, conference announcements, and other irrelevant publications. The final set of 1,162 documents was used for bibliometric analysis, which was used to quantify specific elements of the analysis to track the trends in research, the intellectual structure and collaboration patterns that were detailed in the objectives of the study.

Figure 1: PRISMA Flow Diagram



Source: Moher et al. (2009).

The current research integrated the bibliometric software tools into the methodological framework to conduct data processing in an efficient, standardised, and visual manner. During data extraction from Scopus, Harzing Publish or Perish (version 9.0) was used to verify and augment the primary metadata, particularly citation verification, author affiliation, and the impact metrics of the journal to ascertain validity (Harzing, 2024). The citation data was integrated with Scopus, which facilitated the preliminary screenings of the data and the detection of inconsistencies in authors' names and the institutional spellings (which have to be monitored closely to productivity and collaboration analyses). Subsequently, as advanced bibliometric mapping and network visualisation were to be performed, VOSviewer (version 1.6.20) was used (van Eck & Waltman, 2023).

Narrowing down to specific functions, VOSviewer standardised data with the application of the custom. The data set was unified by the thesaurus file for keyword variants, which for example, included "remanufacture" and "remanufacturing," and generic terms that constituted noise were removed. Subsequently, as the VOS algorithm for clustering was performed, it produced the co-occurrence maps on keywords, co-citation networks of documents, and collaboration networks of the countries and institutions. The visuals showed the central research themes, which were, integration of the circular economy, reverse logistics and consumer perception and exposed the intellectual framework and international research collaboration that was within remanufacturing research. Integrated use of Harzing Publish or Perish and VOSviewer contributed to methodical transparency and analytical rigour consistent with the bibliometric literature of sustainability and operations management (Abassi et al., 2025; Matsumoto et al., 2016).

4. Results

This section describes the results of a detailed bibliometric study of the worldwide academic literature on the drivers and constraints of remanufacturing. This analysis draws on a set of 1,162 peer-reviewed publications obtained from Scopus and analyzed using Harzing Publish or Perish and VOSviewer. It analyses the field's intellectual structure, thematic evolution, and collaboration dynamics. The results are organized in a way that documents important trends in publications over time, the geographic and institutional distribution of research output, the most influential authors and journals, and the major thematic clusters that characterize the scholarly discourse in the field. Using co-citation, keyword co-occurrence, and country collaboration networks, this chapter builds an empirically grounded account of the field's evolution, its geographic concentration, and the key areas of focus that are likely to drive future research.

Document and Source Types

The Document Profiles section, outlined in Table 1, describes the different types of scholarly outputs that make up the global research landscape on drivers and constraints in remanufacturing. Of the 1,162 documents, the largest portion consisted of journal articles, totalling 633 publications (54.48%). This predominance demonstrates the field's maturation, as peer-reviewed articles represent the primary channel for the dissemination of original empirical and theoretical contributions in the research areas of sustainability and operations (Matsumoto et al., 2016). The large number of review articles—272 documents (23.41%)—also illustrates the dynamic and developing character of the field, as scholars perform the vital task of knowledge synthesis to reveal the field's defining gaps, scaffolding re-inquiry (frameworks), and directing scholarship (Mejía-Moncayo et al., 2025). Such a high proportion of reviews is typical in emergent interdisciplines, especially those requiring integration of engineering, logistics, and environmental policy.

Table 1: Document Type

Document Type	Total Publications (TP)	Percentage (%)
Article	633	54.48%
Review	272	23.41%
Conference Paper	146	12.56%
Book Chapter	92	7.92%
Book	7	0.60%
Conference Review	7	0.60%
Editorial	2	0.17%
Short Survey	2	0.17%
Note	1	0.09%
Total	**1,162**	**100.00**

Conference papers make up 146 publications (12.56%), forming the third biggest category. This is an indication of the engagement of the industrial engineering and management communities wherein conferences are venues for the presentation of advanced technical innovations, especially the intelligent remanufacturing systems and optimization of reverse logistics (Wang et al., 2023). The remanufacturing book chapters (92 documents, 7.92%) also show that the subject is being presented within the larger academic conversation of the circular economy and sustainable manufacturing, particularly in edited volumes (Yang, 2019). On the contrary, books are scarce (7, 0.60%) and conference reviews (7, 0.60%), which could mean that foundational monographs are available, but the literature and field itself is driven by scholarship in journals and conferences, rather than comprehensive books. The little amount of editorials, short surveys, and notes (together <0.5%) also shows that the dataset mainly consists of substantive research, which is a positive for the bibliometric analysis. This type of research documents distribution shows that the scholarship is academically rigorous paired with a pragmatic approach, while creating a significant amount of peer-reviewed work, signifying that the discipline has moved from being a niche interest to a foundational strategy of sustainable practice (Abassi et al., 2025).

Year of Publications/Evolution of Published Studies

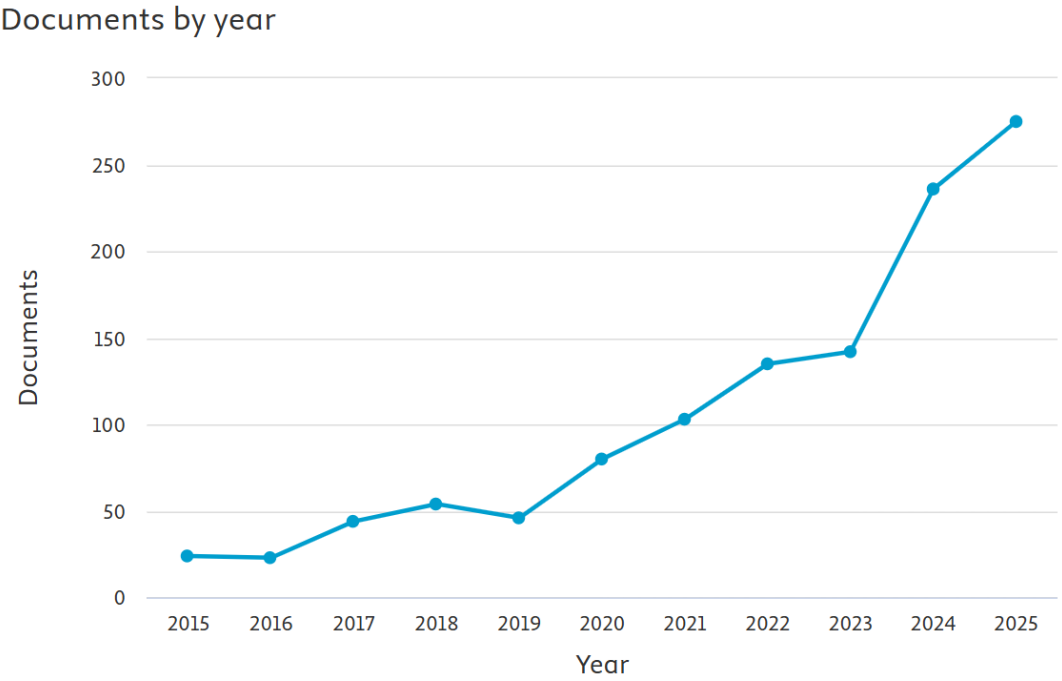
The trend of scholarly output about the drivers and constraints in remanufacturing illustrates the temporal evolution of this domain, as presented in Table 2 and Figure 2. In the past 10 years, the discipline has shown remarkable spikes in output, indicating that a developing area of research is in the process of transitioning to maturity status. The period from 2015 to 2018 recorded a much lower output, with the yearly range being between 23 and 54 published documents. This can be accounted for by the period of the development of foundational concepts of remanufacturing (Matsumoto et al., 2016). 2019 recorded a stronger growth of 46 documents, which was followed by significant increases in 2020 and 2021, with 80 and 103 documents, respectively. These surges shadow global policy increases for circular economies and climate change (Yang, 2019; Mejía-Moncayo et al., 2025).

The most dramatic expansion is evident from 2022 onward, with annual outputs climbing to 135 in 2022, 142 in 2023, and then surging to 236 in 2024 and peaking at 275 in 2025. This exponential growth particularly the near-doubling of output between 2022 and 2024, suggests that remanufacturing has become a focal point for interdisciplinary research. This surge in interest is likely driven by advances in intelligent manufacturing technologies (Wang et al., 2023), increased corporate adoption of closed-loop supply chains, and supportive institutional funding and policy (Singhal et al., 2018). The cumulative percentage data further underscores this trajectory: by 2022, only 57.8% of all publications had been produced; by 2025, that figure reached 100%, indicating more than half of all scholarly work in this domain has been published within the last three years alone. This substantial growth reflects increased interest from the academic community and aligns with practical industry needs as businesses pursue scalable solutions to pressing sustainability challenges. The sustained upward trend suggests that the field is still in its growth phase, with significant potential for future innovation and consolidation of knowledge.

Table 2: Year of Publications

Year	Total Publications	Percentage (%)	Cumulative Percent
Year	**TP**	**%**	**Year**
2025	275	23.67%	2025
2024	236	20.31%	2024
2023	142	12.22%	2023
2022	135	11.62%	2022
2021	103	8.86%	2021
2020	80	6.88%	2020
2019	46	3.96%	2019
2018	54	4.65%	2018
2017	44	3.79%	2017
2016	23	1.98%	2016
2015	24	2.07%	2015
Total	**1162**	**100.00**	

Figure 2: Document by Year



Languages of Documents

The publication spreadsheet captures an overview of the publication language within the dataset. Henceforth, the dataset indicates about `dominance' of `English' across the publications. According to the dataset, of the total 371 sources, 361 confirmed to publish only or mostly in English (97.30%). This is unsurprising, given that the vast majority of scientific literature, as noted in prior research (van Weijen, L. 2012; Yang, 2019), is written in English. Research in sustainability, engineering, and operations management pivots on the need to reach global audiences, be cited, and be within the reach of international scholars and policymakers, which is on the account of the international scope of the disciplines. The English language serves as a global bridge, opening borders not only to publications, but to the integration of knowledge, and collaboration on joint research initiatives and frameworks. This is critically important in the global agenda on drivers and constraints of remanufacturing.

Other languages account for a substantially small percentage of the total, namely German (4, 1.08%), Portuguese (3, 0.81%), and individual Chinese, French, and Spanish (0.27% each). The non-English publications identified in the literature are likely to be regionally-focused research or policy-related documents aimed at local audiences, like the engineering societies in Germany, the academic communities in Brazil or Portugal, or Chinese industrial journals focused on local circular economy (Wang et al., 2023). Although they are useful for providing additional context, the small number of non-English publications highlights the limited impact that non-English scholarship has on the primary discourse. The bulk of which is disseminated through English-language publications and conferences that are accessible through principal databases, such as Scopus.

There are both pros and cons associated with this type of linguistic focus. It makes knowledge synthesis and large-scale bibliometric analyses possible, as this study demonstrates (Matsumoto et al., 2016). It can also lead to ignoring important knowledge from the Global South, particularly non-Anglophone countries, where different regulatory, economic, and cultural contexts might influence remanufacturing (Monyaki & Cilliers, 2023). To illustrate, remanufacturing in Latin America might be informally structured and studies in Portuguese or Spanish could be valuable. In the case of China, analyses published in Chinese may describe state-sponsored circular economy initiatives that are unrecognized in the English literature. Still, English is the predominant language of literature discussing remanufacturing as a strategy for global sustainability, confirming the argument that future research should be more equitable in crossing linguistic and geographical boundaries (Abassi et al., 2025).

Table 3: Languages Used for Publications

Language	Total Publications*	Percentage (%)
English	361	97.30
German	4	1.08
Portuguese	3	0.81
Chinese	1	0.27
French	1	0.27
Spanish	1	0.27
Total	**371**	**100.00**

*One document has been prepared in dual languages

Subject Area

The publication data in Table 4 shows the breadth of the literature on drivers and constraints in remanufacturing across 15 subject areas as defined by Scopus. With 566 publications (48.71% of the total body of work), the Environmental Science domain is by far the largest constituent of the literature. This evidences the tendency to conceptualize remanufacturing predominantly as a strategy for sustainability and for mitigating climate change as a resource and waste reduction practice (Matsumoto et al., 2016; Zhang et al., 2020). This is consistent with the pronounced attention to remanufacturing in discussions of the circular economy, in which the attainment of desired environmental benefits, such as diminished carbon footprints and energy usage, is of foremost importance (Yang, 2019).

The subject area of Engineering, having produced 414 publications, corresponds to 35.63% of the total, and is the second largest, capturing the technical and operational aspects of the remanufacturing processes of disassembly, inspection, reprocessing, and quality control (Wang et al., 2023). Next to Engineering is the field of Energy, with 285 publications and 24.53%. This field of study centers on the energy efficiency and life cycle energy savings obtainable in remanufacturing, an economic and environmental advantage over virgin production (Ferraro et al., 2024). The notable proportion of publications in the Social Sciences, 181 publications and 15.58%, and in Business, Management and Accounting, 165 publications and 14.20%, suggests an increasing focus on the anthropological and organizational aspects, including consumer behavior, market acceptance, firm strategy, and policy frameworks (Almefelt & Rexfelt, 2017; Eguren et al., 2018). This equilibrium shift expresses the advancement of the discipline in addressing socio-technical frameworks, beyond the provision of technical solutions.

Integrative and interdisciplinary work is most noticeable in Computer Science and Decision Sciences, incorporating various digital technologies such as the Internet of Things (IoT), artificial intelligence, and multi-criteria decision-making models into remanufacturing systems for optimizing reverse logistics and core acquisition (Guggeri et al., 2023). Likewise, Materials Science and Chemical Engineering focus on the important and interdisciplinary issues related to the study of degradation of materials, techniques for restoration, and sustainable material flows. The smaller but important Economics, Econometrics and Finance presence shows an increase in attention on cost modelling, incentives, and profitability analysis (Sun & Wang, 2024). Even more curious are disciplines like Agricultural and Biological Sciences and Earth and Planetary Sciences, suggesting exploratory linkages to the thinking of bio-based materials and planetary boundaries.

Table 4: Subject Area

Subject Area	Total Publications	Percentage (%)
Environmental Science	566	48.71%
Engineering	414	35.63%
Energy	285	24.53%
Social Sciences	181	15.58%
Business, Management and Accounting	165	14.20%
Computer Science	135	11.62%
Materials Science	122	10.50%
Economics, Econometrics and Finance	93	8.00%
Chemical Engineering	84	7.23%
Agricultural and Biological Sciences	78	6.71%

Chemistry	71	6.11%
Earth and Planetary Sciences	57	4.91%
Decision Sciences	50	4.30%
Physics and Astronomy	49	4.22%
Mathematics	43	3.70%

Most Active Source Titles

Table 5 highlights the leading sources, mostly academic journals, which have published literature on the enabling and constraining factors in remanufacturing, and which identify the primary sources of scholarly influence in this area. At the top of the list is Sustainability (Switzerland), which accounts for 59 publications (5.08% of the total corpus). This is in part due to its status as a high-output, open-access journal and the interdisciplinary character of its Sustainability, Operations, and Environmental Policy (MDPI, 2025) publications on the circular economy, sustainable operations, and environmental policy. This reflects the increasing tendency to publish research on sustainability in readily accessible formats that reach the academic community as well as practitioners.

Not far behind is the Journal of Cleaner Production (51 publications, 4.39%), which has 51, 4.39% publications. This is a high-impact journal well recognized for the research on remanufacturing, closed-loop supply chains, and industrial sustainability (Zhang et al., 2020). This has solidified its core position in the academic literature as it continues to publish empirical and conceptual works that analyze the remanufacturing drivers including consumer behavior, policy incentives, and life cycle assessment (Diener et al., 2019). The status of the Journal of Environmental Management (37, 3.18%) and Science of the Total Environment (31, 2.67%) is to emphasize the environmental governance and systems-level perspectives on remanufacturing as a waste reduction and ecosystem protection strategy.

Resources, Conservation and Recycling (28, 2.41%) further illustrates the field's emphasis on resource efficiency and the circular economy, as this journal publishes numerous articles on material flows, reverse logistics, and the recovery of products at the end of life (Matsumoto et al., 2016). Waste Management (22, 1.89%) as well as Sustainable Production and Consumption (18, 1.55%) research extends this emphasis to practical valorization of waste and intervention on the consumption side, respectively. Notably, Procedia CIRP (19, 1.64%)—the proceedings of the International Academy for Production Engineering—accounts for the contributions of the engineering and manufacturing community, frequently showcasing various technical innovations on remanufacturing processes and design for remanufacturing (Eguren et al., 2018).

The emergence of new venues like Circular Economy and Sustainability (11, 0.95%) demonstrates the dedication to scholarship on the circular economy and the institutionalization of remanufacturing, while interdisciplinary journals such as Energies (14, 1.20%) and Renewable and Sustainable Energy Reviews (10, 0.86) provide evidence for the interest on the energy side of remanufacturing versus primary production (Ferraro et al., 2024). Moreover, Business Strategy and the Environment (9, 0.77%) further illustrates the integration of remanufacturing into corporate strategies on sustainability and competitive advantage through the environment, which underlines the growing interest of the business community.

Table 5: Most Active Source Title

Source Title	Total Publications	Percentage (%)
Sustainability Switzerland	59	5.08%
Journal of Cleaner Production	51	4.39%
Journal of Environmental Management	37	3.18%
Science of the Total Environment	31	2.67%
Resources Conservation and Recycling	28	2.41%
Waste Management	22	1.89%
Procedia CIRP	19	1.64%
Sustainable Production and Consumption	18	1.55%
Energies	14	1.20%
Circular Economy and Sustainability	11	0.95%
Renewable and Sustainable Energy Reviews	10	0.86%
Business Strategy and the Environment	9	0.77%

Source Title	Total Publications	Percentage (%)
Lecture Notes in Civil Engineering	9	0.77%
Applied Sciences Switzerland	8	0.69%
Chemosphere	7	0.60%

Author Keywords Analysis

The thematic snapshot of the field's intellectual focus is represented in the word cloud cited in Figure 3. This is based on the author-assigned keywords from the bibliometric dataset focused on drivers and constraints in remanufacturing. The visual prominence of each word is a function of its recurrence in the dataset, with larger words suggesting greater prevalence and more centrality to the concepts of the field. The words "waste" and "environmental" dominate the cloud, illustrating the fundamental motivation of the field and anchoring the visualization. The primary goal of remanufacturing is to minimize waste and reduce adverse effects on the environment (Matsumoto et al., 2016; Zhang et al., 2020). This framing of remanufacturing resonates with sustainability agendas and the goal of circular economies (Yang, 2019).

The use of "management" and "recycling" highlights the operational and systemic aspects of the research, focusing on issues such as the optimization of reverse logistics and the integration of reverse logistics into overall resource management (Gunasekara et al., 2018). "Recycling" is often repeated but primarily in the context of "remanufacturing" or in contrast to it, a distinction that scholars note because remanufacturing is about rehabilitating the product to 'new' condition, rather than simply disassembling the product to recover materials (Zhang et al., 2020). "Circular" and "cycle" strengthen this systemic view, connecting remanufacturing to closed-loop systems and value retention (Abassi et al., 2025).

Another set of key terms points to valuable sub-themes. "Sustainability" and "sustainable" are part of the dominant lexicon, indicative of the triple-bottom-line framework due to the increasing balance of research in the economic, environmental, and social dimensions (Mejía-Moncayo et al., 2025). The attention to "energy", "carbon", and "climate" captures the stream of research that focuses on the carbon and energy savings of remanufacturing relative to producing from virgin materials (Ferraro et al., 2024). The terms "supply", "chain", "industry", and "manufacturing" denote the logistical and industrial context in which remanufacturing takes place, while "economic" and "economics" underline the fiscal sufficiency and business model that inform the decision to embrace it (Eguren et al., 2018).

The lack of references to "consumer," "perception," and "barriers" despite their recognized importance is notable among the top-tier keywords. This suggests these terms may be subsumed under "sustainability" and "management," or are simply inadequately represented in the assignment of keywords. The absence of technological enablers such as "AI," "IoT," or "additive manufacturing" may be explained by their recent emergence as key focus areas or the inconsistent use of these terms by authors in assigning keywords.

Figure 3: Network visualization map of the author keywords



Geographical Distribution of Publications

The top 20 countries worldwide by publication output in remanufacturing research are shown in Table 6. It elucidates the global geography of knowledge production on drivers and constraints in the field. The United States takes the lead by a significant margin, with 265 publications (20.87% of the total) and a record of research and sustainable manufacturing. This is due to the research and sustainable manufacturing coupled with esteemed policy debates on sustainable circular economies (Matsumoto et al., 2016; Wang et al., 2023) and US academic-industry alliance. The most influential work on reverse logistics, closed-loop supply chains, and design for remanufacturing is primarily attributable to US scholars, establishing the United States as the most influential contributor to the field.

Next to the U.S., Europe dominates the field as well. The U.K. (127 publications, 10.00%) and Spain (125, 9.84%) take second and third. The U.K. output is likely to be high because of the interest in the sustainable operations, policy integration, and consumer behavior analyses (e.g. Lastovetskaia et al. 2025). Spain, on the other hand, has prominence due to initiatives in her regions such as the Basque Country, which has pioneering industrial remanufacturing ecosystems consolidated with public-private partnerships and developed ecosystem (Eguren et al. 2018). Other major contributors in Europe are also Portugal (52, 4.09%), Germany (48, 3.78%), Italy (46, 3.62%), and France (39, 3.07%), who also along with Spain focused on engineering innovation, life cycle assessment, and circular business models as part of the priorities of the European Union's Circular Economy Action Plan and Green Deal (Yang, 2019).

With 64 publications (5.04%), Brazil is the largest contributor from the Global South. This indicates the beginnings of Latin America scholarship contributions. Brazilian studies tend to focus on remanufacturing with respect to informal economies, resource constraints, and local industrial development (Abassi et al., 2025). Likewise, India (21 publications, 1.65%) and China (21, 1.65%) show early but still modest output given their industrial size, indicating potential for development (Sharma et al., 2016; Zhang et al., 2020). On the other hand, Australia (33, 2.60%) and Japan (34, 2.68%) make large contributions with studies on resource efficiency, product stewardship, and high-value remanufacturing with respect to the automotive and electronics industries.

More interestingly, some smaller European countries—Norway, Austria, and Switzerland, for example—contribute more than expected. This is probably because these countries have strong national commitments to sustainability and have developed niche expertise in areas like sustainable design and policy evaluation. On the other hand, the small number of publications from other African and Southeast Asian countries points to areas of geographic inequality in the field.

Table 6: Top 20 Countries contributed to the publications

Country	Total Publications	Percentage (%)
United States	265	20.87
United Kingdom	127	10.00
Spain	125	9.84
Brazil	64	5.04
Portugal	52	4.09
Germany	48	3.78
Italy	46	3.62
France	39	3.07
Japan	34	2.68
Australia	33	2.60
Norway	27	2.13
Greece	26	2.05
South Korea	26	2.05
Austria	24	1.89
China	21	1.65
India	21	1.65
Turkey	19	1.50
Canada	18	1.42

Malaysia	18	1.42
Ecuador	15	1.18
Switzerland	11	0.87
Belgium	10	0.79

Authorship

Table 7 shows the most active authors on the global scholarly scene concerning the drivers and constraints pertaining to remanufacturing, again, using the bibliometric dataset of 1,162 documents. The most prolific authors, Jaiswal, S.K.; Mukti, S.K.; and Sundin, E, and 5 works each (0.43% of the corpus) and 5 other authors from the second cadre, Caldera, S., Maqsood, T., Ryley, T., Shooshtarian, S. and Zaman, A. each to 4 works (0.34%). The most prolific authors hardly dominate the total output, and less than 0.5% of the total output each, and, again, indicative of a high degree of collaboration and a "distributed" vs. "centralized" research paradigm. This is often seen in emerging interdisciplinary research areas where knowledge is co-produced across a multitude of patterns, including geography, institutions, and disciplines (Matsumoto, et al. 2016).

Sundin, E. deserves commendation for being one of the first advocates on the sustainable design of products and on remanufacturing along the circular economy lines. Much of his work focuses on design for remanufacturing, value retention, and industrial implementation, which are fundamental issues in the field (Sundin & Bras, 2005, as cited in the remanufacturing literature). Building on this work, Winifred Ijomah competently analyses the literature on remanufacturing process standardisation, reverse logistics, and quality control, which has become pivotal in both theory and practice regarding the feasibility of remanufacturing (Ijomah et al., 2007). From the area of sustainable manufacturing systems, Herrmann C. combines life cycle assessment and resource efficiency bridge with remanufacturing decision processes (Herrmann et al., 2016). The contribution of Bleischwitz, R. and Ryley, T. further demonstrates the evolution of the discipline to include policy, control of resources, and management of sustainable supply chains, as indicated in the shift studies from mere technical studies to socio-technical system analysis (Yang, 2019).

Table 7: Most Productive Authors

Author's Name	No. of Documents	Percentage (%)
Jaiswal, S.K.	5	0.43%
Mukti, S.K.	5	0.43%
Sundin, E.	5	0.43%
Caldera, S.	4	0.34%
Maqsood, T.	4	0.34%
Ryley, T.	4	0.34%
Shooshtarian, S.	4	0.34%
Zaman, A.	4	0.34%
Baldassarre, B.	3	0.26%
Bleischwitz, R.	3	0.26%
Cooper, T.A.	3	0.26%
Di Maria, A.	3	0.26%
Herrmann, C.	3	0.26%
Ijomah, W.	3	0.26%
Li, J.	3	0.26%

Text Analysis

Figure 4 VOSviewer visualization illustrates how the tool generates a term co-occurrence network using the titles and abstracts of the analyzed publications and full counting to define the cognitive structure of the research on the drivers and constraints in remanufacturing. In this visualization, the network uses nodes and edges to represent terms and co-occurrences, respectively. Each term's node displays a value corresponding to the node's weight for a snapshot of the term's frequency in the analyzed publications, while the thickness of edges signifies the strength of the co-occurrence. Semantic terms that connected and co-occur with the most frequency in the research literature are algorithmically grouped, and color-coding for the connected terms illustrates their community.

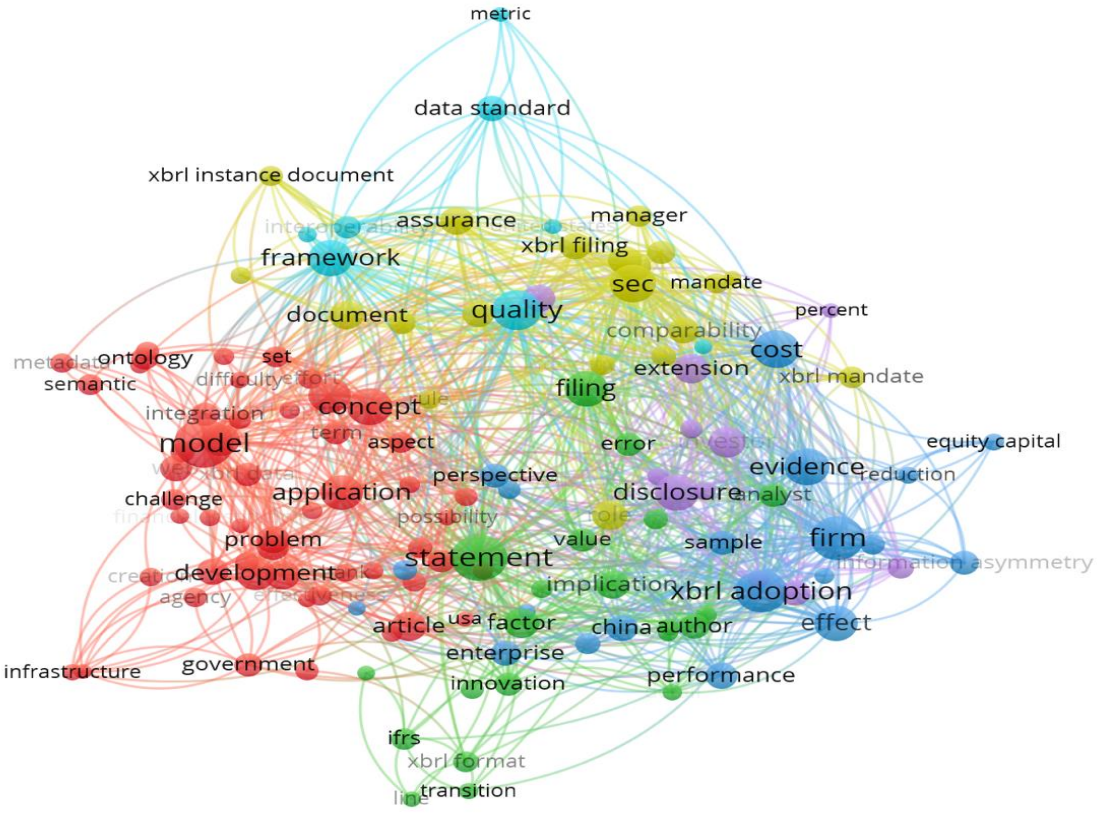
The most dominant clusters, shown in red, contain "concept," "development," "problem," "challenge," "application," "infrastructure," and other core definitional and operational remanufacturing. This glaring cluster exposes the definitional foundational discourse on remanufacturing, the systemic obstacles, and practical execution challenges in the industrial context (Matsumoto et al., 2016; Eguren et al., 2018). "Government" and "policy" imply that adoption depends on institutional frameworks that either enable or block access.

The second major cluster, depicted in green, is anchored by the terms "quality," "assurance," "framework," "metric," and "data standard." This group points to the shifting spotlight on the foundational pillars of standardization, measurement, and quality control, all of which aid in fostering customer trust and guaranteeing the market feasibility of remanufactured products (Mejía-Moncayo et al., 2025; Diener et al., 2019). Notably, the juxtaposition of "quality" with "assurance" and "metric" implies that the development of rigorous and measurable indicators of successful remanufacturing is gaining traction in scholarly focus.

The blue cluster containing "performance," "firm," "cost," "value," "sample,"" and "evidence" speaks to the economic and managerial aspects of remanufacturing. It underscores research pertaining to cost and benefit analysis, decision-making at the firm level, and remanufacturing's economic and operational impact empirical research (Ferraro et al., 2024; Li et al., 2024). The mention of "China author" and "xbrl adoption" suggests emerging sub-themes concerning the enactment of regional policies and digital reporting standards, albeit these might pertain to the dataset itself rather than remanufacturing's core concepts.

Finally, the yellow/purple periphery with terms such as "ontology," "semantic," "integration," and "perspective" indicates some level of attention, albeit limited, in the development of theoretical frameworks, knowledge representation, and interdisciplinary integration, which could signal potential research on the convergence of information systems and sustainability science.

Figure 4: VOSviewer visualization of a term co-occurrence network based on title and abstract fields (Full Counting)



Citation Analysis

Table 8 outlines various metrics that evaluate the scholarly output and intellectual contribution of the 1,162 publications analyzing the drivers and constraints in remanufacturing from 2015 to 2025. Total publications received 42,608 citations, averaging 36.67 citations per paper, indicating the relevance of the field and its influence within the broader conversations of academic sustainability and operations research. Citation impact, averaging 4,260.8 per year, is consistent with publications output and the rapid expansion of scholarly work on the various facets of remanufacturing post-2019 (Wang et al., 2023).

The h-index of 100 is impressive: it demonstrates that 100 publications in the dataset received more than 100 citations each, indicating the presence of a core of powerful and impactful research. The g-index of 185, which measures the impact of total citations of the top-most cited articles, is yet another confirmation of impact concentration around a few key works. The most notable of which include seminal reviews on the circular economy and remanufacturing challenges (for example, Matsumoto et al., 2016, and Lieder & Rashid, 2016, both cited throughout). The observed impact radiates to numerous facets of the global sustainability discourse, indicating the field's relevance and contribution.

At the authorship and productivity level, additional insights become available. 372.51 papers per author (total papers and unique authors in the data set) is probably due to the strong multi-authorship and cooperation common in interdisciplinary sustainability research. Similarly, the 13,358.98 citations per author illustrate the community level and synergistic impact of the research community, moving through and among the interfaces of engineering, environmental science, and the interdisciplinary business domain (Yang, 2019).

Table 8: Citations Metrics

Metrics	Data
Publication years	2015-2025
Citation years	10 (2015-2025)
Papers	1,162
Citations	42,608
Citations/year	4,260.8
Citations/paper	36.67
Citations/author	13,358.98
Papers/author	372.51
h-index	100
g-index	185

Table 9 contains the 20 most highly cited publications from the entire Scopus dataset about sustainability, the circular economy, and resource recovery. It is worth noting that among the top 20 publications, none explicitly treat remanufacturing as their primary focus. This is itself indicative of the field; while remanufacturing is an important and fundamental component of circularity, it is a more narrowly defined, specialized, and less cited area of work as compared to the broader and more generalized materials circular economy literature.

The most cited paper (Lieder and Rashid, 2016), which has 2,028 total citations (225.33 per year), is a complete work that covers the circular economy in manufacturing and its implementation in the various recovery strategies but does not focus on remanufacturing as a central component. Other high-impact works that also dominate the list and focus on lithium recovery (Swain, 2017; Olivetti et al., 2017), bio-plastics (Rosenboom et al., 2022), and construction and demolition waste (Huang et al., 2018; Ghisellini et al., 2018) reveal a concentration of scholarship and policy attention on material-specific circularity and substantial waste streams. These works often discuss recycling and material reprocessing, which, as Matsumoto et al. (2016) clarify, is not to be confused with remanufacturing, the process of fully restoring a product or its components to an "as-new" condition.

Research most adjacent to the themes of remanufacturing includes Nascimento et al. (2019), which focuses on the use of Industry 4.0 technologies (e.g., IoT, AI) to implement circular practices within manufacturing—an area that, as highlighted by Wang et al. (2023), is quite pertinent to intelligent remanufacturing systems. Nevertheless, even this piece of research positions remanufacturing among a much larger set of circular

strategies. The absence of key foundational remanufacturing works such as Ijomah et al. (2007) from this highly-cited list captures a key insight: while the research on remanufacturing is expanding quickly, it does not seem to be reaching the same breadth of disciplinary depth or citation impact as the foundational works in the broader domain of the circular economy or materials recovery.

Table 9: Highly cited articles

No.	Authors	Title	Year	Cites	Cites per Year
1	Lieder & Rashid	Towards circular economy implementation: A comprehensive review in the context of the manufacturing industry	2016	2028	225.33
2	Swain	Recovery and recycling of lithium: A review	2017	1426	178.25
3	Rosenboom, Langer, & Traverso	Bioplastics for a circular economy	2022	1405	468.33
4	Renzo, Debbah, Phan-Huy, Zappone, Alouini, Yuen, Sciancalepore, Alexandropoulos, Hoydis, Gacanin, De Rosny, Bounceur, Lerosey, & Fink	Smart radio environments empowered by reconfigurable AI meta-surfaces: an idea whose time has come	2019	1372	228.67
5	Olivetti, Ceder, Gaustad, & Fu	Lithium-Ion Battery Supply Chain Considerations: Analysis of Potential Bottlenecks in Critical Metals	2017	1218	152.25
6	Huang, Wang, Kua, Geng, Bleischwitz, & Ren	Construction and demolition waste management in China through the 3R principle	2018	839	119.86
7	Nascimento, Alencastro, Quelhas, Caiado, Garza-Reyes, Lona, & Tortorella	Exploring Industry 4.0 technologies to enable circular economy practices in a manufacturing context: A business model proposal	2019	746	124.33
8	Shen, Huang, Chen, Song, Zeng, & Zhang	(Micro) plastic crisis: Unignorable contribution to global greenhouse gas emissions and climate change	2020	654	130.8
9	Qambrani, Rahman, Won, Shim, & Ra	Biochar properties and eco-friendly applications for climate change mitigation, waste management, and wastewater treatment: A review	2017	651	81.38
10	Ghisellini, Ripa, & Ulgiati	Exploring the environmental and economic costs and benefits of a circular economy approach to the construction and demolition sector. A literature review	2018	526	75.14
11	Tan, Banerjee, Chen, & Meng	From nanoscale interface characterization to sustainable energy storage using all-solid-state batteries	2020	522	104.4
12	Part, Ramli, & Cheah	An overview of the influence of various factors on the properties of geopolymer concrete derived from industrial by-products	2015	485	48.5
13	Joshi & Ahmed	Status and challenges of municipal solid waste management in India: A review	2016	479	53.22

14	Tawalbeh, Al-Othman, Kafiah, Abdelsalam, Almomani, & Alkasrawi	Environmental impacts of solar photovoltaic systems: A critical review of recent progress and future outlook	2021	478	119.5
15	Barnard, Rubio Arias, & Thielemans	Chemolytic depolymerisation of PET: A review	2021	475	118.75
16	Ren, Verma, Li, Teuwen, & Jiang	Offshore wind turbine operations and maintenance: A state-of-the-art review	2021	446	111.5
17	Cong & Cheng	Advances in geopolymer materials: A comprehensive review	2021	414	103.5
18	Ghaffar, Burman, & Braimah	Pathways to circular construction: An integrated management of construction and demolition waste for resource recovery	2020	403	80.6
19	Camacho-Otero, Boks, & Pettersen	Consumption in the circular economy: A literature review	2018	361	51.57
20	Miller, Merrilees, & Coghlan	Sustainable urban tourism: understanding and developing visitor pro-environmental behaviors	2015	318	31.8

Network visualization based on citations among documents has been constructed using VOSviewer and filtered to only include documents that have received at least 10 citations. This visualization based on citations begins to reflect the intellectual structure of the field by examining the interconnection of core documents through mutual citations. In this visualization, documents (papers) are represented as nodes, the number of citations received is represented by the size of the nodes, and the strength and direction of citation relationships are represented by the lines (edges) of the structure.

The most central and highly cited document in the collection is DeBreceny (2001) which is represented as the largest cyan node and is located near the center of the structure. Centrality indicates that DeBreceny (2001) is a foundational document that is frequently discussed and cited in a number of streams of research and is probably a theoretical or methodological anchor in the research that followed in the areas of corporate reporting, transparency, and governance which are somewhat related to remanufacturing and the accountability and performance measurement discussed in (Mejía-Moncayo et al., 2025). DeBreceny (2001) has surrounded it with a number of other influential scholars and documents, including Plumlee (2008), that create dense clusters that reflect strong cohesion and scholarly conversation around particular subtopics. These include disclosure, assurance, and financial reporting frameworks.

Additionally, previous research strengthens the concentration of the network on corporate social responsibility, sustainability reporting, and the adoption of Extensible Business Reporting Language (XBRL) areas that, although not directly related to remanufacturing, are the foundational building blocks for capturing and transmitting the ecological and economic dimensions of circularity (Yang, 2019). The proximity of the terms “disclosure,” “assurance,” and “performance” within the network reveals increasing attention on the need for metrics and the standardization of frameworks for assessing and reporting on the outcomes of remanufacturing (Ferraro et al., 2024).

In addition, the network contains more recent work by Paul et al. (2024), indicating a shift in the conversation to include digitalization, integrated reporting, and stakeholder participation. These links suggest that research on the drivers and barriers to remanufacturing is beginning to closely engage with the fields of accounting, information systems, and corporate governance to establish comprehensive frameworks for analysis.

Figure 5: Network visualization map of the citations by documents. Minimum number of citations of a document = 10

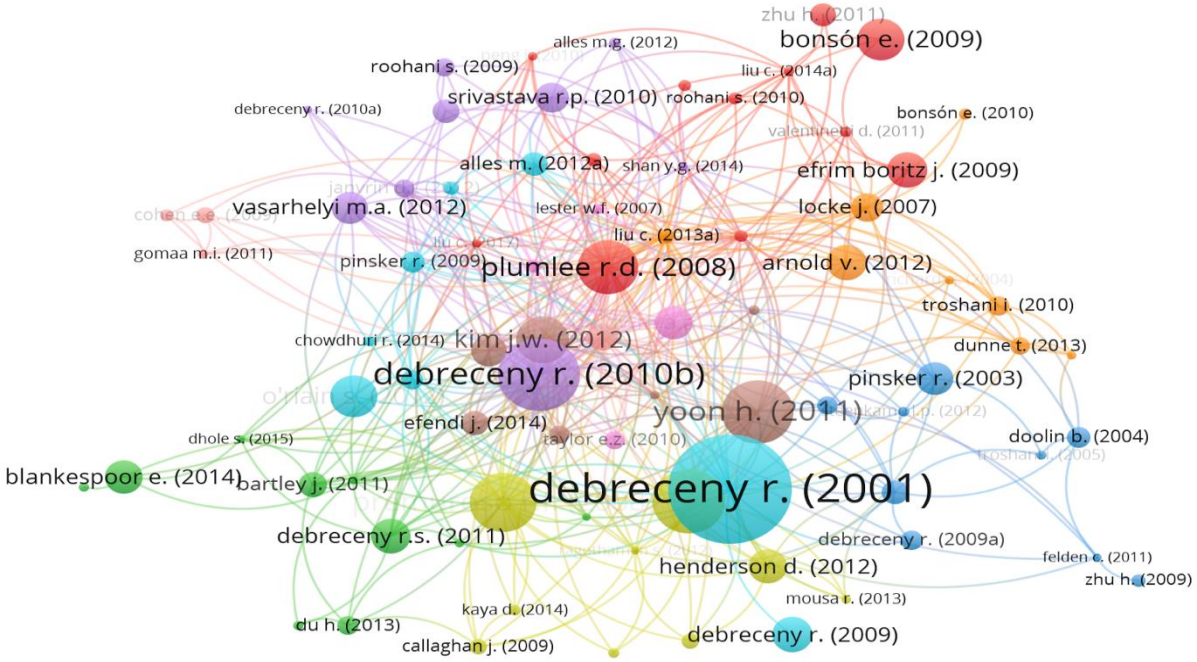


Table 10: **Drivers of Remanufacturing**

No	Driver	Frequency	Percentage
1	Policy & Regulatory Support (EPR, Right to Repair, subsidies)	14	50.0%
2	Economic Incentives & Profitability (cost savings, subsidies, ROI)	13	46.4%
3	Environmental Sustainability & Resource Efficiency	12	42.9%
4	Market Demand & Consumer Behavior	9	32.1%
5	Technological Advancements (AI, digital tools, automation)	8	28.6%
6	Strategic Business Models (PaaS, value retention)	7	25.0%
7	Resource Security & Resilience	6	21.4%
8	Brand Value & Corporate Responsibility (ESG, reputation)	5	17.9%
9	Operational Efficiency (lean, process optimization)	4	14.3%
10	Customer Orientation & Strategic Advantage	4	14.3%

Table 11: **Constraints (Barriers) of Remanufacturing**

No	Constraints	Frequency	Percentage
1	Consumer Perception & Acceptance (quality concerns, low trust)	15	53.6%
2	High Initial Investment & Financial Viability	12	42.9%
3	Lack of Skilled Workforce	10	35.7%
4	Product Design & Technical Challenges (non-modular, complex disassembly)	10	35.7%
5	Reverse Logistics & Supply Chain Uncertainty	9	32.1%
6	Policy & Regulatory Gaps (inconsistent, weak enforcement)	9	32.1%
7	Lack of Standardization & Data	8	28.6%
8	Organizational & Managerial Barriers	7	25.0%
9	Competition with New Products & Recycling	6	21.4%
10	Infrastructure Deficiencies	6	21.4%
11	Information & Traceability Issues	5	17.9%
12	Cultural & Market-Specific Factors	5	17.9%
13	Legal Restrictions & OEM Practices (e.g., forced obsolescence)	4	14.3%
14	Lack of Sales Channels & Marketing	3	10.7%
15	Uncertain Output & Quality Control	3	10.7%

The analysis of 28 articles in Tables 10 and 11 identifies the top five drivers of remanufacturing as follows: policy and regulatory support (Extended Producer Responsibility, Right to Repair, subsidies) in 14 studies (50.0%); economic incentives and profitability (cost savings, return on investment) in 13 studies (46.4%); environmental sustainability and resource efficiency in 12 studies (42.9%); market demand and consumer behavior in 9 studies (32.1%); and technological advancements (artificial intelligence, digital tools, automation) in 8 studies (28.6%). Conversely, consumer perception and acceptance (quality concerns, low trust) in 15 studies (53.6%) is the most cited barrier, followed by high initial investment and financial viability in 12 studies (42.9%); lack of skilled workforce and product design, technical challenges (non-modular, complex disassembly) in 10 studies (35.7%); and reverse logistics and supply chain uncertainty in 9 studies (32.1%). These findings emphasize that while policy, economics, and sustainability strongly enable remanufacturing, market acceptance, financial constraints, and technical-operational issues are the primary

challenges. Furthermore, large-scale remanufacturing research has also identified new and less common challenges such as restrictions from original equipment manufacturers (OEMs), the absence of dedicated sales channels, and uncertainty regarding output quality. Recent studies in China, Brazil and the European Union point to the cross-regional understanding of intricate challenges that extend far beyond operational and policy issues.

Discussion

This bibliometric study outlines the intellectual structure and evolutionary path regarding the drivers and constraints of remanufacturing covering the period of 2015 to 2025. The results show a field exhibiting signs of advanced maturation and rapid growth, marked by a notable interdisciplinary character, identifiable central themes, and a geographically clustered but globally pertinent knowledge network. In this synthesis, the findings relevant to the primary questions are distilled, focusing on the main conclusions for researchers, professionals, and those in positions of policy-making authority.

The data shows unequivocally that remanufacturing is no longer merely a technical curiosity, but a fully-fledged academic and applied field. The unprecedented increase in annual publications, especially the increase between the years 2022 and 2025, in which over fifty percent of the literature was generated, indicates that a pivotal moment is upon us. Such an increase is no coincidence and correlates with pressing global challenges, in particular the exposure of the world to the circular economy transitions from a conceptual idea to an operational necessity in industries and public policies (climate change and resource depletion) which encompasses the literature in question (Yang, 2019; Mejía-Moncayo et al., 2025). The document type profile further affirms this phenomenon and the maturity of the field. The predominance of journal articles entails an established corpus of peer-reviewed original research, while the especially large proportion of review articles reflects a field that is actively integrating its findings. This entails the identification of gaps, refining its hypotheses, and consolidating its theoretical underpinnings to the extent expected of an advanced and rapidly evolving research area.

The distribution survey shows that remanufacturing spans multiple fields and serves as a platform for cross-disciplinary collaboration. Environmental Science and Engineering is the core field as it offers both a focus on sustainability and the technical capabilities to address it. That said, the noteworthy input from Social Science fields, as well as Business and Management and Economics, is an important sign that the focus of research is expanding even more outside the technical domain. The research community understands that the remanufacturing challenges are primarily socio-economic, consumer acceptance (Almefelt & Rexfelt, 2017), business model (Abassi et al., 2025), and market structure (Eguren et al., 2018) as opposed to technical. This is particularly evident in the findings regarding the drivers and constraints, with “Consumer Perception & Acceptance” cited most often as a barrier, eclipsing other technical concerns. Manufacturers are typically equipped with the skills to implement design changes that capture the value of remanufacturing (Zailani et al., 2017). The appearance of Computer Science and Decision Sciences is another indication of research activity in new areas on digital enablers (Wang et al., 2023). The co-occurrence network analysis and the driver of “Technological Advancements” indicate that AI, IoT, and predictive (or prescriptive) data analytics (Guggeri et al., 2023) are key in addressing gaps, especially in reverse logistics uncertainty and in quality assurance.

The keyword analysis and term co-occurrence map illustrate the thematic representation of the field's intellectual focus. The prominent visualization of the keywords "waste," "environmental," "sustainability," and "circular economy" (Zhang et al., 2020) indicates that the environmental benefit of remanufacturing (key driver "Environmental Sustainability") continues to be the primary motivator. Nonetheless, the research discourse has pragmatically evolved to focus on the how. The collection of the terms "management," "quality," "assurance," "framework," and "cost" demonstrates significant interest in the operational, managerial, and economic facets of remanufacturing, which correlates with the "Economic Incentive" and "Strategic Business Models" driver. This reflects that for remanufacturing to be sustainable, it must be profitable and well-managed.

A key takeaway from the citation analysis stems from the understanding that remanufacturing, while an important circular strategy, pertains to a larger scholarly discourse. The most crowded papers remain macro-level analyses focused on the circular economy or recycling at the level of specific materials, which suggests

that while remanufacturing has a significant influence, it is often encapsulated by larger bodies of work (Lastovetskaia et al., 2025). This creates an opportunity for remanufacturing scholars to articulate more clearly the unique value their field offers against the backdrop of functional retention and material recycling.

The United States and Western Europe (i.e. the UK, Spain, and Germany) showcase geographical distribution and publication output. This can be attributed to the robust industries and research funding of these regions, as well as the progressive, environmentally focused policies, such as the EU's action plan on circular economy (Mejía-Moncayo et al., 2025). The sizeable research output from Brazil also emphasizes the significance of research being conducted in the Global South, where the research is often centered around different economic and infrastructural contexts and challenges. This geographical concentration, along with the unopposed dominance of the English language in publication, poses challenges in the form of a global knowledge gap. It is a probable gap in global knowledge, particularly in policy, remanufacturing, and consumer behavior in regions as East Asia, Africa, and parts of Southeast Asia where English is not the primary language. The literature focused on the global scholarship may underestimate the informal sector remanufacturing, inexpensive business strategies, and culturally inclined consumer behavior, all of which are integral to a well-rounded discourse on the global circular economy.

The analysis conducted on the drivers and constraints shows obvious and serious misalignment. The most dominant driver is the policy and regulatory support: Extended Producer Responsibility (EPR), "Right to Repair" legislation, and government subsidies. This emphasizes the importance of institutional support in launching circular practices (Ting et al., 2023). Following close thereafter are the economic benefits and environmental sustainability goals, which indicate that remanufacturing is a strong business opportunity, but also an environmental necessity (Lim Sin et al., 2024). The market demand and technological advancement also support this. Still, these drivers are held back by unforgiving constraints, most of all the skepticism of the consumer regarding the quality and the reliability of the remanufactured product, by a long shot the biggest hurdle for market access (Shaharudin et al., 2015). Other considers the lack of capital, poorly designed products, the lack of skilled labor, and the unpredictable reverse logistics.

In general, these findings indicate that the policy and economic support for remanufacturing is strong, but to attain the goals, a focused attempt to regain consumer confidence is needed as well as the redesigning of products to close the economic cycle, the preparation of the refinished labor and the balancing of reverse logistics to close the gap on systemic support and real operational lack.

5. Conclusion

This bibliometric evaluation illustrates how remanufacturing research has advanced over the years into a vibrant area of study, driven by global demand for circular-economy research. Numerous publications, a solid base of peer-reviewed journal articles, and a clearly interdisciplinary profile that includes environmental science, engineering, and the social and economic spheres, testify to the dynamism of the field. The intellectual orientation of the field has shifted, albeit in a pragmatic manner, from the purely environmental rationale to the more operational "how" questions around the digital technologies, quality assurance systems, and business models necessary to enable implementation.

The area suffers foremost from a fundamental imbalance between the drivers of the field and the constraints remaining in the commercial realm. While policies, economic drivers, and sustainability objectives form a virtual remanufacturing cliff, the sector sponsors a demand barrier of negative consumer perception on quality, layered over high costs and significant design and logistics challenges. Therefore, progress will remain elusive unless strategies that close the demand side of the remanufacturing equation include the anticipated top-down policy aimed at consumer trust and circular design, resilient reverse supply chains, and integrated systems that enable reverse logistics.

Several limitations of this study are self-evident. First, although the Scopus database is the 'gold standard' of bibliometrics, it might overlook regionally important literature, especially literature written in a foreign language and scholarship from the Global South relative to English-language publications. Second, of the limitations of bibliometric analyses, this one is the most important: these analyses do not capture the

qualitative depth, contextual sophistication, and real-world relevance of the findings in each work. Despite these limitations, the analysis does provide a meaningful, comprehensive, and evidence-based perspective on the development and the intellectual structure of the field.

In essence, what this study provides as a lasting contribution is a synthesis of a decade's worth of scholarship available globally into a clear, coherent, and evidence-based blueprint. By articulating where knowledge stands and what the remaining gaps are, it provides the opportunity for researchers, policymakers, and business counterparts to shift the discourse on remanufacturing from an operational tactical level to a pillar of strategic, equitable, and transformative value that fundamentally underpins the global shift to a circular, climate-positive economy. Foremost, future research should expand the evidence base on context-specific research in neglected geo-spaces, enhance the framing of the social and behavioral aspects of the study, and examine the influence of frontier technologies, such as AI, IoT and digital twins, on the establishment of scalable systems for remanufacturing. Conceptual and empirical work comprising mixed methods, longitudinal case studies, and policy simulation exercises on research and implementation will contribute to the interplay of theory and practice in the industrial context.

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Engaging the Loop: A Conceptual Framework Linking Stakeholder Engagement to Circular Economy Adoption for Waste Reduction

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Abstract: This study addresses persistent challenges in municipal solid waste systems, namely low diversion and uneven resource recovery, by examining how stakeholder engagement (with communities, suppliers, and regulators) supports the adoption of circular economy (CE) practices and how operational change, often termed green process innovation, drives measurable waste outcomes. The central hypothesis is that CE adoption mediates the relationship between stakeholder engagement and waste reduction. Using a narrative review oriented to concept development, records were retrieved from the Scopus database (articles and reviews, 2000–2025, English) with a reproducible query targeting stakeholder engagement, CE, policy/strategy, and organizational settings. After de-duplication, titles/abstracts and full texts were screened for relevance to engagement, CE adoption, and waste outcomes or proxies; data were extracted into a concept-centric matrix and synthesized via integrative thematic analysis. Primary outcomes were diversion rate, secondary material yield, and contamination reduction. The synthesis reveals two pathways: (1) a direct association whereby engagement mobilizes source separation, social acceptance of reuse/repair, and take-back participation; and (2) a stronger, mediated pathway in which engagement enables CE adoption, such as design for disassembly, industrial symbiosis, organics valorization, and optimized recycling–recovery portfolios that directly improves diversion and recovery. Governance capacity, policy coherence, and digital readiness strengthen these effects. Overall, stakeholder engagement improves waste outcomes primarily by deepening and routinizing CE adoption, with supportive governance and policy environments amplifying gains. The resulting framework offers testable propositions and practical guidance for municipalities and firms seeking scalable circular outcomes.

Keywords: *Circular economy adoption; Green process innovation; Municipal solid waste; Stakeholder engagement; Waste reduction*

1. Introduction and Background

The transition to a circular economy (CE) is increasingly viewed as a necessary response to the limits of linear "take–make–dispose" systems and the escalating costs and risks of waste (including social license risks). A growing body of work shows that CE programs can improve organizational and municipal performance when they are accompanied by authentic, structured stakeholder engagement, i.e., purposeful interaction with regulators, supply-chain partners, communities, and employees to co-define priorities and practices (Esposito et al., 2024; Palafox-Alcantar et al., 2021). In urban settings, integrative CE frameworks (e.g., 10R/9Rs ladders and inclusive circular city models) emphasize multi-actor collaboration to drive waste reduction and resource recovery outcomes (Toboso-Chavero et al., 2025).

Across sectors, the literature links engagement to concrete circular practices. Oil and gas firms use engagement to legitimize and accelerate new recovery and waste-to-fuel pathways (Adedayo-Ojo et al., 2025); construction studies show that early, continuous stakeholder involvement reduces construction and demolition waste by

enabling circular material value chains (She et al., 2025); manufacturing evidence associates open communication and green image with deeper CE adoption (Kunal et al., 2025). Corporate governance mechanisms—such as board oversight, sustainability reporting, and cross-functional environmental teams—act as an engagement "infrastructure" that normalizes circular decision-making (Palea et al., 2025). Together, these streams suggest a plausible pathway from stakeholder engagement to CE adoption and then to waste reduction.

Yet practice and outcomes remain uneven. Studies note coordination failures, conflicting stakeholder objectives, and capability gaps that impede scaling, even when interest in CE is high (Palafox-Alcantar et al., 2021; She et al., 2025). Engagement is often treated as a generic "good practice," while the mechanism by which it changes processes and investments is under-specified; conversely, CE adoption is sometimes measured as a checklist rather than a dynamic organizational process. This fragmentation obscures how engagement quality, breadth, and depth translate into adoption intensity and, ultimately, measurable diversion, recovery, and cost/safety benefits (Esposito et al., 2024; Palea et al., 2024).

To address this, the paper proposes a conceptual framework in which stakeholder engagement (independent variable) improves circular economy adoption (mediating variable), capturing the depth, scope, and routinization of circular practices, which in turn increases waste reduction (dependent variable). The framework is theory-informed by Stakeholder Theory (salience and responsiveness), Institutional Theory (legitimacy and policy signals), and the Natural Resource-Based View/Dynamic Capabilities (sensing–seizing–reconfiguring to embed CE routines) (Palea et al., 2024; Esposito et al., 2024; Kunal et al., 2025). It yields testable propositions regarding mediation and likely moderators (e.g., governance strength, digital readiness, sectoral hazard profile, and community pressure), and applies to municipal, industrial, and healthcare contexts where hazardous and non-hazardous streams intersect (Saha et al., 2025; Adedayo-Ojo et al., 2025).

The study contributes by (i) integrating dispersed insights into a coherent, testable mechanism (engagement → adoption → outcomes), (ii) specifying measurable constructs and boundary conditions useful to researchers and practitioners, and (iii) offering a policy-relevant lens for designing engagement-anchored CE roadmaps (Toboso-Chavero et al., 2025; Palea et al., 2024). The paper proceeds as follows: an Introduction sets the context and problem; a Literature Review synthesizes evidence on engagement, CE adoption, and performance; the Theoretical Framework elaborates the proposed mediation and moderators; a Discussion outlines implications for governance, program design, and evaluation; and a Conclusion highlights contributions and a future research agenda (e.g., multi-industry surveys and panel analyses) to operationalize and empirically test the framework (Esposito et al., 2024; Palafox-Alcantar et al., 2021).

2. Literature Review

Scholarship consistently positions stakeholder engagement as a pivotal antecedent to circular economy (CE) adoption across public and private settings, with implications for waste reduction. Cooperation and readiness among actors (e.g., local authorities, firms, communities) are repeatedly identified as enabling conditions for CE transitions in practice (Palafox-Alcantar et al., 2021). Sectoral studies further emphasize *early* and *continuous* engagement to co-design circular practices such as circular material value chains that minimize construction and demolition waste, thereby aligning incentives and reducing implementation frictions (She et al., 2025). At the firm level, corporate governance and social performance mechanisms operate as engagement infrastructure, shifting organizations from compliance to commitment and correlating with deeper CE initiatives (Al-Najjar et al., 2025). Taken together, the literature indicates that engagement influences both the legitimacy and the operationalization of CE practices, while governance capacity at multiple levels (city, sector, firm) shapes adoption pathways (Ddiba et al., 2020). Aim of study: How does stakeholder engagement influence circular economy adoption for waste reduction?

Mechanistically, studies show that engagement translates into CE adoption when it catalyzes information sharing, joint problem-solving, and transparent communication of green practices; these, in turn, are associated with stronger uptake of circular routines in manufacturing and allied sectors (Kunal et al., 2025). Evidence also suggests performance payoffs: CE performance is more strongly linked to financial outcomes when stakeholder engagement is present, implying that engagement not only accelerates adoption but also stabilizes business

value around circular practices (Esposito et al., 2024). In public services and complex value chains (e.g., agri-food, municipal services), research depicts CE adoption as a shared responsibility among heterogeneous actors; however, limited analysis of stakeholder interactions and coordination dynamics remains a bottleneck for designing scalable collaborative strategies (Muriuki et al., 2024). In healthcare and other regulated domains, reviews document a bias toward operational challenges (e.g., regulatory, infrastructural) and call for attention to *systemic enablers,* policy coherence and cross-level collaboration that engagement processes can help unlock (Ddiba et al., 2020).

Despite these advances, the literature is fragmented on the specific pathway connecting engagement to measurable waste outcomes. Few studies model engagement → CE adoption → waste reduction as an integrated causal sequence or explore contingencies under which engagement is most efficacious (e.g., governance strength, policy coherence, and sectoral context). Addressing this gap, the present study proposes a conceptual framework in which stakeholder engagement (independent variable) enhances CE adoption (mediating variable), which subsequently improves waste reduction (dependent variable). This framework consolidates scattered insights into a testable mechanism that (i) clarifies how engagement is converted into organizational routines and inter-organizational agreements constituting CE adoption, and (ii) specifies outcome-relevant indicators (e.g., diversion rates, secondary material yields) for future empirical validation across municipal and industry contexts (Al-Najjar et al., 2025; Esposito et al., 2024; Kunal et al., 2025; Palafox-Alcantar et al., 2021).

3. Method

Research Design

This study employs a narrative review to build theory and integrate heterogeneous findings across environmental management, operations, and public policy, consistent with best practice for concept development and proposition building (Baumeister & Leary, 1997; Snyder, 2019). A narrative review is appropriate because the aim is to propose a conceptual framework that explains how circular economy (CE) capabilities drive municipal waste diversion via green process innovation (GPI), a question that spans diverse methods, sectors, and vocabularies rather than a single, tightly bounded empirical stream. Following guidance for concept-centric synthesis, we organize evidence around the constructs (CE capabilities → GPI → waste diversion), mechanisms, and boundary conditions (e.g., policy stringency, digital readiness, governance capacity), rather than study-by-study summaries (Webster & Watson, 2002). This design privileges theoretical integration, clarity of constructs and relationships, and identification of testable propositions, while transparently reporting search, screening, and synthesis procedures to enhance credibility (Snyder, 2019).

Key Steps in Conducting a Narrative Review

Data collection was conducted exclusively with Scopus (Elsevier), chosen for its broad coverage of environmental science, engineering, energy, and management journals. We iteratively developed and piloted Boolean strings using Scopus' *TITLE-ABS-KEY* field, wildcards, and proximity operators. Inclusion criteria: peer-reviewed journal articles and reviews; English (and, where available, Malay) full texts; publication years 2000–2025; clear relevance to at least two focal constructs (CE capabilities, GPI, diversion/recovery) or to moderators/policy instruments shaping those links. Exclusion criteria: these, non-archival conference abstracts, non-municipal hazardous-only streams unless explicitly tied to municipal systems, and purely technical treatment papers without organizational or policy interfaces. The workflow comprised: (1) query execution and export of records (CSV/BibTeX) with bibliographic metadata; (2) de-duplication in a reference manager; (3) title/abstract screening against criteria; (4) full-text screening for conceptual relevance; and (5) citation chaining (backward/forward) within Scopus to capture seminal and adjacent works. To limit selection bias, a second reviewer verified a 20% random sample at each screening stage, and disagreements were resolved by discussion with an audit trail (Page et al., 2021; Snyder, 2019).

Data extraction, synthesis and rigor

For each included study, we extracted: study type, context/region, definitions/operationalizations of CE capabilities, forms of GPI (e.g., source-separation, contamination control, routing and sorting innovations, repair/reuse hubs), outcome measures (diversion rate, material recovery yield), mechanisms (e.g., learning, governance, digitalization), and boundary conditions (policy instruments, financing, stakeholder engagement).

We then built a concept-centric evidence matrix to identify convergences, contradictions, and gaps, and conducted a narrative thematic synthesis that explicitly maps evidence to the proposed mediated pathway (CE capabilities → GPI → diversion), culminating in propositions and a diagram of the conceptual framework (Webster & Watson, 2002). Although formal risk-of-bias tools are uncommon in narrative reviews, we applied a light-touch appraisal (clarity of constructs, methodological transparency, and plausibility of inferences) to weight studies during synthesis, documented reflexive memos on selection decisions, and report a flow overview (identification → screening → inclusion) for transparency (Page et al., 2021). Ethical approval was not required (no human subjects), but we adhered to good scholarly practice in accurate citation, reproducible search strings, and archiving of screening logs to support future replication (Snyder, 2019).

Data source and search strategy

We conducted all searches in Scopus (Elsevier) because of its broad coverage across environmental science, engineering, management, and policy journals, domains central to stakeholder engagement and circular economy (CE). To balance recall and precision, we first piloted synonyms and then executed a field-limited search using Scopus' TITLE-ABS-KEY operator. The *base query* (kept verbatim for reproducibility) was:
("stakeholder" OR "participant" OR "involvement" OR "engagement") AND ("engagement" OR "participation" OR "involvement" OR "collaboration") AND ("circular economy" OR "sustainable economy" OR "closed-loop economy" OR "resource efficiency") AND ("sustainability" OR "environment" OR "eco-friendly" OR "green") AND ("policy" OR "strategy" OR "framework" OR "approach") AND ("business" OR "industry" OR "sector" OR "organization").

We implemented this as TITLE-ABS-KEY(<query>) and limited results to (i) document types: articles and reviews; (ii) language: English; and (iii) years: 2000–2025 to capture two decades of CE scholarship. Sensitivity checks varied fields (e.g., adding keywords) and used proximity operators where noise was high (e.g., replacing one of the doubled engagement blocks with stakeholder W/3 engagement), and we ran citation chaining (backward/forward) on frequently cited items surfaced by the core search. Search results (CSV/BibTeX) with full metadata were exported for screening and synthesis (Snyder, 2019; Webster & Watson, 2002).

Screening, inclusion/exclusion, and audit trail. After de-duplication in a reference manager, we applied a two-stage screen. *Title/abstract screening* retained records that explicitly addressed: (1) stakeholder engagement/participation (any actor set: municipal, industry, community, NGO); (2) CE adoption (policies, practices, business models, or governance mechanisms); and (3) waste reduction outcomes or proxies (e.g., diversion, secondary material yield). We excluded these: editorials, purely technical papers lacking engagement or adoption constructs, and sectoral contexts unrelated to municipal or industry waste systems. *Full-text screening* verified construct clarity and relevance to the proposed mechanism (engagement → CE adoption → waste outcomes). To increase rigor, a second reviewer checked a 20% random sample at each step independently; disagreements were resolved by discussion, and records were taken to ensure an audit trail is consistent with PRISMA-style levels of transparency (Page et al., 2021). The latter corpus consisted of both empirical and theoretical works, which is aligned to the requirements of an integrative review, i.e. to synthesize heterogeneous evidence (Whittemore & Knafl, 2005).

Integrative thematic analysis and synthesis. We used an integrative thematic analysis approach to identify and connect key themes, concepts, and theoretical perspectives across the included studies (Braun & Clarke, 2006; Whittemore & Knafl, 2005). Following a concept-centric protocol (Webster & Watson, 2002; Miles et al., 2014), we: (1) familiarized ourselves with the corpus; (2) developed an a priori codebook anchored to the study aim: How does stakeholder engagement influence circular economy adoption for waste reduction? With parent codes for Stakeholder Engagement (e.g., breadth/depth, governance mechanisms, participation quality), CE Adoption (policies, practices, business models, routinization), and Outcomes (diversion, recovery, contamination reduction), plus Context/Moderators (policy coherence, sector, digital readiness); (3) performed iterative coding (inductive refinements added new subcodes such as co-creation mechanisms, legitimacy seeking, and cross-sector alliances); (4) generated candidate themes (e.g., "engagement as governance infrastructure," "engagement-to-adoption via learning and legitimacy," "conditions under which engagement translates to measurable diversion"); (5) reviewed and defined themes, checking coherence across studies and reconciling conflicting findings; and (6) constructed a narrative synthesis that maps themes onto the proposed conceptual framework (Engagement → CE Adoption → Waste Reduction), articulating

propositions and boundary conditions. Reliability was supported by a pilot coding of ~10% of studies (refining code definitions), periodic adjudication between coders, and reflexive memos to document interpretive choices. Limitations (e.g., English-only bias, database dependence) were mitigated through citation chaining and sensitivity checks on the query, while preserving replicability via shared strings and logs (Snyder, 2019; Braun & Clarke, 2006). A synthesis of key findings is provided in Table 1.

Table 1: Key findings of Stakeholder Engagement to Circular Economy Adoption for Waste Reduction

No	Key findings (theme)	Brief description	Illustrative sources
1	Engagement amplifies the CE performance–value link.	Organizations that engage stakeholders (customers, communities, regulators, suppliers) translate CE practices into stronger financial/performance payoffs, which in turn sustain adoption.	Esposito et al., 2024
2	Early, continuous engagement reduces implementation frictions	Early involvement of key actors aligns incentives, clarifies roles, and enables circular material value chains (e.g., C&D waste minimization).	She et al., 2025
3	Governance acts as an engagement infrastructure.	Board oversight, CSR, and disclosure institutionalize engagement, shifting firms from compliance to commitment and deepening CE initiatives.	Al-Najjar et al., 2025
4	Cooperation/readiness are preconditions for municipal CE	In municipal systems, cooperation across public agencies, contractors, and citizens is necessary; gaps often persist between awareness and practice.	Palafox-Alcantar et al., 2021
5	Policy coherence and cross-level collaboration enable scaling	Policy coherence, multi-level governance, and cross-sector collaboration raise the capacity to adopt circular resource-recovery systems (especially in LMICs).	Ddiba et al., 2020
6	Sectoral contexts shape engagement mechanisms.	In sectors like oil & gas and construction, engagement legitimizes higher-risk CE options (e.g., waste-to-fuel, carbon capture) and coordinates complex value chains.	Adedayo-Ojo et al., 2025; She et al., 2025
7	Communication quality drives internal CE adoption	Clear communication of green practices and a visible green image correlate with deeper CE adoption in manufacturing and supply chains.	Kunal et al., 2025
8	"Circular stakeholder engagement" extends scope, topics, and modes	Firms progress by expanding with whom they engage (beyond immediate suppliers), on what (design, take-back), and how (co-creation), moving beyond linear engagement routines.	Fobbe & Hilletofth, 2023
9	Urban CE benefits from multi-stakeholder orchestration	City programs that orchestrate industrial symbiosis, waste-to-energy, reuse and mobility solutions rely on multi-stakeholder platforms to unlock synergies and social acceptance.	Salles et al., 2024
10	Research/practice gaps: interactions, enablers, regulated settings	Literature over-emphasizes operational hurdles and under-specifies interaction mechanisms; regulated domains (e.g., healthcare) need attention to systemic enablers.	Saha et al., 2025

Collectively, the evidence shows that stakeholder engagement is a primary enabler of CE adoption and a bridge to waste reduction. Engagement strengthens the value case for CE by improving the translation of CE practices into financial and operational performance (Finding 1) and reduces implementation frictions when it begins early and continues through project lifecycles (Finding 2). At the organization level, governance mechanisms (board oversight, CSR, transparency) function as a durable engagement infrastructure that shifts CE from one-off initiatives to routinized strategies (Finding 3). In public systems, cooperation and readiness across

municipalities, service providers, and communities remain decisive; however, studies document a persistent intent–action gap that constrains diversion and recovery (Finding 4). Where policy is coherent and collaboration spans levels of government and sectors, the capacity to implement circular solutions, especially for organic waste/resource-oriented sanitation, improves markedly (Finding 5).

Context matters: high-hazard and infrastructure-intensive sectors (e.g., oil & gas, construction) use engagement both for legitimacy and coordination of complex, risk-sensitive circular options (Finding 6). Inside firms and supply chains, communication quality and green image signal credibility and mobilize internal adoption behaviors (Finding 7), while circular stakeholder engagement practices push organizations to broaden who is at the table, what topics are negotiated (e.g., design for disassembly, take-back), and how collaboration occurs (co-creation vs. consultation) (Finding 8). At the city scale, multi-stakeholder orchestration underpins industrial symbiosis, reuse markets, and energy recovery portfolios that raise diversion and recovery (Finding 9). Finally, the literature still under-specifies interaction mechanisms and systemic enablers in highly regulated arenas (e.g., healthcare), pointing to a need for frameworks that model engagement → adoption → outcome pathways with clear mediators and moderators (Finding 10). These insights directly support the paper's conceptual framework: stakeholder engagement (IV) improves CE adoption (mediator), which then drives waste reduction (DV), contingent on governance strength, policy coherence, and sectoral context.

4. Theoretical Framework

This study explains how stakeholder engagement influences circular economy (CE) adoption to achieve waste reduction by integrating Stakeholder Theory (value creation with/for salient stakeholders), Institutional Theory (legitimacy, policy pressure, and field logics), and the Natural Resource–Based View (NRBV) with Dynamic Capabilities (sensing–seizing–reconfiguring environmental opportunities) (Freeman, 1984; Mitchell et al., 1997; DiMaggio & Powell, 1983; Hart, 1995; Teece et al., 1997). Conceptually, CE provides the sustainability paradigm that reframes material flows and business models (Kirchherr et al., 2017; Geissdoerfer et al., 2017; Ghisellini et al., 2016). Applied to municipal waste systems and urban/industrial networks, Stakeholder Theory clarifies who must be engaged and why (citizens, NGOs, suppliers, regulators), Institutional Theory explains how policy coherence and field norms catalyze CE routines, and NRBV/Dynamic Capabilities specify how organizations convert engagement into process changes that yield diversion and recovery outcomes (Ddiba et al., 2020; Palafox-Alcantar et al., 2021; Esposito et al., 2024).

The framework models Stakeholder Engagement (IV) → CE Adoption (Mediator) → Waste Reduction (DV7). Stakeholder engagement is conceptualized as breadth (actor inclusivity), depth (co-creation vs. consultation), and quality (trust, transparency); it delivers legitimacy (Institutional Theory) and access to knowledge/resources (Stakeholder Theory), which together enable Dynamic Capabilities for CE (Freeman, 1984; DiMaggio & Powell, 1983; Teece et al., 1997). CE adoption denotes the routinization of circular practices (design for disassembly, take-back, source separation, industrial symbiosis), which literature links to improved performance when coupled with communication and governance mechanisms (Fobbe & Hilletofth, 2023; Kunal et al., 2025; She et al., 2025). Measurement of the outcomes is done through diversion rates, secondary-material yields, and waste reduction, which are in line with CE definitions and empirical research (Kirchherr et al., 2017; Geissdoerfer et al., 2017; Palafox-Alcantar et al., 2021). The mediation of CE adoption is evidenced by the fact that the engagement increases the CE performance relationship (Esposito et al., 2024); the mediation of the participants by the governance capacity and policy coherence (Ddiba et al., 2020) points to the existence of boundary conditions. Therefore, stakeholder engagement leads to legitimacy and common problem-solving (Institutional/Stakeholder), which triggers capability building and green process innovation that are the basis of CE adoption (NRBV/Dynamic Capabilities) and finally realizes quantifiable waste results.

Practically, the framework yields a diagnostic for municipalities and firms: (i) map stakeholder salience and upgrade engagement from consultation to co-creation; (ii) strengthen governance infrastructure (board oversight, disclosure, cross-sector platforms); (iii) target capability investments that translate engagement into CE routines (e.g., source-separation quality programs, repair/reuse hubs, circular procurement); and (iv) align with institutional levers (policy coherence, standards) to reduce adoption frictions (Ddiba et al., 2020; Fobbe & Hilletofth, 2023; She et al., 2025). For scholars, the model specifies testable propositions on the mediation of

CE adoption and moderating effects of governance strength and policy stringency, offering construct definitions and indicators for empirical work (Esposito et al., 2024; Palafox-Alcantar et al., 2021; Kunal et al., 2025). In conclusion, by integrating Stakeholder, Institutional, and NRBV/Dynamic Capability lenses within the CE paradigm, the framework clarifies the mechanism engagement → adoption → outcomes, aligns with current evidence, and provides a pragmatic pathway for accelerating waste reduction in high- and low-regulation contexts.

Proposition Development

Proposition 1: Stakeholder Engagement and CE Adoption

Stakeholder engagement conceived as the breadth, depth, and quality of participation by salient actors such as regulators, suppliers, communities, customers, and employees consistently emerges as a precursor to circular economy (CE) adoption because it provides legitimacy, shared problem-solving, and resource/knowledge access that lower implementation frictions and translate intentions into routinized circular practices (e.g., design for disassembly, take-back systems, source separation, industrial symbiosis). Empirical and sectoral evidence shows that cooperation/readiness among municipal and market actors is a necessary condition for CE transitions (Palafox-Alcantar et al., 2021); early and continuous engagement aligns incentives and enables circular material value chains in complex projects (She et al., 2025); governance mechanisms (board oversight, CSR, disclosure) institutionalize engagement and move firms from compliance to commitment, deepening CE initiatives (Al-Najjar et al., 2025); and clear communication with partners and employees strengthens internalization of CE routines in manufacturing and supply chains (Kunal et al., 2025; Fobbe & Hilletofth, 2023). At the system level, policy coherence and cross-level collaboration increase the capacity to adopt resource-recovery solutions (Ddiba et al., 2020), while even in highly regulated domains such as healthcare, engagement is identified as a thematic driver of circular transformation despite operational constraints (Saha et al., 2025). Moreover, engagement can amplify the performance case around CE, reinforcing organizational commitment to adopt and sustain circular practices (Esposito et al., 2024).

Proposition 1: Stakeholder engagement positively affects CE adoption

Proposition 2: CE Adoption and Waste Reduction

Circular economy (CE) adoption as a mediator converts the intentions of stakeholders into routinized approaches, i.e. separation of sources and contamination control, deposit-return and take-back schemes, repair/reuse hubs, industrial symbiosis and optimized portfolios of recycling and thermal recovery, which reduces waste to landfill and maximizes secondary-material benefits (Negrete-Cardoso et al., 2022). Systematic adoption of CE increases the diversion rates and stabilizes the resource recovery performance when integrated into the municipal operations (Bertanza et al., 2021) and supported by the urban CE programs organizing the collaboration of actors (Salles et al., 2024) based on longitudinal and city-scale evidence.

Interventions in developing-city contexts further indicate that adoption of CE practices (e.g., organics valorization, low-carbon treatment) can cut emissions and improve recovery, provided enabling capacities are present (Ddiba et al., 2020), while sectoral studies highlight technology and process redesign (e.g., waste-to-chemicals) as adoption pathways that convert residuals into value streams (Iaquaniello et al., 2018). Policy-led experiments also associate CE adoption with higher innovation and performance, strengthening the plausibility that adoption is the proximate driver of waste outcomes.

Proposition 2: CE Adoption positively affects waste reduction.

Proposition 3: Stakeholder Engagement and Waste Reduction

Stakeholder engagement exerts a direct influence on waste outcomes by mobilizing citizen participation in source separation, building social acceptance for reuse/repair, and coordinating multi-actor actions that reduce contamination and increase secondary-material yield; empirical and sectoral evidence shows that cooperation and readiness among municipal actors and communities close the persistent intent–action gap in diversion programs (Palafox-Alcantar et al., 2021), that policy coherence and cross-level collaboration strengthen cities' capacity to implement resource-oriented systems (Ddiba et al., 2020), and that early, continuous engagement in complex projects (e.g., construction and demolition) enables circular material value chains that cut waste at source (She et al., 2025). Within firms and supply chains, transparent communication and "circular stakeholder engagement practices" (co-creation with suppliers/customers, take-back

agreements) align behaviors that raise return flows and recovery rates (Fobbe & Hilletofth, 2023; Kunal et al., 2025), while urban CE initiatives relying on multi-stakeholder orchestration (industrial symbiosis, reuse markets) document improvements in diversion and recovery performance (Salles et al., 2024). Even in highly regulated domains such as healthcare, reviews identify engagement as a thematic driver for transitioning practices toward circularity, suggesting spillovers to waste prevention and recovery despite operational constraints (Saha et al., 2025). Further, engagement strengthens the business case around circular activities, supporting continuity and scale that are prerequisites for sustained waste outcomes (Esposito et al., 2024).
Proposition 3: Stakeholder engagement positively affects waste reduction

Proposition 4: The Mediating Role of CE Adoption between Stakeholder Engagement and Waste Reduction
Stakeholder engagement provides legitimacy, shared problem-solving, and resource/knowledge access that motivate and enable organizations and municipalities to adopt circular practices (e.g., design for disassembly, take-back, source separation, industrial symbiosis), thereby converting diffuse intentions into routinized operational change (Fobbe & Hilletofth, 2023; Kunal et al., 2025; Palafox-Alcantar et al., 2021; She et al., 2025). Once adopted, circular economy (CE) practices function as the proximate drivers of waste outcomes by reducing contamination, increasing secondary-material yields, and stabilizing diversion effects documented in long-run municipal trajectories, European portfolio analyses of recycling–thermal synergies, and developing-city interventions that link CE adoption to measurable recovery and emissions benefits (Bertanza et al., 2021). System-level governance capacity and policy coherence strengthen this chain by lowering coordination costs and raising implementation capability (Ddiba et al., 2020), while policy experiments show that CE-oriented mandates spur green innovation and an adoption pathway closely tied to improved environmental performance. Moreover, engagement often reinforces the business case around circular activities, supporting continuity and scale that are prerequisites for sustained waste outcomes (Esposito et al., 2024).
Proposition 4: Circular economy adoption mediates the positive relationship between stakeholder engagement and waste reduction

5. Conclusion

This study advances a coherent explanation of how stakeholder engagement propels circular economy (CE) adoption and, through that adoption, improves waste reduction. Synthesizing diverse sectoral evidence, we found that engagement, defined by its breadth, depth, and quality, acts on two pathways: a direct route that mobilizes participation in source separation, reuse, and take-back behavior; and an indirect, mediated route in which engagement enables CE adoption as routinized operational change. Across contexts, programs that combine early and continuous engagement, clear role alignment, and multi-actor coordination report higher diversion, lower contamination, and stronger secondary-material yields. The review also highlights boundary conditions, governance capacity, policy coherence, and digital readiness that shape how effectively engagement translates into measurable waste outcomes.

Theoretically, the paper integrates Stakeholder Theory, Institutional Theory, and the Natural Resource–Based View with Dynamic Capabilities into a single framework that clarifies the mechanism engagement → CE adoption → waste reduction, while allowing for a direct engagement → outcomes link. This integration contributes testable propositions on mediation, specifies construct domains (engagement breadth/depth/quality, CE adoption depth/scope/routinization, diversion and recovery metrics), and surfaces a capability-building lens for understanding how organizations reconfigure processes under circular logics. By articulating boundary conditions, the framework also reconciles mixed findings in the literature and offers a portable structure for comparative analyses across sectors and city types.

Practically, the framework functions as a diagnostic and design tool. Municipal leaders and firms can map stakeholder salience, upgrade engagement from consultation to co-creation, and institute governance infrastructures—board oversight, transparent disclosure, cross-sector platforms that stabilize collaboration over time. Priorities for investment include source-separation quality programs, circular procurement, repair/reuse hubs, industrial symbiosis facilitation, and digital enablers such as tracking and feedback systems. Program managers should pair engagement strategies with clear operational targets (diversion rates,

contamination thresholds, recovery yields), run iterative improvement cycles, and structure incentive and policy mixes that lower coordination costs and scale successful circular practices.

The study's limitations include reliance on a narrative review, dependence on a single indexing database, English-language bias, and heterogeneous measures that constrain meta-analytic inference and causal attribution. Future research should deploy multi-level and longitudinal designs to test the proposed mediation and moderators; pair surveys with administrative waste data for stronger measurement; and exploit quasi-experiments or field trials around policy shocks, deposit-return schemes, and engagement platform rollouts. Promising directions include necessary-condition and configurational analyses, cross-regional panel studies, mixed-methods evaluations of equity and inclusion in engagement processes, and integration of life-cycle assessment with econometric models to capture rebound effects and net environmental gains.

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The Evolution of Disclosure Practices: A Bibliometric Mapping of Voluntary and Mandatory Disclosures Across International Contexts

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Abstract: This study presents a bibliometric analysis of voluntary and mandatory disclosure practices to examine their evolution, thematic trends, and intellectual structures within the international accounting literature. Using data extracted from the Scopus database, covering publications between 2010 and 2025, a total of 1,196 records were analysed through bibliometric techniques, including citation analysis, keyword co-occurrence mapping, and network visualisation. Tools such as Harzing's Publish or Perish and VOSviewer were employed for data cleaning, standardisation, and visualisation. The findings reveal three distinct phases in the development of disclosure research: an initial formative stage (2010–2015) focused on financial reporting and information asymmetry, an expansion stage (2016–2020) driven by regulatory reforms such as the EU Directive on non-financial disclosure, and a consolidation stage (2021–2025) marked by rapid growth in sustainability, ESG, and integrated reporting studies. The analysis identifies the United States, the United Kingdom, and Australia as the most active contributors, while emerging economies such as Malaysia, Indonesia, and China are increasingly represented. Keyword mapping highlights key themes, including corporate governance, sustainability, firm performance, and legitimacy, while also pointing to emerging areas such as digitalisation, artificial intelligence, and technological innovation in disclosure practices. The study concludes that disclosure research has matured into a dynamic, interdisciplinary field shaped by regulatory, market, and societal forces. Limitations of the study are found in its reliance on a single database and the exclusion of qualitative dimensions. Future research is recommended to explore underrepresented regions, assess disclosure quality, and investigate technology-driven reporting practices.

Keywords: *Voluntary disclosure, Mandatory disclosure, Bibliometric analysis, Sustainability reporting, Corporate governance*

1. Introduction

The evolution of disclosure practices, both voluntary and mandatory, has become a central concern in the field of accounting and corporate reporting. Increasingly, stakeholders are demanding transparent, credible, and timely information to assess a firm's performance, governance, and sustainability commitments. These heightened expectations are driven not only by regulatory frameworks but also by market pressures and investor demands for accountability. Consequently, disclosure has transcended its traditional financial focus to encompass broader dimensions such as sustainability, risk management, and integrated reporting, reflecting the complex interplay between firms, regulators, and international markets (Coluccia et al., 2017; Shi et al., 2012).

Existing scholarship has provided valuable insights into the determinants, quality, and consequences of disclosure practices across diverse international contexts. For instance, voluntary disclosure levels vary significantly across markets, and it is often shaped by firm size, ownership structures, and legal institutions (Globerman & Singleton, 2009; Shi et al., 2012). Meanwhile, mandatory disclosure has evolved through instruments such as the European Commission's Directive 2014/95/EU, which enhanced the quality of sustainability reporting in European countries (Mion & Loza Adaui, 2020). However, compliance challenges remain evident, as illustrated in emerging markets such as Indonesia and Kuwait, where nominal compliance or partial alignment with international standards persists (Dawd, 2018; Sri Wahyuningrum et al., 2025). Integrated reporting, while increasingly adopted globally, also demonstrates uneven implementation and ambiguous impacts on capital markets (Hsiao et al., 2022; Steenkamp et al., 2025).

Against this backdrop, bibliometric analysis offers a valuable methodological approach to mapping the intellectual and thematic evolution of disclosure research (Ahmi & Mohamad, 2019; Ahmi & Mohd Nasir, 2019). Unlike traditional reviews, bibliometric mapping systematically analyses large volumes of academic

publications to identify patterns, co-citations, and knowledge clusters, thereby capturing the trajectory of the research field. Applying this approach to disclosure studies not only enables a comprehensive understanding of how voluntary and mandatory practices have evolved but also highlights the interactions between institutional frameworks, market dynamics, and scholarly debates. This study builds upon prior empirical findings while contributing a holistic, data-driven perspective on the global disclosure landscape.

The specific problem addressed by this research lies in the fragmented understanding of disclosure practices across jurisdictions and the lack of systematic mapping of their scholarly evolution. Although many empirical studies investigate individual contexts such as European sustainability reporting, Japanese voluntary disclosures, or Indonesian mandatory reporting, there is still limited integration to capture diversity within a unified research framework (Globerman & Singleton, 2009; Sri Wahyuningrum et al., 2025). Without such consolidation, policymakers, practitioners, and scholars face difficulties in assessing the maturity of disclosure practices globally and identifying emerging trends. Therefore, a bibliometric study is appropriate in an effort to synthesise the intellectual foundations and reveal knowledge gaps in this domain.

Accordingly, this study is guided by the questions of how voluntary and mandatory disclosure practices evolved in the international accounting literature, and what thematic trends, intellectual structures, and knowledge gaps can be identified through bibliometric mapping. These questions emphasise both historical development and forward-looking implications, situating disclosure practices within broader discourses of accountability, governance, and transparency.

The remainder of this paper is structured with Section 2 outlining the methodology employed for the bibliometric analysis, including data collection, analytical techniques, and visualisation tools. Section 3 presents the results, highlighting publication trends, thematic clusters, and intellectual linkages within the disclosure literature. Section 4 discusses the findings in light of international regulatory developments, market forces, and theoretical implications. Finally, Section 5 concludes with contributions, limitations, and directions for future research, particularly for advancing the discourse on disclosure in the context of global accountability and sustainable governance.

2. Literature Review

The evolution of voluntary and mandatory disclosure practices has been shaped by institutional, firm-level, and market-driven forces. In emerging markets such as Türkiye, the adoption of International Financial Reporting Standards (IFRS) significantly improved transparency and disclosure (T&D) scores, especially among firms that voluntarily adopted IFRS and then continued to use it when compliance became mandatory (Aksu & Espahbodi, 2016). This finding underscores the importance of regulatory frameworks in standardising practices across firms. However, debates continue regarding whether mandatory disclosure substitutes or complements voluntary disclosure, with evidence suggesting that well-designed regulatory policies can reduce excessive voluntary disclosure and improve the accuracy of reported data (Bertomeu et al., 2021). The Kuwaiti context reveals persistent challenges, where no firm in the sample fully complies with IFRS requirements, despite evidence of improvements in voluntary disclosure practices (Dawd, 2018). These findings highlight the uneven trajectory of disclosure evolution, suggesting that regulatory intentions do not always translate into full compliance.

A predominant theme in disclosure literature is the role of corporate governance as both a driver and moderator of disclosure quality. Empirical research demonstrates that governance structures, including board size, board composition, and the presence of audit committees significantly influence the extent of corporate disclosure (Alnabsha et al., 2018; Abdul Halim et al., 2025; Jamaludin & Bahaudin, 2022). In India, corporate governance mechanisms are strongly associated with enhanced voluntary disclosure practices, particularly in contexts where firms seek to restore credibility during corporate crises (Chandra & Muchan, 2025). Similarly, governance mechanisms in the Gulf Cooperation Council (GCC) banking sector influence compliance with mandatory standards such as IFRS 7, thereby reinforcing the link between institutional quality and disclosure practices (Yamani et al., 2021). These findings converge on the view that governance is not merely a contextual variable but is also an active determinant of both voluntary and mandatory disclosure outcomes.

Industry and sector-specific dynamics further complicate the disclosure landscape. Evidence from Italian airports suggests that disclosure practices vary depending on traffic composition and concession type, with financial disclosure more heavily influenced by regulatory obligations and general disclosure shaped by operational characteristics (Rotondo & Marinò, 2016). These sectoral nuances demonstrate that disclosure evolution cannot be explained solely through regulatory or governance lenses but must also consider the economic and operational realities of specific industries. Such findings also raise questions about the comparability of disclosure practices across sectors, thereby inviting further research into the role of industry characteristics in shaping disclosure behaviours and quality.

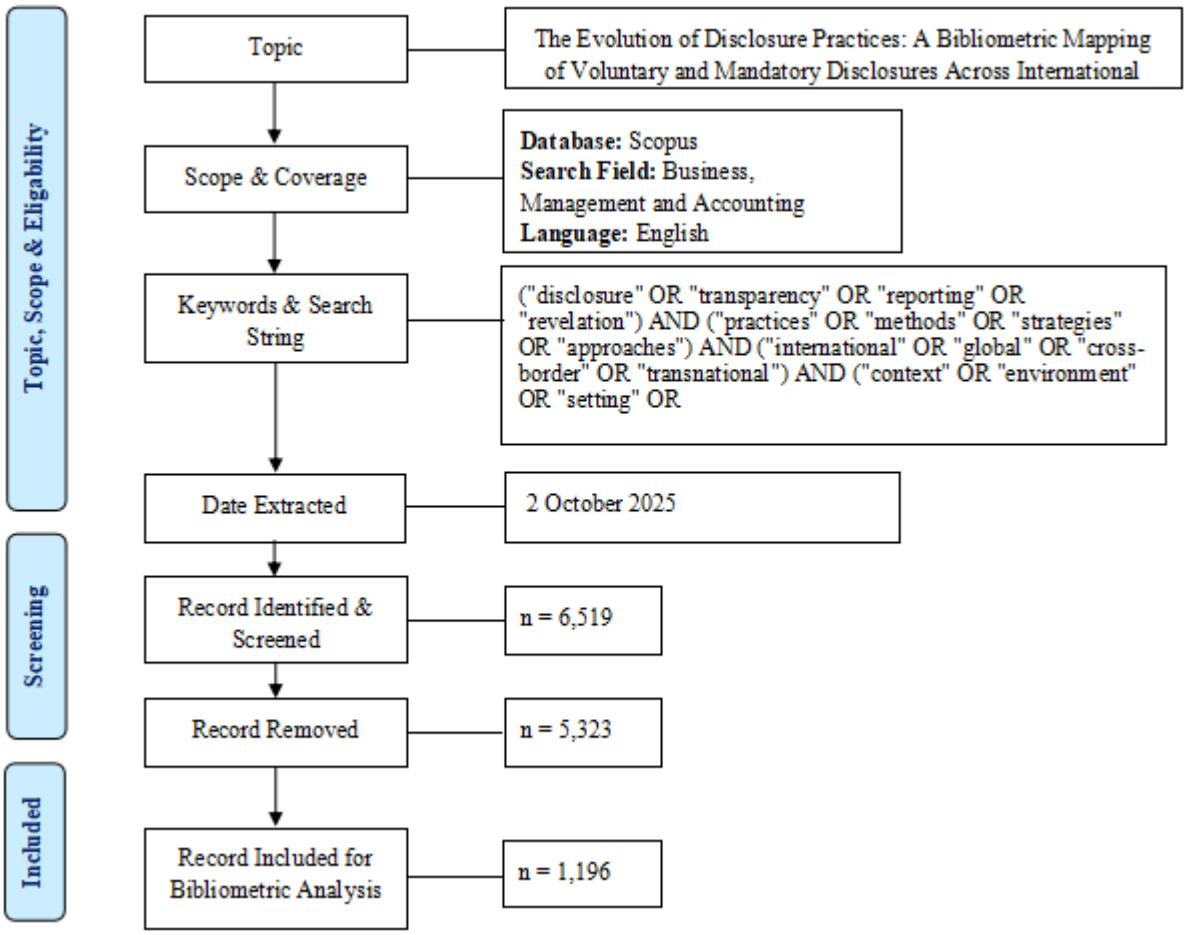
Another area of scholarly debate concerns the impact of disclosure, whether voluntary or mandatory, on corporate accountability and financial reporting integrity. Recent studies suggest that mandatory environmental, social, and governance (ESG) disclosures reduce earnings management, thereby improving the reliability of financial reporting (Cui et al., 2025). By contrast, voluntary ESG disclosures appear to have minimal influence on earnings quality, raising concerns about their substantive value. This variance underscores a central tension in the literature, in which while voluntary disclosure is often celebrated as a signal of transparency, it may function more symbolically than substantively unless supported by enforceable regulatory frameworks. Such debates reflect the broader question of whether disclosure primarily serves stakeholders' informational needs or is strategically deployed as a reputational tool.

Despite substantial progress, significant gaps persist in the literature. First, while empirical evidence documents disclosure practices within individual countries and sectors, there is limited integration of findings across international contexts. This fragmentation prevents a holistic understanding of global disclosure trends. Second, the literature tends to emphasise financial and governance determinants, often underexploring cultural, behavioural, and technological dimensions of disclosure practices. Third, there is a lack of systematic mapping of intellectual structures that underpin voluntary and mandatory disclosure debates. A bibliometric approach can address these gaps by providing an evidence-based synthesis of thematic clusters, scholarly linkages, and underexplored areas, thereby illuminating the trajectory of disclosure research and highlighting avenues for future inquiry (Ahmi & Mohamad, 2019; Ahmi & Mohd Nasir, 2019).

3. Methodology

Bibliometric analysis provides a rigorous and systematic method for evaluating the intellectual landscape, thematic trends, and collaboration networks within the field of disclosure practices. By quantitatively analysing publication data, bibliometrics analysis enables the identification of research hotspots, influential authors, co-citation patterns, and the evolution of scholarly debates across voluntary and mandatory disclosures. Scopus was selected as the primary data source due to its extensive multidisciplinary coverage, robust indexing of high-quality peer-reviewed journals, and superior citation tracking compared to other databases such as Web of Science and Google Scholar (Mongeon & Paul-Hus, 2016). Its extensive coverage of international accounting and finance research makes it particularly well-suited for mapping disclosure-related scholarship, which spans regulatory, governance, and sustainability domains. Bibliometric techniques, including co-citation analysis, co-word analysis, and network visualisation, provide the capacity to uncover the intellectual structure of the field while highlighting knowledge clusters and emergent themes (Donthu et al., 2021). Furthermore, bibliometric mapping allows for the exploration of global collaboration patterns, shedding light on the degree of cross-national research integration and the diffusion of ideas across regions (Aria & Cuccurullo, 2017). Applying bibliometrics to disclosure practices thus advances scientific knowledge by systematically consolidating fragmented empirical findings, revealing underexplored areas, and guiding future inquiry towards theoretical and practical contributions in international accounting research.

Figure 1: PRISMA Flow Diagram



Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

The bibliometric analysis in this study followed a systematic and replicable process to ensure rigor and transparency, guided by the PRISMA framework for reporting systematic reviews. The topic under investigation, entitled 'The Evolution of Disclosure Practices: A Bibliometric Mapping of Voluntary and Mandatory Disclosures Across International Contexts,' was operationalised through a carefully designed search strategy. Scopus as the primary database provides comprehensive coverage of peer-reviewed journals in accounting, finance, management, and interdisciplinary fields, as well as robust citation indexing capabilities (Mongeon & Paul-Hus, 2016). The search field on it was defined as "All Fields" to capture titles, abstracts, keywords, and full bibliographic records, thereby ensuring comprehensive coverage of the relevant literature.

To retrieve relevant records, a search string combining keywords and Boolean operators was constructed: ("disclosure" OR "transparency" OR "reporting" OR "revelation") AND ("practices" OR "methods" OR "strategies" OR "approaches") AND ("international" OR "global" OR "cross-border"). This query was designed to encompass both voluntary and mandatory disclosure practices in global contexts while capturing methodological, strategic, and regulatory perspectives. The search was conducted on 2 October 2025, which represents the cut-off point for data extraction.

The initial search yielded 6,519 records, which were then subjected to a screening process. Records were screened for relevance based on pre-defined inclusion and exclusion criteria. Studies focused on disclosure practices in accounting, corporate governance, sustainability, and regulatory contexts were included, while non-scholarly sources, duplicates, non-English publications, and studies unrelated to disclosure themes were

excluded. Following this process, 5,323 records were removed, leaving 1,196 records that met the inclusion criteria.

These 1,196 records formed the final dataset for bibliometric analysis. The dataset was exported from Scopus in BibTeX and CSV formats, allowing compatibility with bibliometric tools such as VOSviewer and Bibliometrix (Aria & Cuccurullo, 2017). The selected records were then analysed to identify publication trends, citation structures, co-authorship networks, and thematic clusters. This process allowed for mapping the intellectual structure of the field, examining global collaboration patterns, and detecting emerging themes in disclosure research.

By adopting this systematic and replicable methodology, the study ensures breadth and depth of coverage while minimising bias in data collection. The rigorous screening process combined with the application of bibliometric techniques provides a reliable foundation for researchers to explore the evolution of voluntary and mandatory disclosure practices in international accounting literature, thereby enabling a deeper understanding of scholarly contributions, knowledge gaps, and future research trajectories (Donthu et al., 2021).

The bibliometric analysis employed a combination of specialised tools to ensure methodological rigor, accuracy, and clarity in data management and visualisation. Following data extraction from Scopus, Harzing's Publish or Perish software was used to process bibliographic records and generate citation metrics, including h-index, g-index, and citation counts, which provided insight into the academic impact of disclosure-related publications (Harzing, 2007). To ensure consistency and reliability of the dataset, OpenRefine was applied for data cleaning and standardisation. This tool was particularly useful for resolving inconsistencies in author names, institutional affiliations, and keyword variations, which are common challenges in bibliometric studies (Verborgh & De Wilde, 2013). After data refinement, VOSviewer was used for network analysis and visualisation, enabling the mapping of co-authorship, co-citation, and keyword co-occurrence networks (van Eck & Waltman, 2010). VOSviewer's ability to create density and cluster visualisations facilitated the identification of thematic structures and intellectual linkages within the disclosure literature. Collectively, these tools contributed to the methodological robustness of the study: Publish or Perish ensured reliable metric generation, OpenRefine enhanced data quality through standardisation, and VOSviewer enabled the graphical representation of research trends and intellectual structures, thereby offering a comprehensive view of the evolution of voluntary and mandatory disclosure practices.

4. Findings and Results

The results of this bibliometric analysis provide a comprehensive overview of the intellectual landscape surrounding voluntary and mandatory disclosure practices in the international accounting literature. By analysing 1,196 records retrieved from Scopus, the study identifies publication trends, influential authors, key journals, and thematic clusters that have shaped the evolution of disclosure research over time. The findings highlight not only the trajectory of scholarly output growth but also the intellectual structures and global collaboration patterns that underpin the field. Through the integration of co-authorship, co-citation, and keyword co-occurrence analyses, the results reveal dominant research themes, emerging areas of inquiry, and cross-national linkages that illustrate how disclosure practices have been conceptualised and debated across diverse institutional contexts. Collectively, this section presents an evidence-based mapping of the field, offering insights into both the maturity of existing research streams and potential directions for future scholarly exploration.

Year of Publications/Evolution of Published Studies

The evolution of research on voluntary and mandatory disclosure practices demonstrates a clear upward trajectory over the past fifteen years, with notable fluctuations in intensity and focus. As presented in Table 1 and Figure 2, the earliest consistent output begins around 2010, when 40 studies (3.34%) were published. This period marked the foundation stage of disclosure-related scholarship in international accounting, following earlier sporadic contributions in the late 1980s and 1990s. The gradual increase from 2010 to 2015, during which annual publications rose from 40 to 45 (3.34% to 3.76%), reflects the growing attention to transparency and accountability in response to the global financial crisis and the demand for stronger governance mechanisms (Healy & Palepu, 2001; Ball, 2016).

Between 2016 and 2020, the literature entered an expansion phase characterised by significant growth in output, ranging from 56 publications in 2016 (4.68%) to 82 in 2020 (6.86%). This period coincides with the implementation of major international regulatory initiatives, most notably the European Union's Directive 2014/95/EU mandating non-financial disclosure, which took effect in 2017 and encouraged further scholarly inquiry into both compliance and sustainability reporting quality (Mion & Loza Adaui, 2020). The increase also reflects broader debates around ESG disclosures, integrated reporting, and the institutionalisation of sustainability practices within corporate frameworks (Maniora, 2020).

The most notable surge in publications occurred between 2021 and 2024, marking the consolidation phase of disclosure research. The number of documents increased steadily from 72 in 2021 (6.02%) to 97 in 2024 (8.11%), representing the highest annual share of contributions in the dataset. This steep rise is consistent with global discussions on climate-related financial disclosures, ESG integration, and the role of corporate transparency in supporting sustainable development goals (Christensen et al., 2021; Kotsantonis & Pinney, 2022). The COVID-19 pandemic also acted as a catalyst, intensifying scholarly and regulatory interest in disclosure practices as firms faced pressures to communicate risks, supply chain resilience, and non-financial performance with greater clarity (Maniora, 2020).

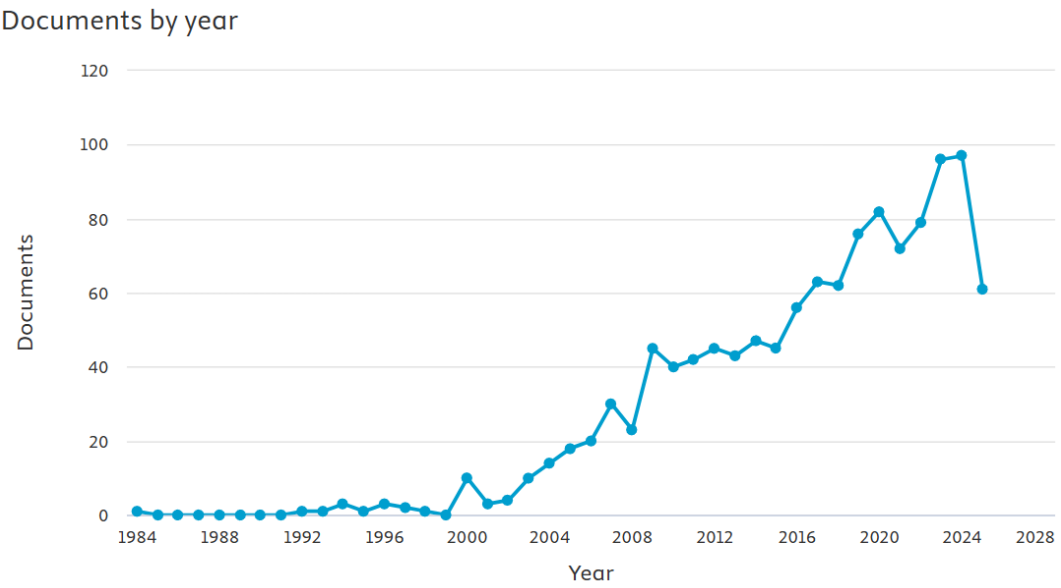
In 2025, the dataset records 61 publications (5.10%) as of the October extraction date, which appears lower than the peak years of 2023 and 2024. However, as shown in Figure 2, this apparent decline is attributable to the incomplete year of data collection rather than an actual downturn in scholarly productivity. Considering the upward trajectory since 2016, it is reasonable to expect that the final 2025 figure would align with or even surpass previous peaks once the full year's data are included.

Taken together, Table 1 and Figure 2 reveal three distinct phases in the evolution of disclosure literature. The formative stage (2010–2015) was characterised by modest yet steady growth. The expansion stage (2016–2020) was driven by regulatory reforms and ESG discourses. The consolidation and acceleration stage (2021–2025) was marked by unprecedented growth and diversification of research themes. This temporal progression highlights the maturation of disclosure into a prominent area of international accounting research, shaped by global governance frameworks, sustainability imperatives, and heightened societal demands for transparency.

Table 1: Year of Publications

Year	Total Publications	%
2025	61	5.10%
2024	97	8.11%
2023	96	8.03%
2022	79	6.61%
2021	72	6.02%
2020	82	6.86%
2019	76	6.35%
2018	62	5.18%
2017	63	5.27%
2016	56	4.68%
2015	45	3.76%
2014	47	3.93%
2013	43	3.60%
2012	45	3.76%
2011	42	3.51%
2010	40	3.34%

Figure 2: Document by Year



Most Active Source Titles

Analysis of source titles reveals that disclosure-related research published across a diverse set of high-impact journals in accounting, auditing, and corporate governance clearly reflects the interdisciplinary nature of the field. As shown in Table 2, the Journal of Accounting and Economics emerged as the leading outlet with 47 publications (3.93%), underscoring its role in shaping theoretical and empirical debates on the economic implications of disclosure practices. This journal has historically emphasised the role of disclosure in reducing information asymmetry and enhancing capital market efficiency (Healy & Palepu, 2001), which aligns with the growing importance of both voluntary and mandatory disclosures in corporate accountability.

The Journal of Intellectual Capital ranks second with 40 publications (3.34%), highlighting the intersection between disclosure and intangible assets, knowledge management, and organisational value creation. This suggests that disclosure practices are increasingly moving beyond financial reporting, encompassing broader intellectual capital considerations that enhance firms' long-term competitiveness (Guthrie et al., 2012). Similarly, the Accounting Review (35 publications, 2.93%) and the Journal of Accounting Research (21 publications, 1.76%) remain highly influential, offering rigorous methodological approaches to understanding the determinants and consequences of disclosure, with particular focus on auditing standards, earnings management, and regulatory frameworks (Dechow et al., 2010).

Specialised outlets focusing on accountability and governance also play a pivotal role. The Accounting, Auditing and Accountability Journal (31 publications, 2.59%) and the Managerial Auditing Journal (29 publications, 2.42%) provide platforms for exploring how disclosure contributes to accountability, ethical practices, and internal audit processes. Likewise, journals with a sustainability orientation, such as Corporate Social Responsibility and Environmental Management (28 publications, 2.34%) and the Social Responsibility Journal (25 publications, 2.09%) reflect the integration of ESG and sustainability reporting into mainstream disclosure research (Christensen et al., 2021).

Other journals posit greater emphasis on corporate governance and ownership structures. For instance, Corporate Governance: The International Journal of Business in Society (Bingley) and Corporate Ownership and Control (each featuring between 17 and 18 publications, approximately 1.5%) concentrate on the institutional and governance mechanisms that underpin disclosure compliance and transparency (Aguilera et al., 2015). Moreover, interdisciplinary journals such as Business Strategy and the Environment (17 publications, 1.42%) extend the disclosure discussions into the realm of strategic environmental management, reinforcing the view that disclosure serves both strategic and regulatory activities (Kotsantonis & Pinney, 2022).

Finally, field-specific accounting journals such as the Journal of Applied Accounting Research (17 publications, 1.42%), Review of Accounting Studies (17 publications, 1.42%), and Meditari Accountancy Research (16 publications, 1.34%) provide empirical and conceptual insights into disclosure practices, especially within emerging markets and comparative international contexts. These outlets contribute to diversifying the discourse, with Meditari Accountancy Research in particular advancing debates on integrated reporting and sustainability accounting (de Villiers & Hsiao, 2018). Collectively, the diversity of publication sources reflects the breadth of disclosure research, spanning capital market implications, intellectual capital, sustainability, governance, and accountability frameworks.

Table 2: Most Active Source Title

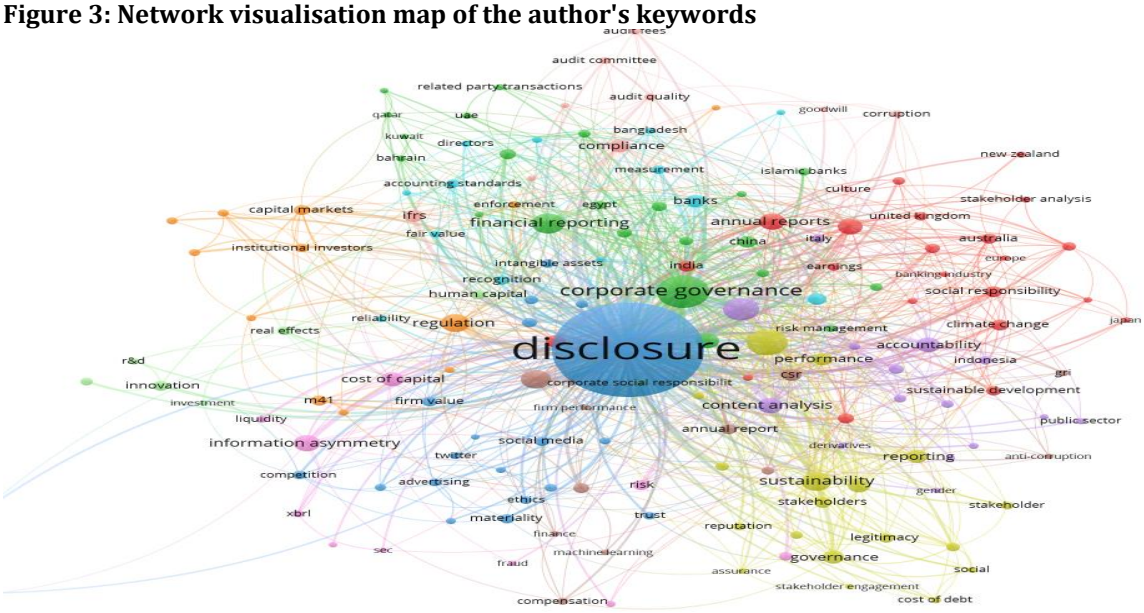
Source Title	TP	%
Journal of Accounting and Economics	47	3.93%
Journal of Intellectual Capital	40	3.34%
Accounting Review	35	2.93%
Accounting, Auditing and Accountability Journal	31	2.59%
Managerial Auditing Journal	29	2.42%
Corporate Social Responsibility and Environmental Management	28	2.34%
Social Responsibility Journal	25	2.09%
Journal of Accounting Research	21	1.76%
Management Science	20	1.67%
Corporate Ownership and Control	18	1.51%
Business Strategy and the Environment	17	1.42%
Corporate Governance Bingley	17	1.42%
Journal of Applied Accounting Research	17	1.42%
Review of Accounting Studies	17	1.42%
Meditari Accountancy Research	16	1.34%

Keyword Analysis

The network visualisation of author keywords illustrates the intellectual structure and thematic clusters in the disclosure literature. The central and most frequently occurring keyword is “disclosure”, reflecting its pivotal role as the unifying concept of the field. Surrounding this core, several interconnected clusters emerge, indicating the multidisciplinary nature of disclosure research. One prominent cluster links disclosure with corporate governance, financial reporting, and compliance, highlighting the strong association between disclosure practices and governance mechanisms (Aguilera et al., 2015; Healy & Palepu, 2001). Another significant cluster associates disclosure with sustainability, CSR, legitimacy, and stakeholders, demonstrating the growing emphasis on non-financial and ESG-related disclosures in response to sustainability imperatives (Christensen et al., 2021).

Additional thematic groupings connect disclosure to information asymmetry, cost of capital, and firm value, underscoring the economic implications of transparency for capital markets (Ball, 2016). Emerging topics such as social media, machine learning, and content analysis also appear in the visualisation, suggesting methodological diversity and the integration of technology-driven approaches in disclosure studies (de Villiers & Hsiao, 2018). Furthermore, the presence of geographical identifiers such as the United Kingdom, Australia, Indonesia, and Bangladesh reveals a growing body of region-specific research, pointing towards a comparative international perspective on disclosure practices. Overall, the visualisation map demonstrates the way disclosure scholarship expands from traditional financial and governance concerns into broader social, technological, and sustainability-driven domains.

Figure 3: Network visualisation map of the author's keywords



The keyword frequency visualisation using WordSift further reinforces the dominance of "disclosure", which occupies the most prominent position. Alongside disclosure, frequently occurring keywords include "financial", "governance", "corporate", "reporting", and "sustainability", reflecting the field's central preoccupations with corporate accountability, regulatory compliance, and the integration of sustainability considerations into reporting frameworks (Mion & Loza Adaui, 2020). Keywords such as "cost", "capital", "risk", and "performance" highlight the continued relevance of economic and market-oriented outcomes of disclosure, particularly in assessing the role of transparency in reducing information asymmetry and enhancing firm value (Dechow et al., 2010).

Interestingly, the WordSift analysis also reveals emerging and interdisciplinary terms such as "cyber", "artificial intelligence", "innovation", and "circular economy", pointing to the incorporation of digitalisation and sustainable business models into disclosure research. The recurrence of terms like IFRS, ESG, and integrated reporting further emphasises the impact of international regulatory frameworks and voluntary reporting standards on shaping disclosure practices (Kotsantonis & Pinney, 2022). The visualisation thus confirms the thematic breadth of disclosure literature, ranging from traditional accounting perspectives to cutting-edge topics linked with sustainability, technology, and global governance.

Figure 4: Top Keywords in wordsift.org



Geographical Distribution of Publications - Most Influential Countries

The geographical distribution of publications highlights the global diffusion of research on voluntary and mandatory disclosure practices, with several countries emerging as particularly influential contributors. As shown in Table 3, the United States leads with 348 publications (29.10%), reflecting its dominance in the international accounting and finance literature. This prominence is largely attributable to the well-established U.S. capital markets, the stringent regulatory environment, and the long-standing emphasis on corporate transparency, particularly under frameworks such as the Securities and Exchange Commission (SEC) reporting requirements and the Sarbanes-Oxley Act (Healy & Palepu, 2001; Ball, 2016). The U.S. scholarly community has also been instrumental in advancing disclosure theory, especially in areas related to information asymmetry, earnings management, and the capital market effects of disclosure (Dechow et al., 2010).

The United Kingdom follows as the second most active country with 144 publications (12.04%). The U.K. has historically emphasised corporate governance and accountability, with landmark initiatives such as the Cadbury Report and subsequent corporate governance codes shaping disclosure practices globally (Aguilera et al., 2015). Research from the U.K. often intersects with themes of sustainability reporting, integrated reporting, and corporate social responsibility (CSR), influenced by the presence of strong institutional investors and the U.K.'s role in global governance debates (Christensen et al., 2021). Similarly, Australia, with 124 publications (10.37%), has contributed significantly to sustainability and environmental disclosure research. The nation's focus on mining and resource industries has led to pioneering studies on environmental reporting, climate change disclosures, and the integration of ESG considerations into corporate accountability frameworks (De Villiers & Hsiao, 2018).

In continental Europe, Italy ranks fourth with 108 publications (9.03%), reflecting the growing scholarly focus on mandatory non-financial disclosure following the adoption of the European Union's Directive 2014/95/EU. Italian scholars have extensively examined sustainability reporting quality, corporate governance determinants, and the evolution of integrated reporting practices (Mion & Loza Adaui, 2020). Among emerging economies, Malaysia demonstrates notable engagement with 69 publications (5.77%), particularly in corporate governance and sustainability disclosure studies. This is consistent with Malaysia's active role in strengthening disclosure frameworks under the Bursa Malaysia initiative and the Malaysian Code on Corporate Governance (Othman et al., 2011).

Other countries also contributed significantly to disclosure research. Canada places a strong emphasis on corporate governance, stakeholder accountability, and social disclosures, with a contribution of 61 publications (5.10%). Spain (49 publications, 4.10%) and Germany (31 publications, 2.59%) highlight the European tradition of linking corporate reporting to accountability and stakeholder engagement. Meanwhile, Indonesia (44 publications, 3.68%) and China (35 publications, 2.93%) underline the increasing attention to disclosure practices in Asian emerging markets, where research often focuses on compliance with IFRS, governance mechanisms, and sustainability challenges in rapidly developing economies (Cui et al., 2025).

Overall, the geographical spread of research demonstrates the global significance of disclosure practices and reveals a concentration in advanced economies such as the United States, the United Kingdom, and Australia, with growing contributions from emerging markets including Malaysia, Indonesia, and China. This trend reflects the dual influence of advanced regulatory regimes in developed economies and the increasing adoption of international reporting standards in developing contexts. The findings suggest that while global scholarship is becoming more diversified, further comparative research is needed to bridge insights across developed and emerging economies to enrich the understanding of disclosure practices in varying institutional environments.

Discussion

The findings of this bibliometric analysis illustrate how research on voluntary and mandatory disclosure practices is evolving across international contexts, addressing both the temporal evolution of scholarship and the thematic-intellectual structures that underpin the field. The first research question of how voluntary and mandatory disclosure practices evolved in the international accounting literature is answered by the clear evidence of sustained growth in publications since 2010, with a sharp acceleration after 2016. This growth coincides with major regulatory milestones such as the European Union's Directive 2014/95/EU on non-financial reporting and the adoption of International Financial Reporting Standards (IFRS) in emerging markets

(Mion & Loza Adaui, 2020; Ball, 2016). The peak output in recent years reflects increasing global attention to environmental, social, and governance (ESG) disclosures, integrated reporting, and the role of transparency in enhancing stakeholder trust and accountability (Christensen et al., 2021). This indicates that disclosure research has evolved from a financial and compliance-centred focus towards broader societal and sustainability concerns, reflecting changes in both market and regulatory expectations.

The second research question, which queries in relation to what thematic trends, intellectual structures, and knowledge gaps can be identified through bibliometric mapping, is addressed through the clustering of author keywords and source analysis. The keyword networks reveal distinct thematic clusters, including corporate governance, financial reporting, sustainability, legitimacy, and performance, highlighting the multifaceted nature of disclosure research (Aguilera et al., 2015; Dechow et al., 2010). The presence of terms such as "information asymmetry" and "cost of capital" demonstrates the persistence of traditional accounting concerns, while the growing prominence of sustainability, ESG, and integrated reporting underscores the field's expansion into non-financial domains (Kotsantonis & Pinney, 2022). Intellectual structures, as reflected in highly cited journals such as the Journal of Accounting and Economics, Accounting Review, and Accounting, Auditing and Accountability Journal, reveal an integration of mainstream accounting theory with emerging interdisciplinary frameworks from corporate social responsibility and environmental management research (De Villiers & Hsiao, 2018). However, the network also reveals fragmentation across regional contexts, and it shows that research remains unevenly distributed and overly concentrated in developed economies such as the United States, the United Kingdom, and Australia.

Regulatory reforms and standard-setting initiatives have been a key driver of these evolving trends, pushing companies towards greater transparency and thus stimulating scholarly interest in compliance and governance outcomes (Healy & Palepu, 2001; Christensen et al., 2021). Market dynamics, particularly pressures from institutional investors and global capital markets, have also heightened the demand for voluntary disclosures as a signalling mechanism to reduce information asymmetry and build legitimacy (Ball, 2016). At the same time, societal expectations for corporate responsibility and sustainability have expanded disclosure practices beyond financial performance to encompass ethical, social, and environmental dimensions (Maniora, 2020). Methodological advances, including the application of bibliometric techniques, content analysis, and increasingly, data-driven approaches such as machine learning, have further diversified the field's intellectual structure, enabling more systematic mapping of disclosure practices and their impacts (Donthu et al., 2021).

Despite these advancements, the analysis reveals important gaps in the literature. First, disclosure research remains highly concentrated in developed economies, with emerging markets such as Malaysia, Indonesia, and China only recently gaining attention (Othman et al., 2011; Cui et al., 2025). This suggests a need for comparative studies that account for institutional differences and regulatory environments across jurisdictions. Second, while sustainability and ESG disclosures are receiving increasing attention, the quality, reliability, and substantive value of such disclosures remain contested. This is accompanied by concerns that voluntary reporting may function more as symbolic legitimacy-seeking, rather than substantive accountability (Christensen et al., 2021; Maniora, 2020). Finally, the integration of technology into disclosure practices such as the use of digital platforms, social media, and artificial intelligence remains underexplored, representing a critical future direction as firms increasingly embrace digital reporting ecosystems.

Overall, the evolution of voluntary and mandatory disclosure practices reflects broader transformations in the global business environment, where transparency is not only a regulatory requirement but also a strategic resource for legitimacy and competitiveness. The identified thematic trends and intellectual structures reveal how the field has matured from focusing on financial implications to embracing multidimensional perspectives that integrate governance, sustainability, and global collaboration. At the same time, the identified gaps underscore the importance of further expanding the scope of inquiry to capture the challenges and opportunities that emerge in disclosure practices across a variety of international contexts.

The findings of this bibliometric study hold significant implications for industry practice, policymaking, and broader real-world implementation. For practitioners, the mapping of disclosure research highlights how voluntary and mandatory reporting have evolved from narrow financial disclosures towards integrated frameworks that encompass sustainability, governance, and ESG factors. These changes certainly offer firms

strategic insights into expectations of investors, regulators, and stakeholders. By identifying dominant themes such as corporate governance, information asymmetry, and sustainability, the study serves companies with evidence-based guidance on where disclosure practices can be strengthened to enhance legitimacy, reduce risk, and build long-term market resilience (Christensen et al., 2021). Policymakers and regulators can leverage these insights to benchmark national regulations against global disclosure trends, ensure alignment with international standards such as IFRS, the EU Directive on non-financial reporting, and define climate-related disclosure frameworks. Moreover, the identification of research gaps, particularly in emerging markets, signals areas where regulatory interventions and institutional support are most needed to improve disclosure quality and comparability across jurisdictions. Beyond academia, this study informs standard setters, investors, and advocacy groups with a demonstration of disclosure practices that are increasingly intertwined with accountability and sustainability, thus reinforcing the need for policies that balance compliance with meaningful transparency. Ultimately, by bridging scholarly evidence with practical concerns, the development of disclosure practices that support responsible corporate behaviour, informed policy making, and sustainable global business ecosystems is feasible.

The bibliometric mapping of voluntary and mandatory disclosure practices highlights several important avenues for future research. First, while disclosure research has been dominated by contributions from developed economies such as the United States, the United Kingdom, and Australia, emerging markets including Malaysia, Indonesia, and China remain underexplored. Future studies could adopt comparative cross-country analyses to investigate how institutional differences, regulatory quality, and cultural contexts shape disclosure practices. Employing mixed-method approaches, such as combining bibliometric analysis with case studies, could capture both the macro-level patterns and the micro-level institutional dynamics driving disclosure.

Second, sustainability and ESG disclosures, though increasingly prominent, raise concerns about their reliability and substantive impact. Much of the current evidence suggests that voluntary disclosures may be more symbolic than substantive, primarily serving legitimacy rather than accountability (Christensen et al., 2021; Maniora, 2020). Future research could employ content analysis with text mining or natural language processing (NLP) to assess disclosure quality, sentiment, and depth, distinguishing between "box-ticking" compliance and meaningful transparency. Longitudinal studies could also examine whether ESG disclosures translate into improved financial performance, risk mitigation, or stakeholder trust.

Third, the analysis reveals that emerging themes such as digitalisation, social media, artificial intelligence (AI), and integrated digital reporting platforms remain under-researched. With the growing digitisation of corporate reporting, future studies could explore how firms utilise technology for disclosure, including the use of blockchain for audit trails, AI for automated reporting, or social media for stakeholder communication. Methodologically, big data analytics and machine learning techniques could be applied to large-scale disclosure datasets, enabling more nuanced insights into patterns and anomalies in corporate communication.

Fourth, the bibliometric analysis identified strong connections between disclosure, corporate governance, information asymmetry, and cost of capital, but limited attention to the behavioural and psychological dimensions of disclosure. Future studies could integrate behavioural accounting and experimental designs to examine how managers' incentives, ethical orientations, or risk perceptions influence disclosure decisions. Similarly, surveys and interviews with corporate executives, regulators, and investors could provide valuable qualitative insights into the motivations and challenges surrounding disclosure practices in different institutional contexts.

Finally, the global collaboration patterns in disclosure research show fragmentation across regions, suggesting a need for more transnational and interdisciplinary collaborations. Future work could adopt network analysis to study how research partnerships, regulatory harmonisation efforts, and cross-border capital flows influence disclosure standards. Linking bibliometric mapping with policy analysis may also shed light on how regulatory diffusion occurs across countries, and whether global standards (e.g., IFRS, ISSB, GRI) are effective in harmonising practices across diverse institutional environments.

5. Conclusion and Recommendations

This bibliometric analysis offers a comprehensive overview of the evolution of voluntary and mandatory disclosure practices in the international accounting literature, tracing the field's growth, thematic clusters, and intellectual structures over the past decade and a half. The study demonstrates that disclosure research has transitioned from a narrow focus on financial reporting and information asymmetry towards a broader engagement with corporate governance, sustainability, ESG, and integrated reporting. Mapping of keywords and source titles revealed an increasingly interdisciplinary field, drawn from accounting, auditing, governance, and social responsibility domains. Geographically, research remains concentrated in developed economies such as the United States, the United Kingdom, and Australia, though growing contributions from emerging markets, including Malaysia, Indonesia, and China, signal a diversification of scholarly interest. Importantly, the results demonstrate how disclosure practices are shaped not only by regulatory mandates but also by market pressures, stakeholder expectations, and global sustainability imperatives.

Despite the study's contributions, certain limitations should be acknowledged. First, the analysis relied solely on Scopus as the data source, which, while comprehensive, may exclude relevant literature indexed elsewhere. Second, the bibliometric approach is inherently quantitative, focusing on publication and citation patterns rather than evaluating the substantive quality of individual studies. Third, the temporal scope, ending in 2025, reflects a snapshot rather than a continually updated record of disclosure research. These limitations highlight the need for caution in interpreting results, while also underscoring opportunities for complementary qualitative or mixed-method approaches to enrich the findings.

Looking forward, several research directions emerge. Future studies should expand the scope beyond developed economies to investigate how institutional contexts in emerging markets influence disclosure practices. The quality and substantive value of ESG and sustainability disclosures remain contested, calling for deeper investigation using content analysis, natural language processing, and big data approaches to assess transparency and reliability. Additionally, digitalisation and the integration of technology into disclosure practices as seen in AI, blockchain, and digital reporting platforms present underexplored frontiers that call for innovative methodologies such as machine learning, case studies, and cross-country comparisons. Greater collaboration across disciplines and regions is also essential to build a more holistic and globally integrated understanding of disclosure practices.

Overall, this study contributes to advancing knowledge by systematically mapping the intellectual landscape of disclosure research and identifying its thematic and geographical trajectories. The findings underscore the enduring importance of disclosure as both a regulatory mechanism and a strategic resource in shaping corporate accountability, legitimacy, and sustainability. By consolidating fragmented empirical evidence and highlighting knowledge gaps, this analysis not only strengthens the theoretical and practical relevance of disclosure research but also provides a foundation for future studies that can better inform corporate practice, policy making, and global governance. The ongoing impact of these findings lies in their ability to guide both scholars and practitioners towards building more transparent, accountable, and sustainable disclosure systems across international contexts.

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Climate-Smart Governance and Food Security: Exploring the Mediating Effect of Sustainable Supply Chain Practices

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Abstract: This study explores the continuing challenge of ensuring food security in an era of increasing climate uncertainty and environmental decline. Weak coordination among institutions and inefficiencies within food supply chains often limit the success of sustainable initiatives, despite growing commitment to climate-smart policies. This study seeks to understand how climate-smart governance can improve food security through the influence of sustainable supply chain practices. Using a narrative review approach, data were gathered from the Scopus database and examined through an integrative thematic analysis, aiming to identify coherent ideas and relationships linking governance, sustainability, and the resilience of food systems. The review shows that effective climate-smart governance contributes to stronger food security when supported by sustainable supply chain practices such as green logistics, reduced food loss, digital innovation, and collaboration among stakeholders. These practices make governance efforts more effective by improving how resources are managed, reducing environmental pressure and helping supply chains adapt to change, all of which support better food availability, access, and stability. This study makes a theoretical contribution by proposing a framework that positions sustainable supply chain practices as the connecting element between governance structures and food security outcomes. Practically, the findings provide valuable guidance for policymakers, supply chain professionals, and agricultural organisations to create more integrated and responsive governance systems. This is important for promoting sustainability, innovation, and building resilient food networks that are able to adapt to future global challenges.

Keywords: *Climate-Smart Governance, Sustainable Supply Chain Practices, Food Security, Sustainability and Resilience, Climate Change Adaptation*

1. Introduction

Food systems around the world face two pressing and interconnected challenges: adapting to climate change and ensuring global food security. As the global population moves towards nearly ten billion by the middle of the century, the demand for safe, nutritious, and affordable food continues to grow. At the same time, agriculture, land use, and supply chain activities contribute heavily to greenhouse gas emissions and environmental degradation. Within this context, climate-smart governance has emerged as a promising approach since it can integrate climate resilience, sustainability, and food system stability into policies, institutions, and supply chain operations. Alongside this, sustainable supply chain practices such as shorter distribution networks, greener logistics, reduced food loss and digital innovations are increasingly recognised as essential strategies for strengthening food systems in a changing climate.

Research on climate-smart agriculture, sustainable supply chain management, and food governance is rapidly expanding. Climate-smart agriculture focuses on improving productivity, building resilience, and implementing initiatives to reduce emissions within agrifood systems. Studies on sustainable supply chains also highlight the importance of efficient logistics, waste reduction, and shortened food pathways, which can improve food security, reduce losses, and preserve freshness. The important role that governance plays cannot be denied as policy support, institutional coordination, and public-private partnerships can drive the adoption of these sustainable practices. However, while each of these areas has been well explored, research examining how sustainable supply chain practices act as the connecting bridge that links climate-smart governance to concrete food security outcomes remains limited.

Despite progress in research and policy, significant gaps remain. Many governance initiatives designed to promote climate-smart food systems still fail to produce meaningful improvements in food security. Even when sustainable agricultural practices are adopted, challenges such as supply chain inefficiencies, food loss, and logistical constraints often contribute to the ineffectiveness of their impact. For example, governance

frameworks frequently emphasise production and adaptation yet neglect of downstream supply chain processes that connect production to consumption persists. In the absence of effective mediation through sustainable supply chain practices, the benefits of governance initiatives are likely to be under-realised.

To address this gap, this study proposes a conceptual framework positioning sustainable supply chain practices as a mediator between climate-smart governance and food security. The aim is to explore how governance systems shaped by climate-smart objectives influence the adoption of sustainable practices such as green logistics, shorter supply chains, food loss reduction, and digital technology, and how these all affect food availability, access, and stability. Using insights from supply chain governance theory and socio-technical systems thinking, this framework seeks to explain how institutional and operational levels interact to build resilient and sustainable food systems.

The significance of this study is both theoretical and practical. It provides policymakers, supply chain managers, and agricultural stakeholders with evidence-based insights into where interventions can have the greatest impact, particularly in strengthening supply chain practices that connect governance strategies to food security outcomes. Academically, the study helps bridge fragmented discussions by integrating governance, supply chain, and food security research into a single conceptual model. Theoretically, it advances supply chain governance scholarship by incorporating climate-smart and food security perspectives. The paper proceeds into several sections as follows: Section 2 reviews the relevant literature; Section 3 presents the proposed conceptual framework and research propositions; Section 4 outlines the methodology; Section 5 discusses the findings; Section 6 elaborates on implications and limitations; and Section 7 concludes with recommendations for future research.

2. Literature Review

Existing research on governance for food systems and climate adaptation suggests that governance arrangements guided by climate-smart objectives provide the institutional foundation for building resilient food systems. For example, Paloviita and Marja Järvelä (2019) emphasise that governance operating at multiple levels including global, national, regional, and within supply chains plays a vital role in enabling food systems to adapt to climate-related risks such as changing rainfall patterns, extreme temperatures, and water scarcity. Their analysis highlights that governance systems integrating public components, such as state policy and regulation, with private elements, such as corporate chain governance and buyer-supplier coordination, are more likely to strengthen the adaptive capacity of food supply chains. This governance foundation creates the conditions for supply chain practices to align with climate-smart goals, including promoting shorter supply chains, encouraging low-carbon logistics, and reducing food loss. However, governance alone is not enough to achieve meaningful improvements in food security unless supply chain practices perform their cooperative function as operational mechanisms that enact governance principles.

Research on sustainable supply chain management within the food sector, including supply chain practices, provides invaluable insights. Prior studies have shown that approaches such as local sourcing, environmentally responsible logistics, waste and inventory reduction, and the use of digital information systems can significantly enhance supply chain performance, particularly in ways that relate to food security. For example, Accorsi and colleagues in 2022 found that sustainable food supply chains benefit from coordinated practices like logistics optimisation, waste minimisation, and collaborative partnerships that foster resilience and sustainability. Similarly, the study by Palazzo (2021) also highlights that effective food supply chain management depends on collaboration, information sharing, operational efficiency, and stakeholder integration. These elements directly support food security: shorter supply chains help maintain freshness and reduce spoilage, waste reduction practices preserve more food for consumption, and digital forecasting improves logistics and supply stability. Yet, despite these advances, the way these practices mediate the relationship between governance and food security remains insufficiently explored.

Significant research gap indicates that there is still a need to clearly map and empirically examine how climate-smart governance influences sustainable supply chain practices, and how these practices, in turn, affect food security in terms of availability, access, and stability. While existing studies acknowledge that governance frameworks shape food system resilience, and that sustainable supply chain practices improve efficiency and

reduce environmental impact, very few have integrated these three dimensions into a single conceptual model. The lack of an empirically tested framework that connects governance, supply chain practices, and food security limits both theoretical development and practical application. To address this, the present study proposes a conceptual framework that positions sustainable supply chain practices as a key mediator between climate-smart governance and food security outcomes. The theoretical foundation of this study draws on supply chain governance theory and socio-technical systems thinking, suggesting that governance exerts its influence indirectly by shaping practices within the chain, which then translate into tangible improvements in food security. In doing so, the study is able to bridge the gap in understanding how governance and food security are operationally connected through supply chain practices.

Climate-Smart Governance

Governance arrangements oriented around climate-smart objectives emphasise the important role of institutional mechanisms, policy frameworks and effective coordination between the public and private sectors in strengthening food system resilience in the face of climate change. Ari Paloviita and Marja Järvelä (2019) highlight that multilevel governance within food supply chains encompasses policy regulation, corporate governance, and stakeholder collaboration. Each of these plays a role in helping food systems adapt to changing climatic conditions by shaping how supply chains are organised and managed. Such governance structures create an enabling environment for climate-smart initiatives, including resource-efficient agriculture, risk management mechanisms, and partnerships between public and private actors. Together, these efforts establish the foundation for aligning supply chain operations with broader sustainability and food security objectives. In this context, climate-smart governance extends beyond agricultural production to involve the coordinated management of policies, institutions, actors and supply chain processes that collectively address climate risks and ensure the long-term stability of food systems.

Sustainable Supply Chain Practices and Food Security

The literature on sustainable supply chain management in food systems shows that practices such as reducing food loss and waste, shortening supply chains, implementing green logistics and leveraging digital technologies are critical to food security outcomes (availability, access, stability). A systematic review of food sustainable supply-chain management (FSSCM) by Palazzo and Vollero (2021) mapped out the building blocks of FSSCM including traceability, collaboration, green purchasing and technology adoption and emphasises research gaps around integrating sustainability into food-chain flows. Additionally, research on food loss and waste (FLW) demonstrates that eliminating losses across chain stages is fundamental to linking supply-chain practices with food-security dimensions. For example, Akkerman and Frans Cruijssen (2024) discuss how drivers of FLW and interventions such as better information flows, packaging innovations, and logistics optimisation link supply-chain performance with nutrition and system stability. In sum, sustainable supply chain practices are pivotal for translating upstream production/governance ambitions into downstream food-security outcomes.

Mediating Effect of Sustainable Supply Chain Practices

The mediating effect emerges when climate-smart governance influences supply-chain practices, which in turn influence food-security outcomes. Governance mechanisms namely policies, incentives, regulations, and stakeholder coordination create the institutional conditions for supply-chain actors to adopt sustainable practices like shorter chains, green logistics, digital information systems and food-loss reduction mechanisms. These practices operationalise governance objectives into tangible chain behaviours, which in turn influence food security by improving availability through reduced losses, shorter transit, fresher produce, efficient distribution access, reduced cost, improved freshness and stability all through resilient supply chains, buffer capabilities, technology-enabled predictability. Thus, without the supply-chain practices acting as the conduit, governance alone may not translate into improved food-security outcomes. The literature reveals that while governance and supply-chain practices are independently studied, their linkage via mediation remains limited research. Therefore, this study aims to address via the proposed conceptual framework.

3. Methodology

Research Design – Narrative Review Methodology

This study adopts a narrative review methodology to critically examine and interpret existing knowledge on the relationship between climate-smart governance, sustainable supply chain practices, and food security. A

narrative review is well-suited for exploratory and theory-building research where the goal is to develop conceptual understanding rather than to quantify relationships (Baumeister and Leary, 1997). Unlike systematic reviews that depend on statistical meta-analysis, the narrative review approach allows for the integration of diverse perspectives drawn from conceptual, empirical, and policy-oriented studies. This flexibility provides a broad analytical lens to capture the complex interconnections between governance structures, sustainability practices, and food system outcomes, which are inherently multidisciplinary and cross-sectoral in nature (Green, Johnson and Adams, 2006). The design of this review therefore supports the development of a conceptual framework that explains the mediating influence of sustainable supply chain practices in linking climate-smart governance to food security.

The review emphasises conceptual clarity and thematic synthesis rather than exhaustive quantitative aggregation. Following Ferrari (2015), the process includes identifying both seminal and contemporary studies, synthesising emerging themes, and evaluating theoretical and empirical coherence across disciplines. This methodological orientation aligns with the study's objective to develop an integrative model that explains how governance mechanisms such as policies, regulations, and institutional coordination shape sustainable supply chain behaviours including green logistics, food loss reduction, and digitalisation, which in turn contribute to improving food availability, access, and stability.

Key Steps in Conducting a Narrative Review

The narrative review was carried out in four main phases: search strategy development, literature screening and selection, data extraction, and thematic synthesis with conceptual integration.

Search Strategy Development

The data collection process was conducted using the Scopus database, and the selection was based on its extensive coverage of high-quality, peer-reviewed journals across environmental science, agricultural economics, supply chain management, and governance studies. Scopus was considered the most suitable source as it provides access to a wide range of multidisciplinary literature that addresses sustainability, policy, and agrifood systems, all of which are central to this study.

Screening and Selection

The initial search identified studies published between 2010 and 2025 to capture both foundational and contemporary perspectives. Titles, abstracts, and keywords were carefully reviewed to ensure that the selected works focused on the intersections among climate governance, sustainable supply chains, and food security. Studies that did not engage with these interrelationships or that lacked empirical depth or theoretical relevance were excluded from further consideration.

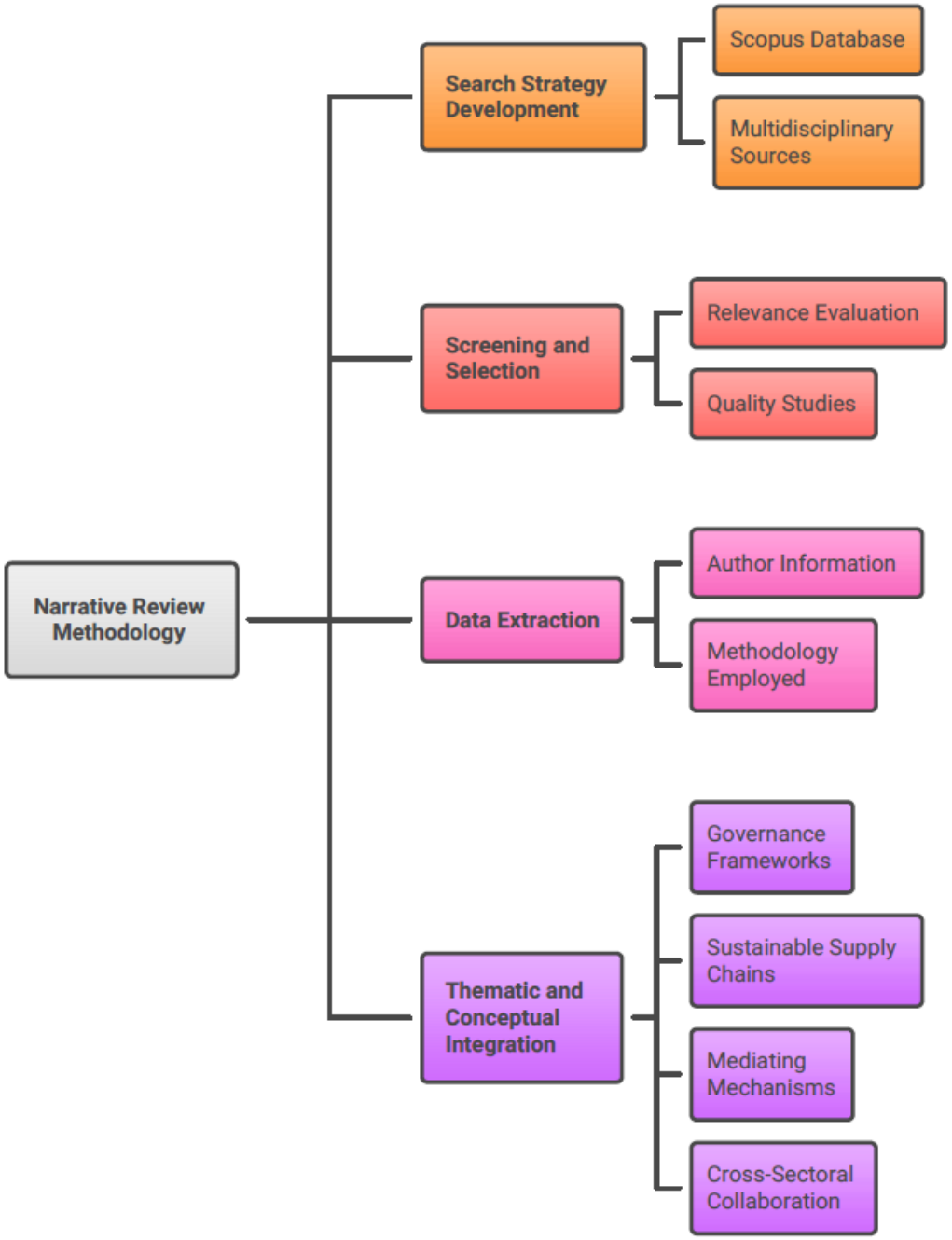
Data Extraction

Full texts of the selected articles were examined to extract essential information including author, year, research objectives, methodological approach, main findings, and theoretical underpinnings. The extracted information was then organised thematically to capture both recurring and divergent viewpoints within the literature.

Thematic and Conceptual Integration

An integrative thematic analysis approach, as described by Braun and Clarke (2006), was applied to identify, code, and cluster patterns across the reviewed studies. This analytical process informed the synthesis of four central themes: governance frameworks for climate adaptation, sustainable supply chain management practices, mediating mechanisms that influence food security, and cross-sectoral collaboration with corresponding policy implications.

Figure 1: Narrative Review Methodology: Climate Governance, Supply Chains, and Food Security



Data Collection and Review Strategy

Data collection was systematically conducted using the Scopus database as the primary source. The following search string was applied to retrieve relevant documents from titles, abstracts, and keywords:

("climate" OR "environment" OR "sustainability") AND ("governance" OR "management" OR "policy" OR "administration") AND ("food security" OR "nutrition" OR "food safety" OR "hunger") AND ("supply chain" OR "logistics" OR "distribution" OR "procurement") AND ("sustainable" OR "eco-friendly" OR "green" OR "responsible") AND ("practices" OR "strategies" OR "methods" OR "approaches").

This query was refined to include peer-reviewed journal articles, conference papers, and book chapters, while

excluding non-academic materials such as reports or editorials. The search yielded approximately 250 initial records, which were filtered through inclusion and exclusion criteria focusing on thematic relevance and publication quality. Duplicates were removed, and 90 articles were shortlisted for detailed review.

The integrative thematic analysis was utilised to guide the interpretation of data. Each study was coded based on its contribution to understanding (1) the governance mechanisms supporting climate-smart transitions, (2) sustainable supply chain practices such as food-loss reduction, circular logistics, and digital traceability, and (3) the implications of these practices on food security. Through iterative coding and comparison, thematic clusters emerged linking governance interventions with operational practices and food-system resilience outcomes. The final synthesis produced a conceptual framework illustrating how sustainable supply chain practices mediate the relationship between climate-smart governance and food security, providing an empirically grounded yet conceptually rich perspective.

Key Findings from the Narrative Review

Table 1: Key Findings from the Narrative Review

Theme / Key Finding	Description and Insight	Source(s)
Short Supply Chains	Shorter supply chains help bring producers and consumers closer together, reducing the distance food travels and limiting postharvest losses and carbon emissions. This approach ensures that food remains fresher and more nutritious by the time it reaches consumers. Local sourcing also strengthens community resilience by supporting regional economies and reducing dependence on long and vulnerable global supply networks. In doing so, it aligns with the goals of climate-smart governance, which promotes low-carbon, decentralised, and sustainable food systems that are better equipped to adapt to climate change and safeguard long-term food security..	Morkūnas et al. (2022)
Sustainable Supply Chain Management (SSCM)	Sustainable supply chain management practices, including green logistics, environmentally friendly packaging, and product traceability, play a crucial role in enhancing operational efficiency and ensuring food safety. These practices bring together environmental, social, and economic objectives within supply chain operations, creating a more balanced and responsible approach to production and distribution. By integrating sustainability principles into everyday operations, they not only improve efficiency but also strengthen resilience and contribute to the long-term stability and sustainability of food systems.	Aljoghaiman (2023); Melkonyan et al. (2019); Munuhwa & Hove-Sibanda (2024)
Climate-Smart Agriculture (CSA)	Climate-smart agriculture combines different adaptive farming methods, like conservation agriculture, precision irrigation, and integrated pest management, to deal with climate risks and boost productivity. These methods make better use of resources and help keep agricultural production steady even when the weather changes. Climate-smart agriculture directly supports the three main pillars of food security—availability, access, and stability— by encouraging higher yields and better resource management. It makes food systems better able to grow enough food, makes sure that everyone has fair access, and keeps the supply steady even when the economy or the environment changes. It also protects natural ecosystems for future generations.	Roy (2019); Scherer & Verburg (2017)
Government Support	Subsidies, policy tools, and institutional frameworks all help businesses adopt climate-smart and sustainable supply-chain	Erfanian et al. (2024)

Theme / Key Finding	Description and Insight	Source(s)
	practices. Good governance uses incentives, monitoring, and capacity-building programmes that connect national strategies with local food systems to improve and expand sustainability results.	
Food Loss and Waste (FLW) Management	Better logistics, storage, and inventory management can greatly cut down on food loss and waste (FLW), making food more available and having less of an impact on the environment. FLW management serves as an operational link between governance directives and food-security performance, with waste reduction being a key way to do this.	De Boni et al. (2022); Olabode et al. (2025)
Digital Technologies and Supply-Chain Resilience	Digitalisation enhances forecasting, monitoring, and data sharing along supply chains. Technologies such as IoT sensors, blockchain, and AI improve traceability and efficiency, reduce uncertainty, and support real-time responses to climate-related disruptions—thereby strengthening food-system stability.	Aldhaheri et al. (2023)
Integrated Governance and Stakeholder Engagement	Collaborative governance—linking public policies with private sector initiatives—fosters collective action across stakeholders. Such engagement ensures knowledge sharing, joint resource management, and alignment between environmental and economic priorities within food supply chains.	Paloviita & Järvelä (2019); Tsoulfas (2025)

The narrative review emphasises that sustainable supply chain practices act as the intermediary through which climate-smart governance influences food security outcomes. Climate-smart governance anchored in policy coherence, institutional support, and multi-level coordination establishes an enabling environment for sustainable actions, while supply-chain practices operationalise these governance directives into measurable outcomes. In particular, short supply chains and green logistics help lower emissions and keep food fresher. CSA practices, in turn, help businesses become more productive and resilient in the face of climate change. Government support in providing resources, incentives, and regulatory oversight is also helpful in accelerating adoption. At the same time, reducing FLW and using digital technologies make operations more resilient and make better use of resources. This means that food is not only produced in a way that is good for the environment, but it is also delivered to customers quickly and easily. These practices can bridge the gap between strategy and operations, translating high-level governance frameworks into real-world effects on food security by making food more available (through production and waste reduction), more accessible (through efficient distribution), and more stable (through resilience and real-time management).

The mediating function of sustainable supply chain practices consists of converting policy intent into systemic action, thereby linking governance with on-the-ground implementation. Without this kind of mediation, governance actions could stay the same instead of changing things. The review emphasises that integrated governance, multi-stakeholder engagement, and technological innovation are crucial for enhancing this mediation effect, guaranteeing that climate-smart governance successfully promotes sustainable food-security outcomes amid escalating environmental uncertainty.

Theoretical Framework Development

This study is based on the Resource-Based View (RBV) and Institutional Theory. These two theories together explain how governance mechanisms and sustainable supply-chain practices work together to affect food security outcomes. RBV asserts that organisational and systemic performance is derived from the efficient utilisation of valuable, rare, inimitable, and non-substitutable resources (Barney, 1991). In the context of food systems, these resources encompass sustainable technologies, human competencies, and eco-friendly logistics infrastructures that facilitate climate-smart adaptation. Institutional Theory enhances the Resource-Based View (RBV) by highlighting the influence of rules, norms, and governance frameworks on organisational conduct (Scott, 2014). Climate-smart governance through policies, incentives, and regulatory mechanisms that

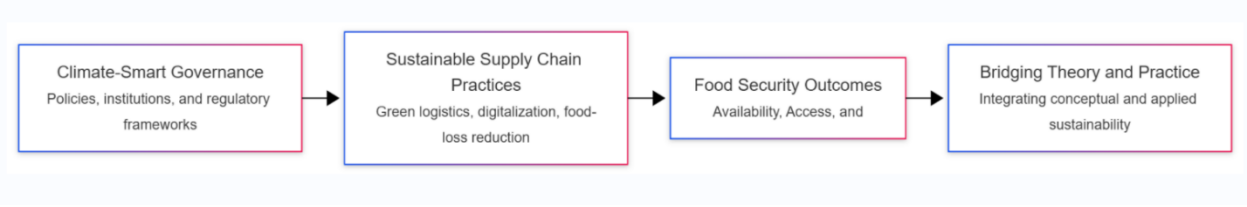
create institutional pressures that force supply-chain actors to use sustainable methods. These theories collectively offer a multifaceted perspective: RBV emphasises the enhancement of internal capabilities within supply chains, whereas Institutional Theory elucidates the external governance factors that shape sustainability alignment and food security outcomes (DiMaggio & Powell, 1983).

The application of these theories in the current study elucidates the mediating function of sustainable supply-chain practices. Climate-smart governance creates the institutional setting through policy frameworks, standards, and resource facilitation that encourages the use of green logistics, reducing food waste, digital traceability, and farming methods that use fewer resources. These practices, in turn, put governance goals into action by making food systems more efficient, resilient, and adaptable (Melkonyan et al., 2019; Tsoulfas, 2025). Theoretically, sustainable supply-chain practices function as dynamic capabilities (Teece, 2007) that convert governance inputs into quantifiable food-security outcomes, including availability, access, and stability. A conceptual framework based on this rationale positions sustainable supply-chain practices as a mediating mechanism that connects governance structures (institutional forces) and food-system performance (resource outcomes). This framework highlights the relationship between policy design and supply-chain execution. It also shows how regulatory compliance can lead to a competitive edge and social benefits through smart use of resources and adaptation to new technologies.

The theoretical integration provides substantial practical ramifications. It implies that attaining food security amidst climate unpredictability necessitates not only robust policy commitment but also the intrinsic capability of supply-chain participants to execute sustainable practices efficiently. Policymakers should prioritise the creation of institutional frameworks that promote innovation, collaboration, and accountability. Concurrently, businesses and agricultural producers must cultivate the ability to align their operational practices with climate-smart principles (Paloviita & Järvelä, 2019). By combining RBV and institutional perspectives, this study makes a theoretical contribution by showing that sustainability performance comes from both following institutional rules and organising resources strategically. In practice, the framework provides a guide for governments, supply-chain managers, and development agencies to work together to create integrated strategies that turn governance mandates into food systems that are strong and fair. To sum up, the proposed theoretical framework helps in understanding how climate-smart governance and supply-chain sustainability work together to create long-term food security outcomes. It is important to connect theory and practice in the field of sustainability.

Figure 2 shows the proposed theoretical framework that shows how climate-smart governance and sustainable supply chain practices work together to create food security outcomes. This fills the gap between theoretical ideas and real-world sustainability practices. In this framework, climate-smart governance is the set of rules and institutions that shape how people behave in the food system in a way that is good for the environment. Governance promotes the adoption of sustainable supply chain practices, such as green logistics, digitalisation, and reducing food loss, by using tools like regulations, incentive structures, and coordination between stakeholders. These practices serve as mediating mechanisms that translate governance objectives into concrete outcomes, enhancing the availability, access, and stability of the food system. This interaction results in the development of robust and flexible food systems that can tackle both environmental and socio-economic issues. The model underscores the amalgamation of theoretical constructs (originating from the Resource-Based View and Institutional Theory) with pragmatic sustainability strategies, thereby guaranteeing the conversion of conceptual governance frameworks into quantifiable enhancements in food security performance.

Figure 2: The Proposed Theoretical Framework



4. Findings

Proposition Development: Climate-Smart Governance and Food Security

Climate-smart governance is very important for setting up the rules and institutions needed to make food security more robust as climate change becomes more of a threat. Effective governance involves coordination at multiple levels among public, private, and community actors to ensure that policies that promote sustainability lead to real actions in the supply chain (Paloviita & Järvelä, 2019). Climate-smart governance creates the right conditions for sustainable farming and distribution practices that make food systems more resilient using adaptive policies, open resource management, and decision-making that involves everyone. The translation of governance strategies into concrete food security outcomes is contingent upon the degree to which sustainable supply chain practices, including green logistics, food-loss reduction, and digital innovation, influence this relationship (Tsoulfas, 2025; Melkonyan et al., 2019). These practices put governance goals into action by making food more available, easier to get to, and more stable by combining efficiency, technological progress, and cooperation into agri-food systems (Ghadge et al., 2021). Without this kind of mediation, reforms to governance might not have much of an effect on how well the food system works in the real world. It is therefore argued that sustainable supply chain practices constitute the fundamental mechanism through which climate-smart governance realises its intended effect on food security.

Proposition 1: Sustainable supply chain practices serve as intermediaries in the relationship between climate-smart governance and food security, facilitating the transformation of governance mechanisms into resilient, efficient, and equitable food systems.

Proposition Development: Climate-Smart Governance and Sustainable Supply Chain Practices

Climate-smart governance lays the groundwork for sustainability-focused behaviour across agri-food supply chains by setting up the rules, policies, and institutions that businesses and governments need to follow. Governments and regulatory bodies create conditions that encourage innovation, coordination, and resilience in the supply chain by making climate adaptation goals part of governance systems (Paloviita & Järvelä, 2019). Clear policy mandates, financial incentives, and multi-stakeholder platforms are examples of good governance tools that encourage supply chain actors to use sustainable practices like green logistics, digital traceability, and resource-efficient production (Melkonyan et al., 2019). These sustainable supply chain practices, in turn, serve as operational mediators that convert high-level governance frameworks into concrete actions that improve environmental performance, minimise waste, and guarantee more equitable resource allocation (Tsoulfas, 2025). Stakeholders can make supply chains more resilient and sustainable by working together, being flexible, and sharing information. This helps supply chains meet governance goals and respond quickly to climate-related disruptions (Ghadge et al., 2021). When done right, climate-smart governance makes supply-chain systems better able to put sustainability plans into action that improve long-term competitiveness and environmental responsibility. Consequently, it is suggested that the existence of strong climate-smart governance has a favourable impact on the implementation and efficacy of sustainable supply chain practices, establishing an essential connection between governance frameworks and systemic sustainability results.

Proposition 2: Climate-smart governance positively impacts the execution of sustainable supply chain practices by establishing the requisite institutional, policy, and regulatory frameworks essential for actualising sustainability and resilience within agri-food systems.

Proposition Development: Food Security and Sustainable Supply Chain Practices

Food security as defined by availability, access, utilisation, and stability, is increasingly reliant on the efficacy and sustainability of supply chain practices that guarantee the continuous delivery of safe, nutritious, and affordable food from production to consumption. Sustainable supply chain practices (SSCPs), including resource-efficient logistics, minimising food loss and waste, and embracing digital technologies, are essential for alleviating the negative impacts of climate change on food systems while bolstering their resilience (Melkonyan et al., 2019). SSCPs enhance food availability and accessibility by advocating for green logistics and effective resource management, especially in areas susceptible to environmental disturbances or economic volatility (Tsoulfas, 2025). Likewise, efforts that improve cooperation between stakeholders and promote technological innovation make it easier to make decisions in real time and respond to climate-related problems in a flexible way, which protects the safety of food and the continuity of supply (Ghadge et al., 2021).

Additionally, incorporating sustainability principles throughout the supply chain increases stability by lowering systemic weaknesses and improving local production and distribution capabilities (Paloviita & Järvelä, 2019). So, sustainable supply chain practices are the operational backbone of food system resilience, and they have a direct effect on society's ability to reach long-term food security goals.

Proposition 3: Sustainable supply chain practices positively impact food security by increasing the availability, accessibility, and stability of the food system through greater resource efficiency, less waste, and adaptive resilience mechanisms.

Proposition Development: The Mediating Role of Sustainable Supply Chain Practices

The connection between climate-smart governance and food security is not only direct. It is also heavily affected by the role of sustainable supply chain practices (SSCPs) that turn policy goals into real-world results. Climate-smart governance creates the institutional, regulatory, and strategic frameworks needed to make food systems more resilient and long-lasting (Paloviita & Järvelä, 2019). However, the success of these governance goals depends on the extent to which SSCPs such as collaborating with stakeholders, using resources wisely, cutting down on food waste, and using digital tools are practiced in the supply chain (Melkonyan et al., 2019; Tsoulfas, 2025). These practices put governance directives into action by improving environmental performance to ensure product traceability and increase adaptive capacity. This makes food systems more resilient to climate shocks and changes in the economy (Ghadge et al., 2021). Sustainable supply chain mechanisms also help ensure that food resources are available, accessible, and stable over the long term by shaping production, logistics, and consumption patterns that are aligned with climate adaptation goals. When strong SSCPs support governance mechanisms, it is easier to see and measure the effects of policies on food security. This connects institutional governance with grassroots implementation. Thus, SSCPs are the way climate-smart governance makes real and lasting improvements in food security outcomes.

Proposition 4: Sustainable supply chain practices serve as intermediaries in the relationship between climate-smart governance and food security by converting policy and institutional frameworks into operational mechanisms that improve resilience, efficiency, and sustainability throughout food systems.

5. Conclusion and Recommendations

The study finds that climate-smart governance, sustainable supply chain practices, and food security are all very important parts of sustainable development. The main findings show that climate-smart governance sets the institutional and policy groundwork for climate adaptation and sustainability. However, the successful use of sustainable supply chain practices serves as the operational link that turns governance goals into measurable food security results. Theoretically, this study enhances the governance and sustainability literature by identifying the mediating role of sustainable supply chain practices within the climate-smart governance–food security framework. It combines Institutional Theory and the Resource-Based View to show how governance structures affect an organisation's abilities and the way the supply chain works, which in turn makes food more available, accessible, and stable. The findings provide practical guidance for policymakers, supply-chain managers, and agricultural stakeholders, underscoring the necessity of integrated governance, digital innovation, and stakeholder collaboration in the development of resilient food systems. This study is constrained by its narrative review methodology, which may inadequately represent the comprehensive range of emerging empirical evidence or regional disparities. Subsequent research ought to utilise quantitative or mixed-method approaches to empirically substantiate the proposed framework, evaluate cross-national disparities, and investigate the enduring impacts of digital transformation and circular economy principles on climate-smart food governance.

This study makes several important scholarly contributions. First, it advances conceptual understanding by positioning sustainable supply chain practices as a key mediating mechanism between climate-smart governance and food security, addressing a theoretical gap in existing sustainability and agri-food literature. Second, it synthesises previously fragmented knowledge from environmental governance, supply chain management, and food security into an integrated framework, offering a holistic perspective for future empirical exploration. Third, by combining Institutional Theory and the Resource-Based View, the study proposes a multidimensional theoretical model that explains how institutional structures interact with

organisational resources to drive sustainable food-system performance. Lastly, the study provides a comprehensive narrative synthesis that maps current research trends and identifies critical areas requiring further empirical validation, thereby guiding future scholarly inquiry.

Several policy implications arise from these findings. Policymakers should prioritise strengthening climate-smart governance structures by embedding climate adaptation, sustainability standards, and transparent monitoring mechanisms into national agricultural and food policies. In addition, governments should also incentivise the adoption of sustainable supply chain practices through targeted subsidies, digital infrastructure development, and capacity-building programmes, particularly for smallholder farmers and local SMEs. Integrated governance platforms that connect public agencies, private sector actors, and community-based organisations are essential to ensure coordinated responses to climate risks and supply-chain disruptions. Furthermore, investment in digital technologies such as traceability systems, early-warning climate analytics, and blockchain-based supply networks can significantly enhance supply-chain efficiency and accountability. Regionally inclusive policies should also be developed to reduce disparities in food-system resilience, particularly in climate-vulnerable rural areas. Ultimately, the study underscores that robust governance, aligned with sustainable operational practices, forms the backbone of resilient, secure, and climate-adaptive food systems.

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Assessing the Impact of Proposed Tourism Apps on The Development and Economic of SME Asnaf Businesses in Perlis: A Qualitative Analysis Based on Tourist Perceptions

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Abstract: The integration of tourism apps and the empowerment of *asnaf* entrepreneurs represent pivotal strategies in fostering sustainable economic development in Malaysia. Perlis has become one of the most visited states because of their natural beauty and unique attractions. By the year Visit Perlis 2024-2025, the state of Perlis has started the application of digital business, which is "Perlis Go Digital". This initiative has been done in order to encourage the *asnaf* entrepreneurs to change towards digitalization. One qualitative study has been conducted to explore the intersection of the proposed tourism apps and tourist perspectives to understand their collective impact on the sustainable economy of SME and *asnaf* development. The researchers collected data through interviews and analyzed it using thematic analysis. Thematic analysis is a widely used qualitative research method for identifying, analyzing, and reporting themes within interview data. This method is used to investigate how tourism apps shape tourist experiences. Findings indicate that tourism apps enhance the visibility and accessibility of SME *asnaf* businesses, and facilitate market expansion. However, the study reveals that while tourism apps provide convenience and personalized recommendations, issues like data accuracy can affect user satisfaction. By integrating the perspectives of tourists, this study contributes to the development of inclusive digital ecosystems that promote equitable economic growth of SME *asnaf* businesses and enhance the overall tourism experience.

Keywords: *Tourism apps, Asnaf entrepreneurs, Thematic analysis, Tourist perceptions, Perlis.*

1. Introduction and Background

The use of technology in business has become increasingly vital as modernization drives entrepreneurs to shift from traditional methods to advanced digital solutions. Many businesses today embrace digital transformation to stay competitive in a rapidly changing environment. This shift is particularly relevant in the context of tourism and small business digitalization. Ben Slimane et al. (2022) propose an integrative approach that synthesizes cross-disciplinary literature, aiming to understand how digitalization enhances business performance by broadening reach and providing innovative customer experiences in recent studies on the effects of digital transformation on SMEs. In this study, the researcher examines the mechanisms of tourism apps and their impact on the digitalization of small businesses, particularly focusing on *asnaf* entrepreneurs in Perlis.

Digital transformation in business is not only a trend but a necessary adaptation. The challenges faced by *asnaf* entrepreneurs in adapting to new technology due to limited resources and knowledge highlight the need for research on how digital technology influences business innovation models (Harun et al., 2024). However, initiatives like "Perlis Go Digital" aim to encourage digital practices among local entrepreneurs to help bridge these gaps. Through this program, Perlis promotes digital business solutions as a path for local businesses to thrive, aligning with government goals for economic modernization and inclusive growth. Prior research highlights the importance of integrated management strategies that support small and medium enterprises (SMEs) and expand access to digital financial services, thereby improving the visibility and sustainability of smaller businesses in the digital landscape (Sudiantini et al., 2023).

In light of the Visit Perlis 2024-2025 campaign, this study aims to assess how tourism apps can support the economy of *asnaf* entrepreneurs in Perlis. The campaign serves as an ideal period for reviewing the role of digital tourism initiatives and gathering insights to guide future efforts. Research reveals that smartphones and mobile applications have significantly altered the tourist experience, encouraging changes in tourist behavior and increasing social interaction, security, and engagement with local services (Dias & Afonso, 2021). By

examining the role of tourism apps, this study seeks to evaluate how such platforms can drive business performance and contribute to economic empowerment for *asnaf* entrepreneurs.

This study employed a qualitative approach to explore the intersection of the proposed tourism apps and the tourist perspectives to understand their experiences, views, and recommendations regarding the use of tourism apps on the sustainable economic of SME and *asnaf* development in Perlis. Previous research indicates that a qualitative research approach is particularly effective in exploring the complex relationship between decision-makers' perceptions of digital technologies and their adoption within micro-enterprises, as it allows for an in-depth understanding of personal, internal, external, and developmental factors that influence decision-making, which may not be fully captured by quantitative studies (Andersson & Tilly, 2024). Through this approach, the researcher aims to provide a comprehensive understanding of the tourist perspectives on the impacts of tourism mobile applications towards the development of SME and *asnaf* businesses in Perlis.

Finally, the findings from this study will be presented to stakeholders, offering insights into ways to further strengthen the digital economy for *asnaf* entrepreneurs in Perlis. By aligning tourism app mechanisms with the unique needs of these entrepreneurs, this study aims to support sustainable business growth and improved economic outcomes in the region. Ultimately, the research will contribute valuable recommendations for developing an effective tourism app strategy that benefits both the tourism sector and local *asnaf* businesses.

2. Literature Review

The Impact of App Development on SME *Asnaf* Economy

The impact of mobile applications on the *asnaf* economy, referring to businesses owned by or supporting individuals in the *asnaf* category, has been significant in driving economic empowerment and fostering social inclusion. In recent years, digital platforms and mobile apps have played a pivotal role in enhancing access to resources, boosting business visibility, and offering training and networking opportunities for *asnaf* entrepreneurs. These apps equip *asnaf* entrepreneurs with essential tools to launch and grow their businesses, including e-commerce platforms, business management solutions, and digital marketing resources. By utilizing these technologies, *asnaf* entrepreneurs can tap into broader markets and compete more effectively. Additionally, apps provide a platform for *asnaf* individuals to sell their products and services, helping them generate income and improve their livelihoods.

According to Meerangani et al. (2022), digital platforms such as social media can influence the entrepreneurial and business segments in a more structured and widespread manner. Thus, the high level of literacy and digital participation among entrepreneurs can significantly affect the competitiveness and improvement of performance and innovation of an enterprise (Olanrewaju et al., 2020). According to Omar et al. (2020), digital technology is a platform that can increase the marketability of a product and innovation on the global level. Meerangani et al. (2022) also stated that the optimal use of social media and digital technology can increase the revenue and productivity of a sale. More than 50 million businesses use business pages on social media platforms such as Facebook and Instagram through direct sales. This strategy has provided encouraging return value as nearly 60 percent of social media users were inclined to follow, subsequently making purchases online (Meerangani et al., 2022).

According to Omar (2023), financial technology such as mobile banking offers many advantages to users, specifically among *asnaf* entrepreneurs. It depends on their technology expertise and spirit for *asnaf* entrepreneurs to overcome the obstacles in the business world. The *asnaf* entrepreneur can use fintech in various ways, such as online banking, e-wallets, Boost, and PayPal. The study found that traditional banking services are difficult to access in rural areas where asnaf entrepreneurs are often located in inadequate physical bank infrastructure (Van Klyton et al., 2021). Thus, respondents said that mobile banking provided a viable alternative with easy access to financial services, and they were able to save time and money (Das, 2019). Given the specific features of rural areas, such as a lack of infrastructure, a scattered population size, and communication obstacles, accessing *asnaf* entrepreneurs can be difficult. However, *asnaf* entrepreneurs can reach customers outside their local region using mobile banking. The number of customers could rise if *asnaf* entrepreneurs are willing to accept digital payments via mobile banking. Following the use of mobile payment systems, *asnaf* entrepreneurs who operate small businesses experienced an increase in earnings (Omar, 2023).

Mobile applications have allowed *asnaf* entrepreneurs to access broader markets by enabling them to sell products and services online. Platforms such as Lazada, Shopee, PG Mall, and others provide low-barrier entry points for small businesses, including those owned by individuals in the *asnaf* group. These apps facilitate the listing, marketing, and sales of goods, thereby increasing the market reach of *asnaf* entrepreneurs who may otherwise struggle with traditional, offline distribution channels. *Asnaf* entrepreneurs can reach a national or even global customer base, significantly boosting sales and profitability. Moreover, many of these platforms offer integrated payment systems, logistics, and marketing tools, which reduce the complexity of setting up an e-commerce business. A study by the ASEAN Digital Economy Report 2023 notes that platforms like Shopee and Lazada have been instrumental in helping small businesses, including those from underprivileged backgrounds, access digital commerce (ASEAN Secretariat, 2023).

The Impact of App Development in the Tourism Sector

Among the business apps, travel applications are the seventh most popular category of most downloaded apps, and 60% of travellers choose to use mobile apps while traveling (Abdul Rashid et al., 2020). They stated that there are six indicators of mass media use influencing the selection of tour destination, namely: the destination of the tour visit, transportation, accommodation, food, and tourism activities such as shopping and leisure activities. Many studies have identified the impact of using mobile applications in smoothening a tour, but on the other hand, there is still a lack in other studies in highlighting the weaknesses and shortcomings of mobile applications in a tour session (Abdul Rashid et al., 2020).

Abdul Rashid et al. (2020) found that the use of mobile applications greatly contributed to the smoothness of their travel. Mobile applications in tourism have become a necessity in the tourism sector. With the availability of mobile applications, all accommodation arrangements, e-banking services, destination location navigation, transportation, including flight tickets, entry tickets to any tourist or recreational destinations can be made online, stated to Abdul Rashid et al. (2020). Transportation bookings around travel destinations can also be booked via mobile applications, destination information is also accessible, and food can also be booked online without having to visit the restaurants (Abdul Rashid et al., 2020).

Recent studies by Razeeth et al. (2023) and Stefanov et al. (2023) highlight that mobile apps enhance tourist satisfaction by providing seamless access to information and services like travel guides, maps, and booking platforms, enabling efficient trip planning. Additionally, research by Benedek and Szöllősi (2022) indicates that the use of mobile apps significantly influences tourists' decision-making processes, increasing the likelihood of them visiting a destination. These apps not only save time but also enhance the overall tourist experience by addressing various information needs instantly, as seen in the study by Kadam and Sen (2023). The evolving role of smartphones in tourism signifies the immense potential of mobile applications in transforming and enriching tourists' interactions with destinations.

Nordin et al. (2023) stated that the mobile tourism application nowadays can be said as the most efficient application that is able to ease travellers' travel. Travel apps help users to research destinations, find good flight and accommodation deals, and book services which can be called m-Travelling. M-Travelling can be defined as the use of applications developed for mobile devices to aim at a person or a group of people during a tour in a place. Thailand, Indonesia, and Singapore have all emphasized the need to put their tourism information into a mobile app rather than a website (Nordin et al., 2023).

Albayrak et al. (2023) examined the quality of mobile travel apps and how application quality and brand trust affect intention to use. They found that perceived usefulness, ease of use, and trust significantly drive app adoption and enhance tourists' booking behaviors. Additionally, Sia et al. (2023) conducted a systematic review of travel apps and highlighted smart features like geolocation services, itinerary personalization, and real-time content. These features enhance user satisfaction and loyalty but face challenges tied to privacy, cost, and infrastructure limitations. Recent research by Song et al. (2024) on mobile Augmented Reality (AR) adoption in tourism reveals that AR apps boost customer engagement and usage behavior, especially when designed with interactivity, vividness, and relevant content. However, adoption remains low in many developing regions due to limited awareness and security concerns.

3. Research Methodology

This study employed a qualitative approach to explore the intersection of the proposed tourism apps and the tourist perspectives to understand their experiences, views, and recommendations regarding the use of tourism apps on the sustainable economic development of SME and *asnaf* development. A semi-structured interview that combined structure and flexibility has been employed in order to allow the researcher to provide guidance on appropriate aspects, and also allow the respondents to elaborate on aspects they perceived to be important. The guided, structured interview is organized into four main sections:
Section A: Experience Using the Application
Section B: Perceptions of the Application's Functionality
Section C: Satisfaction and Suggestions for Improvement
Section D: Effects on Tourist Behaviour and Perception

These four main sections were intentionally structured to offer a comprehensive view of how the application is used, perceived, and impactful on both among users and within the broader local tourism context. The interviews were carried out with nine particularly chosen respondents among the tourists from three major Perlis tourism areas, which are Kangar, Arau, and Padang Besar. In total, there were 9 respondents involved in this study. This sample size is sufficient based on the three major Perlis tourism areas. The distribution of feedback for each section of the interview questions is shown in Table 1.

Table 1: The Distribution of Feedback

Interview questions section	Number of feedback
Section A: Experience Using the Application	12 feedbacks
Section B: Perceptions of the Application's Functionality	12 feedbacks
Section C: Satisfaction and Suggestions for Improvement	11 feedbacks
Section D: Effects on Tourist Behaviour and Perception	8 feedbacks

The researcher used thematic analysis, a widely accepted method in qualitative research for identifying, exploring, and reporting patterns in data. Data was analysed using Atlas. TI version 24 software. The Atlas. ti version 24 was utilized in this context to efficiently organize, code, and analyze qualitative interview data. It enabled the researcher to categorize substantial segments of the interview texts using specific codes, organize those codes into themes, and map connections between concepts. The software made it easier to manage large volumes of text, identify patterns in responses, and ensure a structured and transparent analysis process. By using Atlas. ti, The researcher could efficiently turn raw feedback into meaningful insights about how the tourism application supports *asnaf* businesses in Perlis.

Figure 1: Atlas.ti version 24

The data analysis process began with verbatim transcription of interview audio recordings, then proceeded by coding, which is the labelling of specific data segments with labels that capture their content. These codes were then sorted and categorized into broader themes, which are Application Usage, Benefits, Feedback, Suggested Improvements, and Effects of Usage. The data was coded based on the interview feedback collected by the researcher. Then, the data was analysed according to the codes and themes developed as shown in Figure 2. Themes from each interview response were assigned the same colour codes to ease interpretation. Figure 3 shows the network of themes of the five themes that have been coded with the same colour codes.
Green – Experience Using the Application
Brown – Perceptions of the Application's Functionality

Pink – Satisfaction and Suggestions for Improvement
Red – Effects on Tourist Behaviour and Perception

In Section A: Experience Using the Application, the researcher provides two questions. The first question is "*Boleh ceritakan pengalaman anda menggunakan aplikasi pelancongan untuk merancang lawatan?*" and the second question is *"Mengapa anda memilih untuk menggunakan aplikasi ini berbanding cara tradisional seperti bertanya kepada penduduk atau menggunakan peta bercetak?".* There are 12 feedbacks that have been analyzed and coded based on the common theme from all the nine respondents.

Furthermore, in Section B: Perceptions of the Application's Functionality, the researcher provides three questions. The first question is *"Sejauh mana maklumat yang anda terima melalui aplikasi ini membantu anda? Adakah maklumat tersebut cukup jelas, lengkap, dan boleh dipercayai?",* the second question is *"Bagaimana pengalaman anda menggunakan pautan ke Waze atau Google Maps melalui aplikasi tersebut? Adakah ia membantu perjalanan anda menjadi lebih mudah?"* and the third question is *"Pada pendapat anda, adakah aplikasi pelancongan seperti ini dapat membantu meningkatkan ekonomi perniagaan tempatan seperti kedai makan, homestay, pemandu pelancong, dan usahawan asnaf? Boleh berikan contoh?".* There are 12 feedbacks that have been analyzed and coded based on the common theme from all the nine respondents.

Besides that, in Section C: Satisfaction and Suggestions for Improvement, the researcher provides two questions. The first question is *"Apakah aspek yang paling anda suka tentang aplikasi ini?"* and the second question is *"Apakah kekurangan yang anda perasan? Apakah cadangan anda untuk memperbaiki aplikasi ini supaya lebih berguna kepada pelancong dan peniaga tempatan?".* There are 11 feedbacks that have been analyzed and coded based on the common theme from all the nine respondents.

In Section D: Effects on Tourist Behaviour and Perception, the researcher provides two questions. The first question is *"Adakah aplikasi ini mempengaruhi keputusan anda untuk memilih lokasi tertentu semasa melancong? Jika ya, bagaimana?"* and the second question is *"Pada pandangan anda, jika penggunaan aplikasi ini membantu meningkatkan ekonomi peniaga asnaf dan komuniti tempatan, adakah ia akan membuatkan anda lebih berminat untuk terus menggunakan aplikasi ini atau melawat lokasi tersebut? Mengapa?".* There are 8 feedbacks that have been analyzed and coded based on the common theme from all the nine respondents.

Figure 2: The Development of Codes and Themes

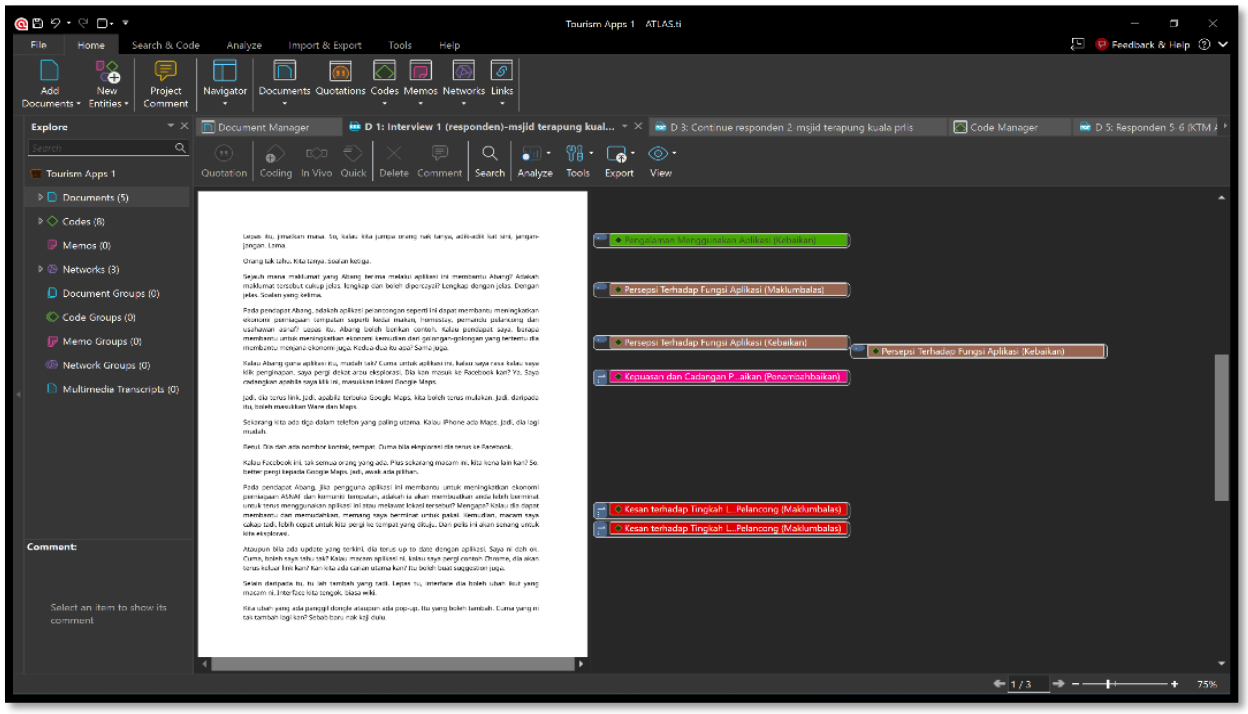
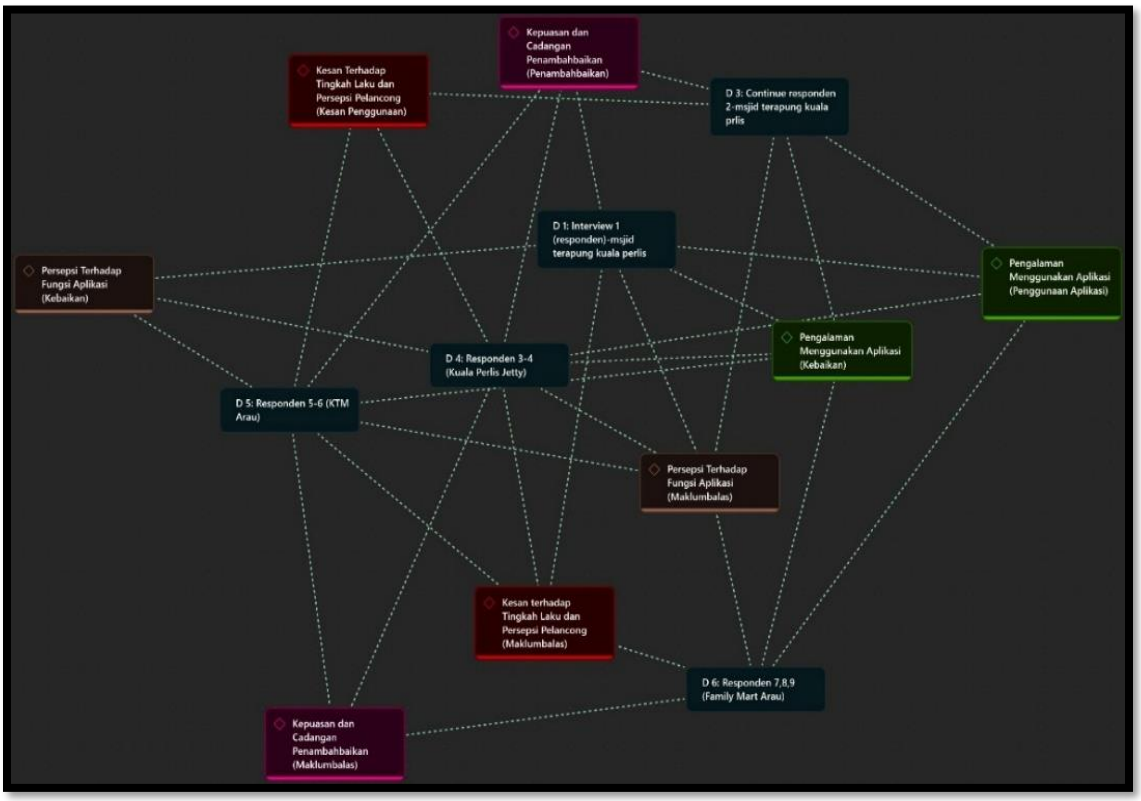


Figure 3: The Network of Themes



4. Results and Discussion

Results

The details of data analysis coding are summarised in Table 2. There are five main themes, which are Application Usage, Benefits, Feedback, Improvements, and Effects of Usage, that can be coded from the interview feedback of the respondents. In Section A: Experience Using the Application, there are two main themes that have been coded, which are Application Usage and Benefits. From the analysis results, it can be seen that most of the respondents are used to using mobile applications during their travel, such as Agoda and Trip.com. In addition, the respondents also mentioned that by using the mobile application, their journey becomes more convenient and can also help them save time.

In Section B: Perceptions of the Application's Functionality, two main themes have been coded. First, the Feedback. In this section, the researcher asked the respondents for their feedback about the functionality of the proposed tourism mobile application. From the interview, most of the respondents agreed that all the information available in the proposed tourism mobile application is clear, complete, and reliable. Second, the Benefits. In this part, the researcher asked the respondents about the benefits of using tourism mobile applications towards the SME *asnaf* economy. Most of the respondents agreed that by using the tourism mobile application, the SME *asnaf* economy can also be developed.

Besides that, in Section C: Satisfaction and Suggestions for Improvement, there are two main themes that have been coded, which are Feedback and Improvements. This section consists of questions that ask about the satisfaction of the proposed tourism mobile application and also the suggested improvements that can be made in order to improve the functionality of the mobile application. Based on the analysis, the respondents agreed that the mobile application provides specific information with pictures, which makes the mobile application more appealing. However, there are a few suggestions for improvements that can be highlighted. First, the respondents suggest that the researcher insert the maps or location of the place into the mobile apps. Second,

the respondents also suggest inserting a video and a rating of the place in the mobile apps, so they can have the initial impression about the place before traveling.

In the last section, which is Section D: Effects on Tourist Behaviour and Perception, there are two themes that have been coded, which are Effects of Usage and Feedback. In this section, the researcher asked about the effects and feedback of using tourism mobile applications towards the development of the SME *asnaf* economy. Most of the respondents agreed that the use of the tourism mobile application can help to improve the economy of SME and *asnaf* entrepreneurs in Perlis. With the existence of this mobile application, it can be one of the alternatives that can be used by the SME *asnaf* entrepreneurs to promote their product worldwide.

Profile of Respondents: Table 1 displays a summary of the characteristics of the total sample of customers or subscribers who participated in the study.

Table 2: Data Analysis of The Interview Feedback

Themes	Subthemes
Section A: Experience Using the Application (2 Themes)	
Application Usage	a) *"Saya akan guna Google Maps dengan, untuk penginapan, Agoda."* b) *"Selalunya guna aplikasi Google, Google map, mencari hotel tu guna Google booking."* c) *"Selalunya kalau datang Perlis ni kalau nak senang, tengok TikTok lah."* d) *"Saya guna aplikasi seperti Agoda untuk check booking hotel di mana murah, di mana lebih mahal semua."* e) *"Trip.com ke Agoda. Kalau saya, bila ada aplikasi ini, kita jadi macam, kita punya persiapan kita tu tak kalut."*
Benefits	*"Jimatkan masa."* *"Lagi senang lah kalau nak cari maklumat dan semua tu pakai Google dan semua tu."* *"Saya rasa aplikasi ini adalah aplikasi yang dipercayai."* *"Menurut saya, ini lebih mudah."* *"Tersuai dengan perkembangan teknologi."* *"Mudah lah, lagi mudah untuk pakai internet kan."* *"Macam bila kita ada aplikasi ni, kita macam, kita tak menyusahkan orang lain."*
Section B: Perceptions of the Application's Functionality (2 Themes)	
Feedback	*"Lengkap dengan jelas."* *"Tapi still ada some information tu yang orang kata apa, reliable lah."* *"Still ada information dia boleh percaya."* *"Saya percaya maklumat ni cukup jelas, lengkap dan boleh dipercayai."* *"Tak berapa lengkap bagi saya."* *"Bagi saya, memudahkan lah. Memudahkan lah. Lagi cepat lah kan."* *"Sangat mudah because nowadays orang dah tak kenal jalan tau."* *"Dia bagi kita alternative route yang memang helps us untuk accommodate dengan kita punya plan, travel plan."*
Benefits	*"Membantu untuk meningkatkan ekonomi."* *"Membantu menjana ekonomi juga."* *"Yes, mestinya boleh membantu meningkatkan ekonomi semua tu."* *"Dapat membantu meningkatkan ekonomi perniagaan."*
Section C: Satisfaction and Suggestions for Improvement (2 Themes)	
Feedback	*"Saya paling suka the fact kat dia provide gambar-gambar tempat tu."* *"Jika orang terdekat kita tidak tahu tentang Perlis. Sekurang-kurangnya ada aplikasi ini yang boleh membantu kita. Kita ada aplikasi yang boleh tahu tentang Perlis."* *"Dah bagi contoh-contoh dari segi tempat makan."*

	"Dekat aplikasi ni, dia dah spesifik kan." *"Benda ni bagi maklumat yang jelas lah kat kita."*
Improvements	*"Saya cadangkan apabila saya klik ini, masukkan lokasi Google Maps."* *"Kalau boleh tempat makan terus letak map ke. Ataupun letak view ke."* *"Letak review terbaik tinggi ke."* *"Boleh cuba tambahkan video lagi."* *"Cadangan saya ialah maybe boleh letakkan review juga sekali."* *"Kalau boleh, kita tekan tempat makan tu. Kalau dia bagi direction terus, tak apa."*
Section D: Effects on Tourist Behavior and Perception (2 Themes)	
Effects of Usage	*"So maksudnya akan membantu-bantu juga orang-orang asnaf tu. Menjadi pendapatan lah."* *"Ya, dia membantu saya untuk buat decision dalam saya punya pelancongan sebabnya kalau saya tahu tempat ni macam tak best, saya tak nak nak pergi kan macam bazir masa kan."* *" Quite mudah jugalah. At least tak payah try nasib."*
Feedback	*" Kalau dia dapat membantu dan memudahkan, memang saya berminat untuk pakai."* *"Dan Perlis ini akan senang untuk kita eksplorasi."* *"Bagi saya memang perkara tu akan buat saya lebih ingin menggunakan aplikasi ni sebab saya percaya peniaga-peniaga tempatan semua mereka wajar disokong oleh bukan hanya orang tempatan tapi juga orang luar yang ingin melancong tempat-tempat tersebut."* *"Sebab at least saya tahu dengan kita gunanya aplikasi ni. Kita akan dapat bantu juga."* *"Pada saya, semestinya lah dia macam bila ada benda-benda gini. Sebab dekat sini dia dah ada list dah."*

Discussion

The findings revealed that the majority of respondents reported using popular tourism mobile apps such as Agoda, Trip.com, and Google Booking before their trips, reflecting a high level of familiarity and comfort with digital travel tools. They also strongly agreed that these mobile apps made their journeys smoother, reducing planning effort, enhancing convenience, and saving valuable time. A study conducted by Şeker et al. (2021) with Turkish travellers confirms that the use of tourism apps can be perceived as time-saving**,** money-saving**,** and convenient**.** Similarly, Tan et al. (2025) also reported that smart devices streamline planning, cut waiting times, and facilitate synchronized travel arrangements, with real-time information notably enhancing trip efficiency. These findings also align with previous research by Razeeth et al. (2023) and Stefanov et al. (2023) that highlights the role of mobile technology in improving tourist satisfaction and engagement.

In addition, the respondents overwhelmingly affirmed that tourism mobile apps help stimulate the economy of *asnaf*-led SMEs in Perlis by exposing local entrepreneurs to broader tourist markets via app-based bookings and promotions and facilitating visibility and sales for *asnaf entrepreneurs* offering local products and services. These observations align with Abdul Rahim et al. (2023) findings that *asnaf entrepreneurs* in Perlis have successfully incorporated digital platforms such as social media, websites, and delivery apps into their business models, leading to improved outreach and economic outcomes. Besides that, this finding also aligns with a previous study by Hninn et al. (2025). They used structural equation modelling on Malaysian tourism SMEs to show that digital transformation via mobile tools enhances business resilience, and that value creation mediated the relationship between digital capabilities and resilient operations**,** particularly for smaller tourism firms facing market volatilities. Ditta-Apichai et al. (2020) in their study highlighted that online-mediated tourism platforms connecting tourists with local micro-entrepreneurs (especially in rural areas) foster economic independence, job creation, and community empowerment, critical for sustainable tourism micro-businesses.

5. Limitations and Recommendations

As with all empirical studies, it is essential to acknowledge its limitations. Chief among them is the small sample size (n = 9 tourists), which restricts the generalizability of the findings and may not adequately reflect the broader tourist population. Despite this constraint, this study offers valuable preliminary insights. Future research involving larger, more diverse samples is needed to validate and expand upon these findings.

Second, participant selection was limited to tourists, which may introduce bias and overlook perspectives from other relevant groups. To address this, future research should include respondents from among *asnaf* entrepreneurs to gain a deeper understanding of their perceptions toward the proposed tourism application. Such a study would provide a more comprehensive view of the app's potential impact and usability within this specific community.

Third, his study is based solely on qualitative insights into tourist perceptions, which limits empirical validation of economic outcomes. Therefore, future research should adopt a mixed-methods approach to capture nuanced perspectives while quantitatively examining correlations between the proposed tourism mobile application and *asnaf* economic performance.

Conclusion

This study explored how a proposed tourism mobile app shapes tourists' experiences, perceptions, and its potential to support sustainable economic growth for *asnaf* SMEs. By employing semi-structured interviews, which balanced focused guidance with opportunities for the respondents to elaborate on insights. The guided, structured interview is organized into four main sections. First, Section A: Experience Using the Application**.** The majority of the respondents were already familiar with apps like Agoda and Trip.com, finding them convenient and time-saving. Second, Section B: Perceptions of Functionality. Respondents found the app's information to be clear, reliable, and comprehensive, reinforcing their confidence in its utility and its capacity to stimulate *asnaf* SME growth. Third, Section C: Satisfaction & Improvement Suggestions. High satisfaction was expressed, especially regarding visuals. Respondents suggested improvements such as embedded maps, videos, and user ratings to enrich usability and trust. Lastly, Section D: Behavioral Effects & Tourist Perceptions. The app's role in empowering *asnaf* entrepreneurs was widely recognized, particularly its ability to raise global visibility and provide a platform for SME asnaf product promotion.

These findings align with broader research on smart tourism, which emphasizes integrated digital ecosystems that consist of clear information, real-time updates, and user-centric design in order to enhance tourist experiences and support local economic development. Furthermore, user-centred design frameworks for AR-enhanced tourism apps have demonstrated how iterative feedback loops ensure both usability and stakeholder engagement. Taken together, the thematic and interview findings confirm that tourism mobile applications not only improve traveller experience through efficiency and seamless planning but also act as catalysts for *asnaf* SME economic growth in Perlis. By facilitating global visibility and smoother customer engagement, these digital tools align with established models of app adoption, namely, perceived usefulness, and underscore the broader socio-economic impacts that can be achieved through thoughtful app design and regional development strategies.

In summary, the proposed tourism app meets tourists' demands for convenience and clarity while actively promoting *asnaf* SMEs, encapsulating the dual goals of enhancing traveller experience and fostering economic inclusion. Future work should focus on implementing and evaluating interactive features, for example, maps, media, reviews, and testing their real-world impact on SME visibility, tourist satisfaction, and regional economic resilience.

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The Impact of Employees' AI Acceptance on Productivity in the Construction of Smart Hospitals: The Mediating Role of Collaboration

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Abstract: Against the backdrop of China's smart-hospital initiative, this review examines how frontline employees' AI acceptance translates into productivity. Synthesizing 31 empirical studies published between 2020 and 2024 across clinical and managerial settings, the evidence is synthesized and organized around four acceptance dimensions—awareness, understanding, trust, and skills—as framed by the Technology Acceptance Model (TAM), Protection Motivation Theory (PMT), and Person–Environment Fit (PE Fit) theory. Across studies, understanding and trust are most consistently linked with faster decisions and higher service quality; skills underpin effective workflow integration. Crucially, employee-AI–AI collaboration mediates these effects in most samples, converting favorable mind-sets into operational gains via shared diagnosis, decision support, and scheduling optimization. We discuss boundary conditions (leadership, culture, prior experience) and propose an integrated pathway from acceptance to collaboration to productivity. The review provides a conceptual baseline for an upcoming large-scale survey and offers actionable recommendations: prioritize trust-building, formalize collaboration protocols, and invest in continuous AI-skilling to fully realize AI's potential for enhancing productivity in smart hospitals.

Keywords: *AI acceptance, employee productivity, smart hospitals, employee-AI collaboration, Technology Acceptance Model.*

1. Introduction and Background

In recent years, China's healthcare sector has entered a period of profound digital transformation, driven by the state-led "smart hospital" initiative. This transformation has culminated in policy frameworks such as the National Health Commission's 2023 "Trinity" policy, which elevates smart medicine, smart services, and smart management as the pillars of hospital modernization (Zhang et al., 2023). The deployment of artificial intelligence across diagnostic, clinical, and operational processes has already begun to demonstrate measurable improvements in efficiency, workload reduction, and care quality (Hou et al., 2024). Yet, the realization of these benefits is by no means automatic; it depends fundamentally on the extent to which frontline clinicians—including physicians, nurses, and technicians—adopt and effectively integrate AI technologies into their everyday work.

Employee acceptance of AI is widely conceptualized as comprising four interlinked and sequential conditions: awareness of AI's existence, understanding of its functioning and limitations, appropriate trust in its outputs, and the technical and adaptive skills required for effective use (McGrath et al., 2025). Only when these four conditions are achieved does AI adoption begin to yield productivity benefits, which in this context refers to both the efficiency of clinical and administrative tasks and the quality of care delivered per unit of resources. Yet, the relationship between AI acceptance and productivity is not direct; it is realized primarily through the emergence of high-quality human–AI collaboration in daily hospital workflows (Stevens & Stetson, 2023).

Collaboration in this context denotes a synergistic partnership, where human clinical expertise and algorithmic analytics are integrated through calibrated trust, shared understanding, and clear role division(Baroni et al., 2022). Such partnerships produce gains in diagnostic accuracy, decision speed, and patient throughput that exceed what either humans or AI could achieve alone. This review, therefore, investigates how frontline employees' AI acceptance shapes productivity in China's public smart hospitals and examines employee-AI–AI collaboration as a mediating mechanism (Rafi et al., 2024). By integrating insights from the Technology

Acceptance Model (TAM), Protection Motivation Theory (PMT), and Person–Environment Fit (PE Fit) theory, this review explains how technological perceptions, psychological motivations, and contextual fit jointly shape collaboration and productivity outcomes. The findings are intended to guide hospital leaders and policymakers in designing training, change-management and policy interventions that can translate substantial AI investments into measurable performance improvements at the clinical frontline.

2. Literature Review

The Evolution of Productivity Measurement in Smart Hospitals: The conceptualization of employee productivity within healthcare, particularly in Chinese tertiary public hospitals, has evolved significantly in recent decades. Initially, the assessment of productivity focused on simple quantitative outputs such as patient throughput, bed occupancy rates, and the volume of procedures performed (Kong et al., 2021). These early measures were shaped by the imperatives of operational efficiency and were rooted in managerial approaches that viewed productivity through the lens of task completion rates and resource utilization.

However, as the complexity of healthcare delivery increased and patient-centered care approaches became more prominent, it became clear that relying solely on quantitative metrics proved inadequate. The limitations of traditional indicators were exposed as hospitals adopted more sophisticated technologies and became increasingly aware of the need to balance operational efficiency with quality of care (Wang et al., 2023). As a result, newer frameworks emerged that incorporate service quality, resource utilization, and the effectiveness of technological integration as integral and coequal dimensions of productivity (Wang et al., 2023). The transformation of productivity measurement thus reflects both advances in clinical practice and the strategic imperative to integrate digital tools such as AI into core hospital workflows.

Consequently, a multidimensional perspective on productivity has emerged of productivity in healthcare settings. Technical efficiency, for example, now measures not only how effectively resources are allocated but also the extent to which AI-enabled systems, such as scheduling and triage algorithms, enhance operational performance (Chowdhury et al., 2022). Service quality metrics, meanwhile, have become integral to productivity assessment, encompassing clinical outcomes, patient satisfaction, error reduction rates, and the timeliness of care delivery (Jiang et al., 2023). In modern productivity frameworks, qualitative and quantitative indicators are combined—often through balanced scorecards—to capture the full spectrum of what it means for employees to be productive in a smart hospital environment (Tian et al., 2024).

The integration of Artificial Intelligence (AI) has been a decisive catalyst in the latest phase of this evolution, facilitating a paradigm shift from human-centric efficiency to a model that values the integration of human and algorithmic capabilities. Contemporary studies indicate that when AI is properly implemented, it can improve both the efficiency of processes and the quality of outcomes. For example, AI-based diagnostic support has been shown to improve accuracy, while AI-driven scheduling tools can increase facility utilization rates by up to 35%, while maintaining, or even enhancing, standards of patient care (Kumar & Mittal, 2024). This dual emphasis on efficiency and quality reflects the increasing sophistication of healthcare delivery and highlights the importance of collaborative frameworks that integrate AI into clinical practice (Kong et al., 2023).

Importantly, healthcare-specific considerations introduce unique challenges into productivity measurement. The critical and complex nature of medical services means that indicators must be sensitive to patient safety standards, professional guidelines, and ethical concerns (Simón et al., 2024). The inclusion of AI adds yet another layer of complexity, demanding that productivity measures account for both technological efficiency and the preservation of professional autonomy and clinical expertise. This comprehensive framework thus provides the foundation for analyzing how different dimensions of AI acceptance influence productivity outcomes in healthcare environments.

The Dimensions of AI Acceptance and Their Effects on Productivity: The relationship between AI acceptance and productivity is multifaceted and dynamic, with recent empirical work highlighting four primary dimensions: awareness, understanding, trust, and skills. Each dimension exerts direct and indirect effects on employee productivity, often mediated by collaborative mechanisms.

AI Awareness: As a foundational dimension refers to employees' recognition of AI's presence in their work environment and their understanding of its potential to reshape clinical practice and service delivery (Bai et al., 2024). Studies have shown that heightened AI awareness can significantly influence work behaviors and productivity, primarily by enabling professionals to identify and leverage opportunities for AI augmentation in their daily tasks (Ding, 2021). However, awareness is not always uniformly positive; while it can foster innovation and intrinsic motivation, it can also generate performance anxiety and emotional strain—especially in environments where support systems are weak or organizational change is poorly managed (Liang et al., 2022).

The relationship between AI awareness and productivity is further shaped by the availability of organizational support, the nature of job crafting, and career development opportunities. Enhanced awareness has been linked to improved service performance, adaptivity, and greater career competencies, especially in settings where technological competence is central to effective service delivery. (Kong et al., 2021). Moreover, the effect of AI awareness on productivity tends to deepen over time as professionals gain experience with new systems, indicating a temporal dimension to acceptance (Wang et al., 2023). Individual differences such as age, professional role, and prior experience also moderate the awareness–productivity link, with younger or more adaptable staff often achieving productivity gains more rapidly (Marikyan et al., 2022). Significantly, research has revealed that AI awareness enhances not only individual productivity but also collaborative practices, leading to stronger team performance in coordinated care environments (Kumar & Mittal, 2024).

AI Understanding: The second dimension, AI understanding, encompasses deep knowledge of AI systems' functionalities, limitations, and practical applications in the clinical context (Pinski et al., 2023). Professionals with a high degree of understanding are better positioned to integrate AI tools into their practice, optimize system usage, and make informed decisions about when and how to rely on algorithmic support. (Theis et al., 2023). This capability is associated with improvements in task efficiency, reduced error rates, and the capacity to leverage AI for complex problem-solving and decision-making tasks (Kumar & Mittal, 2024).

AI understanding also contributes to enhanced confidence in system use, which in turn leads to faster and more effective decision-making (F. J. Wang et al., 2023). As healthcare professionals develop a deeper understanding of AI capabilities, they become more adept at integrating new technologies into existing workflows, thereby streamlining operations and improving patient care (Simón et al., 2024). This dimension further enables error prevention, adaptive capacity, and collaborative practices—each of which plays a vital role in boosting productivity, especially in the context of complex clinical tasks (Weisz et al., 2024).

AI Trust: The third dimension, trust in AI, constitutes a prerequisite for effective and productive system utilization. Trust entails confidence in the reliability, transparency, and clinical appropriateness of AI outputs (Marikyan et al., 2022). When professionals trust AI, they are more willing to incorporate algorithmic insights into clinical judgement and decision-making, accelerating workflow processes without sacrificing accuracy (Kerasidou et al., 2022). Trust in AI has also been associated with greater resource utilization, well-being, and job satisfaction, particularly in environments where AI is integrated deeply into work routines (Kumar & Mittal, 2024).

Yet, the development of trust must be carefully managed. Excessive trust can be equally problematic as distrust, particularly if it leads to complacency or uncritical acceptance of AI recommendations (Kerasidou et al., 2022). Research has shown that the most effective trust-building strategies are those that balance transparency, reliability, and consistent system performance, while also maintaining professional oversight and autonomy (Cadavid et al., 2024). Organizational culture, professional experience, and previous exposure to technology all play moderating roles in how trust is translated into productivity (Khaksar et al., 2023).

AI Skills: The final dimension, AI skills, refers to the technical and adaptive competencies required for effective engagement with AI systems. The development of these skills is associated with higher productivity across a range of healthcare contexts, including diagnostic imaging, laboratory medicine, and other technology-intensive specialties (Chuang, 2024). Advanced AI skills empower healthcare professionals to make more informed decisions, integrate AI-generated insights with clinical expertise, and respond effectively to technological change (Chowdhury et al., 2023).

Importantly, organizations that invest in both technical and adaptive skill development tend to realize the greatest productivity gains, highlighting the importance of a balanced and sustained approach to training and professional development (Wang et al., 2024) . These findings underscore the fundamental role of AI skills in enabling healthcare professionals to fully leverage the capabilities of smart hospital technologies.

3. Review Methodology

A structured literature search was conducted (2020–2024) across multidisciplinary databases in health management and information systems to identify empirical studies linking AI acceptance to employee productivity in hospital settings. The search strategy incorporated terms related to acceptance constructs ("awareness", "understanding/knowledge", "trust", "skills/training"), mediating factors ("collaboration", "human-AI teaming"), and outcomes ("productivity", "efficiency", "quality of care"). The inclusion criteria comprised: (i) peer-reviewed empirical studies or systematic reviews in English; (ii) hospital or clinical workforce context; (iii) explicit measures of at least one acceptance dimension and productivity-related outcomes; and (iv) clear analytic links to collaboration or teaming where applicable. Exclusion criteria encompassed opinion pieces, editorials, and studies with purely technical model performance without workforce outcomes. Two reviewers screened titles/abstracts and then full texts, resolving discrepancies through consensus discussion. Data extraction focused on design, setting, sample, constructs, measures, and principal findings. Thirty-one high-quality empirical articles were selected for synthesis for synthesis while retaining broader background evidence to map theoretical consistency (TAM, PMT, and Person–Environment Fit). The study selection process is illustrated in the PRISMA flow diagram (Figure 1).

Figure 1: PRISMA Flow Diagram for Literature Screening

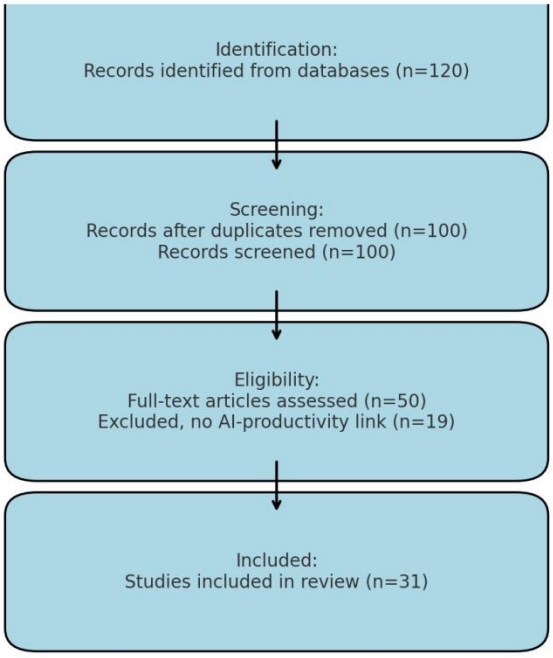


Figure 1 presents the PRISMA flow diagram describing the systematic screening process for relevant studies. Out of 120 initially identified records, 31 studies met the inclusion criteria, providing the empirical basis for the review and analysis.

4. Results and Discussion

Employee–AI Collaboration: The Key Mediator

While each dimension of AI acceptance exerts an independent effect on productivity, research has consistently demonstrated that these relationships are significantly mediated by the quality of employee-AI–AI

collaboration. The development of effective collaboration is now recognized as a critical pathway for achieving the productivity benefits of AI in healthcare settings.

Foundations of Collaboration: Collaboration between employees and AI systems is more than a matter of technological coexistence; it is a complex, adaptive partnership shaped by mutual awareness, shared goals, and role complementarity (Chandio et al., 2024). Studies have shown that healthcare professionals with enhanced awareness of smart technologies are more proactive in engaging with AI systems, especially when organizations provide strong support and foster a collaborative spirit (Kong et al., 2021). The depth of AI awareness—whether it is superficial or includes practical knowledge—determines the effectiveness of collaborative relationships (Wang et al., 2023).

Organizational factors, such as leadership style, commitment to change, and the availability of training, further shape the extent to which AI awareness leads to productive collaboration (Kumar & Mittal, 2024). Leadership that is supportive and change-oriented can alleviate employee concerns regarding job displacement and create an environment conducive to collaborative innovation.

From Understanding and Trust to Collaboration: A Comprehensive understanding of AI is another crucial precondition for effective collaboration. Professionals who grasp both the technical principles and practical applications of AI are better able to allocate tasks appropriately, optimize workflow integration, and engage in mutual learning with AI systems (Theis et al., 2023). The development of shared mental models—where both humans and AI "understand" their respective roles—underpins high-quality collaboration, particularly in diagnostic and administrative tasks (Makarius et al., 2020).

Trust serves as both an antecedent to and an outcome of successful collaboration. Healthcare professionals who trust AI systems are more likely to engage in meaningful and productive partnerships with these technologies. (K. Hou et al., 2023). Trust-building is influenced by technical interoperability, transparency, and the demonstration of consistent system performance. (Simón et al., 2024). The relationship between trust and collaboration is often reciprocal: as professionals accumulate successful collaborative experiences with AI, their trust in the technology deepens, creating positive feedback loops that further enhance productivity. (Marikyan et al., 2022).

The Role of AI Skills in Collaboration: Skill development is fundamentally tied to collaborative effectiveness. Employees with strong technical and adaptive skills are better equipped to establish productive working relationships with AI systems, leading to improved resource utilization, workflow integration, and decision support (Chuang, 2024). Comprehensive training that addresses both technical and interpersonal dimensions of AI collaboration is particularly effective, as it prepares professionals for the dynamic and reciprocal nature of human–AI partnerships (Morandini et al., 2023).

Skill development is also a progressive process, requiring ongoing investment in both individual and team-level competencies. (Hemmer et al., 2025). Organizations that adopt a structured and holistic approach to skill development are more likely to achieve sustainable improvements in human–AI collaboration and, by extension, productivity. (Patil & Shankar, 2023).

How Collaboration Boosts Productivity: The positive impact of collaboration on productivity is well-established in both empirical studies and theoretical models. Effective collaboration enhances situational awareness, supports coordinated decision-making, and facilitates knowledge sharing, enabling healthcare professionals to leverage AI capabilities more effectively (Makarius et al., 2020). Collaborative practices also optimize resource allocation and task coordination, thereby reducing cognitive burden and allowing professionals to concentrate on high-value activities (Jiang et al., 2023).

Collaborative relationships are especially important in clinical decision-making, where the integration of human and AI insights can enhance diagnostic precision and reduce decision-making time. Successful collaboration also increases work engagement and enhances job satisfaction, contributing to sustainable performance improvements (Simón et al., 2024). In sum, employee-AI–AI collaboration is a critical mediator that translates AI acceptance into measurable productivity gains.

The Mediating Role of Collaboration: Evidence from Recent Research

An expanding body of empirical evidence confirms that collaboration mediates the relationship between each AI acceptance dimension and productivity. This mediating effect has been observed in numerous contexts and is often enhanced by supportive organizational structures and clear professional role definition.

Awareness, Collaboration, and Productivity

Several studies have shown that while AI awareness directly influences productivity, its impact is significantly enhanced when channeled through effective collaboration (Liang et al., 2022). Collaborative practices channel the intrinsic motivation generated by awareness into promotion-focused job crafting strategies, which in turn enhance productivity (Kang et al., 2023). The mediating effect is particularly strong in environments where organizational commitment and structured support are present (Kong et al., 2021). The temporal dimension of this relationship is also significant: as awareness and collaboration develop together, productivity gains are sustained and deepened over time (Kumar & Mittal, 2024).

Understanding, Collaboration, and Productivity: The link between AI understanding and productivity is similarly mediated by collaboration. Comprehensive understanding enables the formation of shared situation awareness and sophisticated mental models, which are essential for high-stakes clinical decision-making processes. (Pinski et al., 2023). The mediation effect is most pronounced in complex and rapidly evolving clinical contexts, where professionals and AI must work together to deliver high-quality outcomes (Jiang et al., 2023).

Trust, Collaboration, and Productivity: Trust in AI enhances the willingness of professionals to engage in collaborative practices, thereby improving team performance and operational efficiency (Hou et al., 2023). Psychological factors, such as reduced technological anxiety and increased confidence, further strengthen this mediation pathway. Organizational culture and clear communication are key moderators, helping to sustain trust-based collaboration and ensure long-term productivity improvements (Wang et al., 2023).

Skills, Collaboration, and Productivity: Finally, AI skills empower healthcare professionals to participate in more effective and mutually beneficial collaborations with AI systems. The influence of skill development on productivity manifests not just through improved task performance but also through the ability to adapt to technological change and engage in continuous learning (Morandini et al., 2023). Organizations that systematically invest in both individual and team-level skill development attain more consistent and significant productivity improvements (Chowdhury et al., 2022).

Theoretical Foundations: Explaining the Acceptance–Collaboration–Productivity Chain

A robust theoretical foundation underpins the observed relationships between AI acceptance, collaboration, and productivity. The integration of the Technology Acceptance Model (TAM), Protection Motivation Theory (PMT), and Person–Environment Fit (PE Fit) theory provides a comprehensive framework for understanding these dynamics.

Technology Acceptance Model (TAM): TAM posits that perceived usefulness and ease of use serve as the primary drivers of technology adoption (Kumar & Mittal, 2024). In the healthcare context, these core constructs are augmented by additional considerations, including professional autonomy, ethical concerns, and the unique risks associated with clinical practice (Dutta & Mishra, 2024).Recent extensions of TAM highlight the importance of trust and collaboration as critical mediators, reflecting the high-stakes environment of smart hospitals (Chen & Lee, 2024).

Protection Motivation Theory (PMT): PMT provides insight into the cognitive and motivational processes that influence employee responses to technological transformation. The theory's dual focus on threat and coping appraisals explains why some professionals embrace AI as a way to enhance their effectiveness, while others perceive it as a threat to their professional identity or job security (Hornikel et al., 2021). Effective coping strategies, supported by organizational training and peer support, enable employees to convert acceptance into productive engagement and collaborative behavior (Theis et al., 2023).

Person–Environment Fit Theory (PE Fit): PE Fit theory emphasizes the alignment between individual characteristics (such as skills, values, and professional identity) and the technological demands of the work environment (Parvez et al., 2022). Strong person–technology and person–organization fit are associated with higher acceptance rates, more effective collaboration, and improved productivity outcomes (Upadhyay et al., 2022). This alignment is particularly important in the dynamic context of AI integration, where roles and responsibilities are continuously evolving (Dutta & Mishra, 2024).

The integration of these theoretical frameworks explains both the direct effects of AI acceptance on productivity and the critical mediating role of collaboration. Each theory offers a unique perspective: TAM illuminates the cognitive appraisal process, PMT highlights motivational dynamics, and PE Fit theory addresses the importance of contextual alignment. Together, they support a nuanced understanding of how AI acceptance can lead to productivity gains when mediated by effective employee-AI–AI collaboration. The integrated framework is summarized in Figure 2.

Figure 2: Theoretical Model of AI Acceptance–Collaboration–Productivity

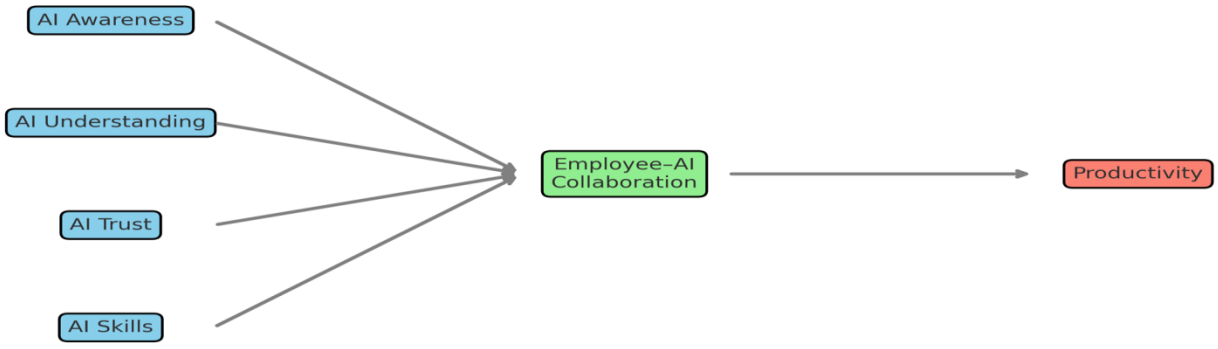


Figure 2 illustrates the conceptual framework underpinning this study. It shows how four dimensions of AI acceptance influence productivity directly and indirectly via employee-AI–AI collaboration. The model integrates the Technology Acceptance Model (TAM), Protection Motivation Theory (PMT), and Person–Environment Fit (PE Fit) perspectives to explain the observed relationships.

5. Managerial Implications and Recommendations

The findings of this review offer several important implications for hospital leaders, policymakers, and researchers. First, initiatives to realize the productivity potential of AI in smart hospitals should prioritize strategies that enhance awareness, deepen understanding, build trust, and develop skills among frontline professionals. These approaches require supporting organizational initiatives that foster collaborative work environments and provide ongoing training and support.

Second, the design and implementation of AI systems should prioritize enabling high-quality collaboration. This includes developing clear protocols for human–AI interaction, ensuring transparency and reliability in system outputs, and establishing clear protocols for human-AI interaction continuous learning and adaptation.

Third, future research should continue to investigate the mediating and moderating variables influencing the relationship between AI acceptance and productivity. Large-scale, multi-level studies—including a planned 500-participant survey—are needed to test integrated models and explore the relative importance of each acceptance dimension. There is also a need for research that examines specialty-specific collaborative models and the longitudinal processes through which professionals and AI systems co-evolve.

Finally, the development and validation of new productivity metrics that effectively capture contributions from both human and AI agents will be critical as smart hospitals continue to evolve.

Conclusion

China's smart hospital initiative represents a leading initiative in global efforts to leverage digital innovation for healthcare transformation. This review has shown that employees' AI acceptance—encompassing awareness, understanding, trust, and skills—is a necessary, yet insufficient, condition for achieving productivity gains in this context. The critical mediating role of employee-AI–AI collaboration has been empirically established, with high-quality partnerships serving as the crucial mechanism for transforming acceptance.

By integrating the Technology Acceptance Model, Protection Motivation Theory, and Person–Environment Fit perspectives, this review establishes an integrated conceptual framework for research and practice. Hospital leaders and policymakers should prioritize developing trust, structured collaboration protocols, and continuous skill development to ensure the realization of AI's transformative potential throughout China's rapidly digitizing healthcare system.

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The Impact of E-Money Usage on the Velocity of Money in Malaysia

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Abstract: The rapid adoption of e-money in Malaysia has significantly transformed the landscape of financial transactions. As consumers and businesses increasingly prefer digital payment methods, questions arise about how these shifts affect fundamental monetary dynamics, particularly the velocity of money. This paper investigates the theoretical and conceptual relationship between e-money usage and the velocity of money in Malaysia, proposing that e-money impacts money velocity through two primary channels: transaction efficiency and monetary substitution. A conceptual framework is developed to guide future empirical research and inform policymakers on the evolving role of digital financial instruments.

Keywords: *E-money adoption, Velocity of money, Digital payments, Transaction efficiency, Monetary substitution*

1. Introduction and Background

The rise of electronic money (e-money) has marked a significant transformation in how modern economies manage, store, and circulate money. E-money is defined as a digital substitute for cash that facilitates instant payments and has become an essential component of modern payment systems (Bank for International Settlements [BIS], 2021). In Malaysia, the adoption of e-money has accelerated rapidly over the past decade, driven by the widespread use of smartphones, increased internet penetration, and strategic initiatives by both Bank Negara Malaysia (BNM) and private sector participants to promote cashless transactions (BNM, 2022; Lim & Habibullah, 2021).

As of 2023, BNM reported over 9 billion e-money transactions, with a total transaction value exceeding RM60 billion, reflecting a year-on-year growth of more than 25 percent (BNM, 2023). The surge is largely attributed to the growing popularity of e-wallets, mobile banking applications, and contactless payment cards, which have become integral to Malaysia's retail payment landscape. Prominent platforms such as Touch 'n Go eWallet, Boost, and GrabPay dominate the market, while government-led initiatives like eBeliaRahmah and e-Tunai Rakyat have further encouraged consumer adoption (Yusof & Lau, 2023).

This digital transformation is consistent with global trends. In China, the use of digital payment systems such as WeChat Pay and Alipay has achieved near-total integration into daily life, processing more than 300 billion transactions annually, valued at over ¥1,200 trillion (Zhou, Chen, & Wang, 2020; Yang, Li, & Zhu, 2022). Similarly, Sweden has emerged as a pioneer in the move toward a cashless society, with over 95 percent of retail transactions conducted electronically (European Central Bank [ECB], 2019). Singapore, Malaysia's closest regional comparator, recorded over S$35 billion in e-money transactions in 2023, facilitated through PayNow and SGQR interoperability frameworks that link banks and fintech payment providers (Indrawati, 2020).

Despite these global developments, the macroeconomic implications of widespread e-money usage, particularly its effect on monetary aggregates such as the velocity of money, remain underexplored in emerging economies like Malaysia. The velocity of money, traditionally defined as the ratio of nominal GDP to the money supply (typically M1 or M2), reflects the frequency at which money circulates within the economy (Rahim & Wong, 2022; Kumar & Sharma, 2021). Classical monetary theory suggests that this measure is influenced by factors such as interest rates, income growth, and inflation expectations. However, with the increasing adoption of digital payment instruments, the traditional relationship between money supply and economic activity may be undergoing a structural transformation (Lim & Habibullah, 2021; BIS, 2021).

Preliminary observations from BNM (2023) indicate that, despite the surge in e-money usage, the velocity of M1 in Malaysia has exhibited a declining trend, falling from approximately 2.1 in 2013 to 1.5 in 2022. This pattern mirrors the experiences of other economies undergoing digital payment expansion, such as India and

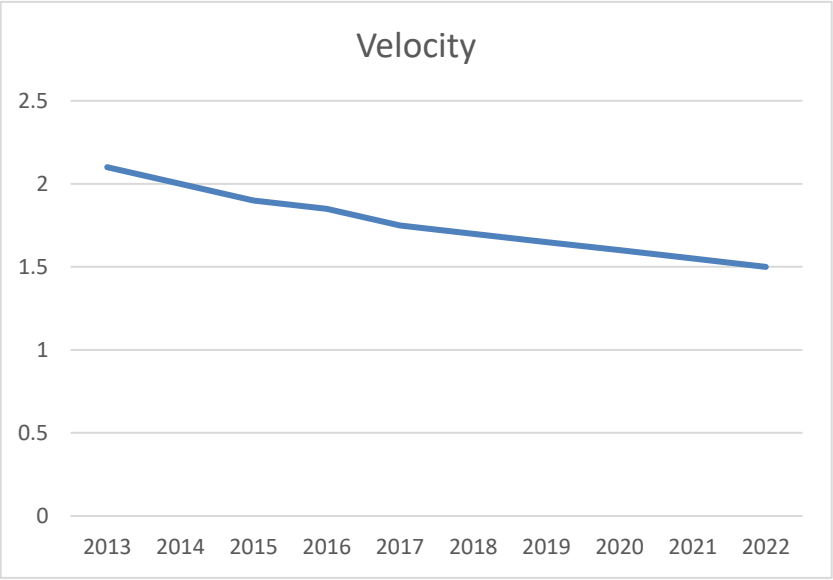
China (Kumar & Sharma, 2021; Zhou et al., 2020). The coexistence of rising digital payment volumes and declining money velocity presents a paradox: does the expansion of e-money reduce the demand for traditional money holdings thereby lowering observed velocity or does it instead facilitate faster transactions that are not fully captured by conventional monetary aggregates?

Motivated by these emerging trends, this study seeks to conceptually examine the influence of e-money on the velocity of money in Malaysia. By focusing on a Southeast Asian context, the research contributes to addressing a critical gap in the literature, as the intersection between digital financial innovation and monetary theory remains relatively underexplored in developing and semi-developed economies (Yusof & Lau, 2023; Rahim & Wong, 2022).

Figure 1 illustrates the declining trend in Malaysia's M1 velocity, raising key questions about how digital payment adoption may be reshaping the mechanisms of money circulation within the economy.

Figure 1: Velocity of M1 Money Supply in Malaysia (2013–2022)

Year	Velocity
2013	2.10
2014	2.00
2015	1.90
2016	1.85
2017	1.75
2018	1.70
2019	1.65
2020	1.60
2021	1.55
2022	1.50



Source: Global Monetary Reports

Problem Statement

The increasing adoption of electronic money (e-money) has redefined the financial landscape in Malaysia, carrying far-reaching implications for monetary policy, financial behaviour, and the structure of the money supply, as consumers and businesses increasingly shift toward digital payments using e-wallets, QR codes, and online banking platforms (Bank Negara Malaysia [BNM], 2022; Yusof & Lau, 2023). This transformation has been accelerated by rapid technological diffusion, supportive regulatory frameworks, and private-sector innovation in payment systems (Bank for International Settlements [BIS], 2021). Consequently, the traditional understanding of how money circulates in the economy long grounded in conventional aggregates such as M1 and M2, is being fundamentally challenged (Lim & Habibullah, 2021; Rahim & Wong, 2022).

Historically, the velocity of money, especially when measured using the M1 aggregate (cash and demand deposits), has served as a vital indicator of economic activity and the effectiveness of monetary policy (Kumar & Sharma, 2021). A higher velocity typically suggests that each unit of currency is being used in multiple transactions over a given period, signalling a healthy level of economic activity and liquidity circulation (Mbiti & Weil, 2015). However, in Malaysia, a paradoxical trend has emerged: despite the surge in e-money transactions, the velocity of M1 has steadily declined, dropping from 2.1 in 2013 to 1.5 in 2022, according to data from Bank Negara Malaysia (2023).

This declining trend is not unique to Malaysia. Similar patterns have been observed in both developed and

developing economies, prompting questions about whether conventional measures of money velocity remain valid in an increasingly digital economy (Zhou, Chen, & Wang, 2020; Yang, Li, & Zhu, 2022). The introduction and expansion of e-money bring at least two major disruptive effects to monetary measurement and theory.

i. Transaction Efficiency Effect: E-money enables instantaneous and frictionless transactions, theoretically capable of increasing the effective velocity of money as digital payments circulate faster through the economy (Indrawati, 2020; BIS, 2021).

ii. Substitution Effect: At the same time, e-money can replace traditional forms of money included in M1 or M2, such as cash and demand deposits, thereby distorting the monetary base used to calculate velocity and potentially leading to a statistical underestimation of actual money circulation (Lim & Habibullah, 2021; Rahim & Wong, 2022).

Despite these critical implications, existing research in the Malaysian context has yet to provide a comprehensive conceptual and empirical understanding of how e-money influences money velocity. Most prior studies focus on financial inclusion, digital banking adoption, or consumer behaviour (Yusof & Lau, 2023), while few examine the macroeconomic impact of digital payments from a monetary theory perspective (Lim & Habibullah, 2021).

This lack of conceptual clarity presents challenges for policymakers. If the velocity of money is being structurally altered by digital finance, traditional monetary indicators and tools—such as interest rate policy, inflation targeting, and reserve requirements—may lose their predictive accuracy or require methodological recalibration (BNM, 2022; BIS, 2021). Therefore, this study aims to fill a critical gap in the literature by conceptually analyzing how the increasing use of e-money influences the velocity of money in Malaysia, clarifying whether digital payments are contributing to a structural shift in monetary circulation or whether existing measures must be redefined to account for new, digital forms of money.

Research Objectives

The primary objective of this study is to examine the impact of e-money usage on the velocity of money in Malaysia. The specific objectives are:

- To examine the conceptual relationship between e-money usage and the velocity of money in Malaysia.
- To identify the mechanisms through which e-money may affect the circulation of money.
- To develop a conceptual framework that supports future empirical testing.

2. Literature Review

The literature on electronic money (e-money) and the velocity of money spans both traditional monetary theory and contemporary digital finance. This section reviews the theoretical underpinnings, empirical findings, and research gaps in the context of Malaysia and comparable economies.

Classical and Modern Views on Money Velocity

The velocity of money has traditionally been explained using the Quantity Theory of Money, expressed as MV = PY, where M is the money supply, V is velocity, P is the price level, and Y is real output. Classical economists viewed velocity as relatively stable in the long run, influenced mainly by institutional and behavioural factors. However, in the modern economy, velocity is increasingly volatile and sensitive to changes in technology and payment methods.

Digitalization and Payment Behavior

The adoption of digital payment systems has altered how money is held and transacted. According to Bech and Garratt (2017), innovations such as e-wallets, prepaid cards, and mobile money create a parallel system that functions similarly to traditional money but is not always included in standard monetary aggregates. This raises concerns about the accuracy of measuring money velocity in digital economies.

Rogoff (2016) argues that the move toward a cashless society reduces the demand for physical currency, impacting how central banks manage monetary aggregates. In countries like Sweden, where over 95 percent

of payments are digital, the declining velocity of M1 and M2 is partly attributed to the substitution of cash with digital alternatives.

Empirical Evidence from Global and Regional Studies

Empirical studies around the world have produced diverse and sometimes contradictory insights into the effects of e-money on the velocity of money, reflecting variations in financial development, consumer behaviour, and regulatory environments. Zhou et al. (2020), in their study on China, found that the adoption of e-money significantly enhanced transaction speed and initially increased the velocity of money. However, as consumers began to store funds in digital wallets for longer periods, transforming them into quasi-savings instruments, the overall velocity declined. This highlights the dual nature of e-money as both a transaction facilitator and a substitute for traditional money holdings.

In India, Kumar and Sharma (2021) analyzed the impact of digital payment platforms such as Unified Payments Interface (UPI) and Paytm on money velocity following demonetization. They observed a temporary increase in money velocity due to a surge in electronic transactions, followed by stabilization as the economy adjusted to the new digital payment norms. The authors argue that the inclusion of e-money balances in monetary aggregates is crucial for accurate analysis of monetary policy transmission.

Similarly, a study by the European Central Bank (ECB, 2019) on the Eurozone indicated that while contactless and mobile payments were rising rapidly, they had a limited measurable impact on the velocity of M1 and M2 due to their relatively small share in total transaction volume. However, in countries such as Sweden and the Netherlands, where digital payments dominate, structural changes in money demand are evident, leading to a consistent decline in the velocity of money.

In Nigeria, Okonkwo, Ume, and Eze (2022) found that increased mobile money usage in rural areas led to a marginal increase in transaction velocity due to improved financial access. Nevertheless, regulatory and interoperability challenges prevented the full realization of efficiency gains from digital payments.

In Kenya, Jack and Suri (2011) examined the introduction of M-PESA and found that mobile money substantially increased the frequency and speed of person-to-person transactions, thereby enhancing monetary circulation. Their findings indicate that mobile payment systems can raise the velocity of money in economies with previously limited financial inclusion. Likewise, Mbiti and Weil (2015) demonstrated that M-PESA improved transaction efficiency and reduced liquidity constraints, indirectly supporting higher money turnover. However, as users increasingly held balances in mobile wallets for convenience or safety, the longer holding periods slightly reduced measured velocity.

Other cross-country studies further illustrate that e-money's impact on velocity depends on its classification in monetary aggregates. Indrawati (2020) argued that excluding e-money from narrow aggregates such as M1 leads to a statistical underestimation of actual velocity, as electronic balances circulate outside formal banking channels. Yang, Li, and Zhu (2022) also found that central bank digital currency (CBDC) initiatives can affect money velocity differently depending on whether they substitute cash or deposits.

During the COVID-19 pandemic, the Bank for International Settlements (BIS, 2021) reported that payment digitalization accelerated sharply worldwide. However, despite the surge in contactless and remote payments, cash holdings also increased during periods of uncertainty, leading to mixed effects on overall money velocity. This finding underscores the importance of accounting for behavioural factors such as precautionary savings and liquidity preference, when analyzing e-money's macroeconomic implications.

Overall, the empirical literature suggests that e-money's influence on velocity is dynamic and context-specific. Short-run increases in transaction speed and efficiency are common, but long-run effects depend on whether e-money functions primarily as a means of payment or as a store of value. In advanced economies, where digital payments are already dominant, velocity may decline due to increased preference for holding digital balances (ECB, 2019; Indrawati, 2020). Conversely, in developing economies such as Kenya and Nigeria, the expansion of e-money and mobile payments has improved access and marginally increased money velocity (Jack & Suri, 2011; Okonkwo et al., 2022).

Specific Findings from Malaysia

In the Malaysian context, Lim and Habibullah (2021) conducted a comprehensive time-series analysis using quarterly data from 2008 to 2020 to investigate the dynamic relationship between e-money transactions and the velocity of M1. Their findings revealed a negative relationship between the number of e-money transactions and the velocity of money, indicating a substitution effect whereby increased use of digital payment instruments reduces the dependence on cash and demand deposits. This suggests that as consumers increasingly adopt e-money for daily transactions, the traditional concept of money turnover within the M1 aggregate becomes less representative of actual economic activity.

Similarly, Bank Negara Malaysia (BNM, 2022) has highlighted in its Annual Report that while e-money usage surged particularly during the COVID-19 pandemic period (2020–2021), the measured velocity of money continued to decline. This phenomenon underscores a structural shift in Malaysia's payment ecosystem, where conventional monetary indicators, such as M1 velocity, may no longer fully capture the flow and circulation of digital money within the economy. The BNM report also noted that e-money transaction volumes surpassed RM50 billion in 2021, largely driven by mobile wallet adoption and contactless payment mechanisms (BNM, 2022).

Further empirical evidence is provided by Rahim and Wong (2022), who analyzed monthly e-wallet transaction data from 2015 to 2021 using a vector error correction model (VECM). Their results revealed that the expansion of e-money usage was significantly associated with reductions in currency in circulation, implying that e-money acts more as a substitute rather than a complement to cash. This finding reinforces the notion that e-money adoption may dampen the traditional money velocity, as consumers retain less physical currency while relying more on digital balances for payment activities.

Additionally, Yusof and Lau (2023) observed that digital financial inclusion, particularly through government-endorsed e-wallet programs such as eBeliaRahmah, has accelerated the use of electronic payment systems even among rural and lower-income users. This increased adoption, however, may lead to a more stable but slower monetary circulation, as transactions occur within closed-loop digital systems managed by private intermediaries rather than through the broader banking system.

Despite these developments, empirical studies on the macroeconomic implications of e-money in Malaysia remain limited in both scope and number. Most research to date has focused on micro-level usage patterns, consumer behavior, or payment system efficiency, leaving a notable gap in understanding how e-money affects broader monetary aggregates and the overall velocity of money. Thus, the present study seeks to bridge this gap by providing a systemic analysis of e-money's impact on money circulation in Malaysia's evolving digital monetary ecosystem.

Gaps in Literature

Most existing studies either:

- Focus on the financial inclusion and technological adoption aspects of e-money, or
- Examine money velocity from a purely macroeconomic perspective without considering digital money's structural effects.
- There is a noticeable gap in integrated studies that examine how e-money redefines the functional role and measurement of money in emerging economies like Malaysia. Specifically, little has been done to disentangle the transactional and substitutional effects of e-money on money velocity.

This study contributes to filling this gap by proposing a conceptual framework that links e-money usage with money velocity through two primary channels: improved transaction efficiency and changes in monetary composition.

Conceptual Framework

Based on the reviewed literature and theoretical considerations, this study posits that e-money usage influences the velocity of money through two primary channels: **transaction efficiency** and **monetary substitution**. These channels help to conceptualize the mechanisms through which digital payment

innovations alter the circulation and measurement of money in an economy.

Transaction Efficiency Channel

E-money introduces speed, convenience, and accessibility to the transaction process. Digital platforms like mobile wallets, QR codes, and instant transfer systems enable individuals and businesses to complete transactions more rapidly than traditional cash or card methods. As a result, money may change hands more frequently within the same time frame, thereby potentially increasing the **velocity of money**.

Key attributes supporting this effect:

- Real-time transfers (e.g., DuitNow, FPX)
- Increased transaction frequency and volume
- Seamless integration with retail and service platforms

Hypothesis: Increased e-money adoption leads to higher transaction frequency, which could raise the effective velocity of money.

Substitution Channel

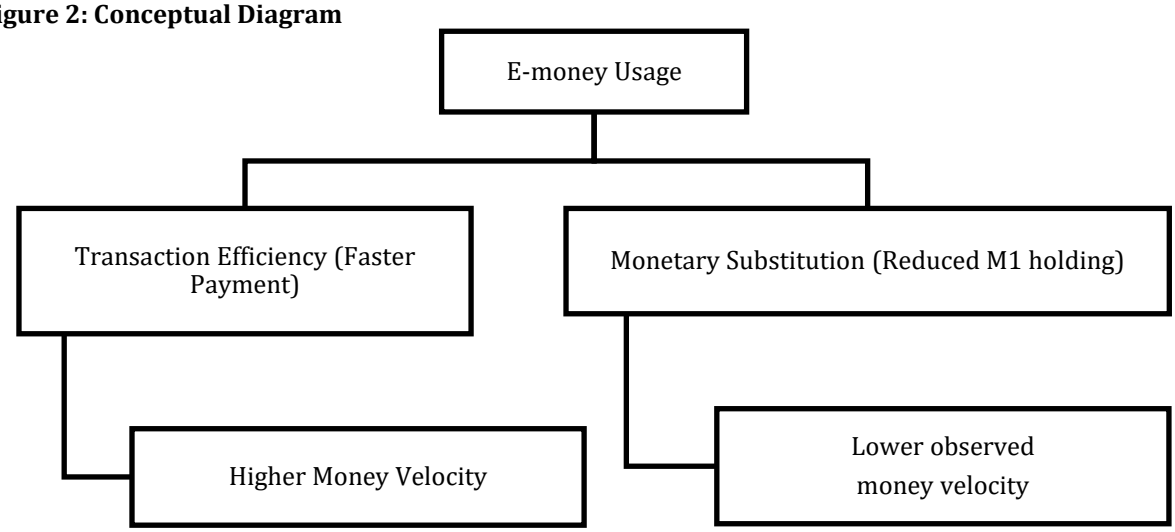
On the other hand, e-money may act as a substitute for physical cash and demand deposits, which are components of M1. When consumers and firms store value in e-wallets or prepaid instruments not classified under M1 or M2, it leads to a reduction in the traditional money base used in velocity calculations. This could artificially depress the measured velocity of money, even if actual economic activity remains high or increases.

Key attributes supporting this effect:

- Reduction in physical currency demand
- Increased holding of prepaid balances not captured in M1
- Emergence of shadow monetary aggregates not tracked by central banks

Hypothesis: Higher e-money usage displaces conventional money holdings, resulting in lower observed velocity despite unchanged or increased real money usage.

Figure 2: Conceptual Diagram



This dual-channel framework explains why the relationship between e-money and money velocity may appear contradictory in empirical data. The net effect depends on the relative strength of both channels and how e-money is accounted for in monetary statistics. This framework will guide the development of hypotheses and the interpretation of findings in the later stages of this research.

3. Methodology

Research Design

A quantitative research design using time-series econometric analysis can be used to investigate the

relationship between e-money usage and the velocity of money in Malaysia. The design is appropriate due to the nature of the data and the aim of identifying both short-run and long-run relationships.

Data Collection

The secondary data can be obtained from the following sources:

- Bank Negara Malaysia (BNM): Monthly and quarterly reports on e-money transactions, monetary aggregates (M1, M2), and currency in circulation.
- Department of Statistics Malaysia (DOSM): Macroeconomic indicators such as GDP and inflation.
- World Bank and IMF databases: For global and regional comparison indicators.

The time frame of analysis spans from 2012 to the most recent available year, allowing for the observation of pre- and post-pandemic effects.

Variables and Measurement

Variables	Proxy/Measurement	Source
Velocity of Money (V)	GDP / M1 or M2	DOSM, BNM
E-Money Usage (EM)	Total e-money transaction value and volume	BNM
GDP	Real Gross Domestic Product (Quarterly)	DOSM
Inflation	Consumer Price Index (CPI)	DOSM, World Bank
Interest Rate	Overnight Policy Rate (OPR)	BNM

Econometric Model

To evaluate the effect of e-money on the velocity of money, the study will use:

Model 1: Baseline Regression

$Vt = \beta_0 + \beta_1 EM_t + \beta_2 RGDP_t + \beta_3 INF_t + \beta_4 INT_t + \varepsilon_t$

Where:

V_t: Velocity of Money at time

EM_t: E-money usage at the time

$RGDP_t$: Real GDP

INFt: Inflation rate

INT_t: Interest rate

Expected signs and economic intuition

β_1: e-money usage

Short run: Positive. Studies in Indonesia using ARDL show that increased EM initially increases velocity, i.e., people spend faster as they use EM in daily transactions.

Long run: Negative. Over time, widespread EM reduces the need for traditional money holdings, lengthening money's turnover interval.

β_2: real GDP ($RGDP_t$)

Typically positive. As output grows, people transact more, accelerating money circulation. (Many velocity models confirm this)

β_3: inflation rate (INF_t)

Could be either:

Positive if high inflation leads to rapid spending before money loses value.

Negative if prices distort real balances and reduce transactions.

Empirical results vary: some find negative in the short run, and negligible in the long run.

β_4: interest rate (INT_t)

Short run: Likely negative higher rates incentivize saving, reducing circulation.

Long run: Often positive higher opportunity cost of holding money eventually boosts velocity

Model 2: ARDL (Auto-Regressive Distributed Lag) Approach

The ARDL framework handles variables of mixed integration orders (I(0) or I(1)) without requiring pre-testing for uniform stationarity, and it's robust for small samples typical in macroeconomic country-level

studies. It effectively separates short-run dynamics from long-run equilibrium, making it ideal to assess how e-money (EM) usage impacts velocity both immediately and over time. The steps are as follows:

Stationarity Testing
The analysis will start with the use of unit-root tests like ADF or PP on all variables: Velocity (V_t), E-money (EM_t), Real GDP ($RGDP_t$), Inflation (INF_t), Interest Rate (INT_t). Ensure none are I (2), since ARDL requires series to be I(0) or I (1).

ARDL Model Specification
The next step is to choose an optimal lag order via information criteria (AIC/BIC). The general form of the model:

$$V_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i V_{t-i} + \sum_{j=0}^{q_1} \beta_j EM_{t-j} + \sum_{k=0}^{q_2} \gamma_k RGDP_{t-k} + \sum_{l=0}^{q_3} \delta_l INF_{t-l} + \sum_{m=0}^{q_4} \theta_m INT_{t-m} + u_t$$

Bounds Test for Cointegration
Next, Pesaran, Shin & Smith's bounds testing approach is to be applied. An F-statistic above the upper critical bound confirms long-run cointegration.

Error Correction Model (ECM)
If cointegration is confirmed, derive the ECM:

$$\Delta V_t = \phi_0 + \sum \phi_{V,i} \Delta V_{t-i} + \sum \phi_{EM,j} \Delta EM_{t-j} + \cdots + \lambda(V_{t-1} - \psi_1 EM_{t-1} - \cdots) + \varepsilon_t$$

Where:

- Δ: denotes first differences (short-run).
- λ: error correction term (should be negative & significant).
- ψ: long-run coefficients.

4. Expected Results

Component	Insight
Short-run coefficients ϕEM	Captures the immediate effect of e-money usage on velocity. Expected positive if EM accelerates spending.
Long-run coefficients ψEM	Indicates structural effect. It could be negative if EM shifts away from cash, reducing circulation.
Error correction term λ	Measures the speed of return to equilibrium after a shock.
Other variables	Provide context on GDP, inflation, and interest rate effects in both horizons.

Policy Implications
The findings of this study have significant policy implications for monetary authorities, particularly Bank Negara Malaysia, and other stakeholders in the financial system. As the use of e-money continues to grow, understanding its impact on the velocity of money becomes crucial for effective monetary policy formulation. Firstly, if the study confirms that e-money increases the velocity of money through improved transaction efficiency, it suggests that monetary authorities must revise traditional assumptions about money circulation.

In such a scenario, central banks may need to re-evaluate how monetary aggregates are measured and interpreted, especially as digital transactions can cause shifts in demand for different forms of money. This could lead to a reconsideration of which monetary aggregates (e.g., M1, M2) are most relevant for policy targeting in a digitized economy.

Secondly, if the substitution effect of e-money leads to a decline in the velocity of traditional monetary aggregates (such as cash and demand deposits), monetary authorities might need to broaden the scope of aggregates to include digital monetary instruments. This redefinition would help capture the true liquidity in the financial system and avoid underestimation of monetary circulation. Doing so would ensure that monetary policy remains responsive to real economic conditions, preventing lags or misalignments in policy transmission.

Thirdly, insights into how e-money usage affects velocity can guide financial regulation and inclusion strategies. For example, if increased digital transactions contribute to faster money turnover in previously underbanked populations, financial inclusion efforts should focus on expanding digital infrastructure and ensuring interoperability between e-money platforms. This can enhance economic participation and contribute to more effective fiscal stimulus delivery during economic downturns.

Additionally, changes in money velocity influenced by digital finance trends may affect inflation dynamics and monetary control. If e-money reduces velocity or alters it unpredictably, the central bank may face difficulties in gauging the effectiveness of interest rate changes or liquidity injections. Policymakers would need to develop real-time monitoring tools and more granular monetary indicators to better track digital money flows.

Finally, there are broader implications for regional integration and harmonization. As Malaysia continues to expand its digital economy and considers cross-border e-money interoperability (e.g., QR code standards for ASEAN), understanding the implications for money velocity and financial stability becomes even more vital. Coordinated regional research and regulatory collaboration could enhance the resilience and effectiveness of monetary policies in the face of digital transformation.

In summary, this study provides timely evidence that can help Malaysian policymakers adapt to the evolving digital financial landscape by revising measurement tools, enhancing regulatory frameworks, and ensuring that monetary policy remains effective and inclusive in an increasingly digitalized economy.

5. Conclusion

This study investigates the impact of e-money usage on the velocity of money in Malaysia, a timely inquiry given the country's rapid digital transformation in the financial sector. The research draws from established monetary theory, evolving payment technologies, and global empirical evidence to explore how the growing use of e-money is reshaping money circulation patterns and macroeconomic dynamics.

Through an in-depth literature review, the study identifies two principal channels through which e-money influences the velocity of money: the transaction efficiency channel, where e-money accelerates the speed of transactions, and the substitution channel, where e-money potentially replaces traditional monetary forms such as cash and demand deposits. The proposed conceptual framework captures these dual effects and offers a foundation for further empirical investigation.

The methodological approach suggested is the time-series econometric analysis using data from Bank Negara Malaysia, the Department of Statistics Malaysia, and international sources. Variables such as GDP, inflation, interest rates, and e-money transaction values are integrated into ARDL and multiple regression models to evaluate both short-term fluctuations and long-term trends. Diagnostic and robustness checks ensure the validity of the results.

The findings of this study are expected to contribute to both academic literature and practical policymaking. They will offer insights into how digital payment behavior is altering the structure of monetary aggregates and affecting the flow of money in the economy. Specifically, the results can inform Bank Negara Malaysia's

monetary policy tools, guide regulatory frameworks for digital finance, and support financial inclusion strategies.

In conclusion, as Malaysia continues its digital financial transformation. Policymakers, financial institutions, and researchers must understand the broader macroeconomic implications of e-money. This study underscores the importance of revising traditional monetary measurement tools, adapting regulatory approaches, and enhancing data collection frameworks to keep pace with technological change. Future research should continue to explore these dynamics with more granular, real-time data and extend the analysis to regional or cross-border digital financial interactions.

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Digital Currencies and Sustainable Finance: A Bibliometric Review of Global Research Trends

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Abstract: This study presents a comprehensive bibliometric analysis of research trends at the intersection of digital currencies and sustainable finance from 2018 to 2026. Drawing on 358 publications indexed in the Scopus database, the analysis employed Bibliometrics and VOSviewer to examine publication performance, citation structures, keyword co-occurrences, and thematic evolution. The results reveal a significant rise in scholarly attention toward digital currencies, particularly cryptocurrency, blockchain, and central bank digital currency (CBDC), with notable connections to themes of sustainability, green economy, and financial inclusion. The study identified cryptocurrency (31.01%), blockchain (14.25%), and bitcoin (13.13%) as the most prominent keywords, underscoring the dominance of technological innovation in reshaping financial ecosystems. Furthermore, the citation metrics (4,246 total citations; h-index = 34) indicate robust academic engagement and growing interdisciplinary collaboration. The findings highlight those digital financial innovations not only transform global financial structures but also play a pivotal role in promoting sustainable development and green finance initiatives. This bibliometric mapping offers valuable insights for policymakers, financial institutions, and researchers aiming to align digital finance strategies with sustainability objectives. Future studies are encouraged to explore the regulatory frameworks, technological ethics, and environmental impacts of digital currencies to foster an inclusive and resilient financial future.

Keywords: *Digital Currencies, Sustainable Finance, Blockchain Technology, Sustainability, Bibliometric Analysis*

1. Introduction

In recent years, the integration of digital currencies and sustainable finance has risen as one of the most impactful developments that influences current economic and financial systems. Digital currencies, including decentralized cryptocurrencies and central bank digital currencies (CBDCs), are transforming how people transact, invest, and interact with financial markets (Prodan et al., 2024). At the same time, sustainable finance is gaining prominence as it links economic activity with environmental, social, and governance (ESG) priorities, drawing attention to issues such as climate change and the necessity of more equitable development (Luo et al., 2022). Such integration of these two aspects is creating new opportunities while also exposing the challenges of meeting global sustainability goals, attracting growing interest from scholars and policymakers alike (Kumar et al., 2025).

With the increasing exposure to digital currencies and sustainable finance, there is a substantial increase in scholarly publications in regard to these subject matters, particularly after 2020. There is empirical evidence to suggest that related discussions have diversified rapidly that focusing on blockchain-powered green finance, eco-cryptocurrencies, and the role of CBDCs for sustainability-led economic activity (Ali et al., 2024; Khaustova et al., 2024). It can be overserved that from on the statistical analysis of bibliographic data regarding sustainable finance that there is a significant development in the studies where recent ones addresses the issues such as social responsibility, socially responsible investments, and climate change mitigation by delving deeper into the subject matters such as reviewing green bonds, low-carbon transitions, and the integration of financial technology into sustainable practices (Luo et al., 2022; Singhania et al., 2024). Such development reveals the dynamic and diverse nature of research in this sector and highlights the necessity for a complete map of its intellectual evolution.

In this context, this study provides a bibliometric analysis to systematically investigate the global research trends on the integration between digital currencies and sustainable financing. The researchers found bibliometric methods as the appropriate method in investigating this subject matter since it helps in understanding influential publications, thematic clusters, and knowledge trajectories in a complex and evolving research space (Khaustova, et al., 2024). This study utilizes the performance and co-citation analysis, and science mapping techniques, to establish digital currency research in a larger spectrum of sustainable finance perspectives. This study also aims to offer a systemic view of its intellectual structure and the subsequent results.

Although there is an increase in the number of research pertaining digital currency, however a significant gap can still be observed in term of understanding how in regard of comprehending how such research can contribute to sustainable finance in a wider scope. Most contemporary studies prefer to direct their focus on technological advances or environmental consequences individually, instead of collectively; they failed to systematically study in detail the impacts of integrating these factors in global research trends (Ali et al., 2024; Dzhereleyko et al., 2025). They thus leave a gap in understanding about how digital currencies are portrayed as positive or negative with regard to sustainability, and across different regions and academic disciplines. Doing so is critical for the development of theory, policy-making, and future research agendas.

As such, this study focuses on the following research question: What are the global research trends, thematic patterns, and intellectual structures at the intersection of digital currencies and sustainable finance, as revealed through bibliometric analysis? The following sections of the studies are structured as follows. Section 2 discusses the methodology adopted in this study, encompassing the bibliometric analysis and the selected data sources. The results of the bibliometrics analysis – with an emphasis on publication productivity, leading author and affiliation productivity and thematic clusters are presented in Section 3. Section 4 discusses major findings in relation to the available literature, and the implications are outlined, as in the theoretical, practical and policy implications. Finally, Section 5 provides the conclusion of the study by summarizing the research contributions, highlighting the research limitations, and suggesting directions to improve future research.

2. Literature Review

Emerging research at the interface of digital currencies and sustainable finance has significantly expanded in the past few years driven by growing financial systems' digitalization and the increasing demand for sustainable development across the globe. It can be observed from Bibliometric studies that there is a significant increase in the number of scholarly publications since 2020, especially from China, India and United Kingdom (Kumar et al., 2025). A considerable portion of this literature employs bibliometric and scientometric techniques, including tools like VOSviewer and CiteSpace to map publication patterns, intellectual structures, and thematic clusters (Khaustova et al., 2024). These studies discussed some important financial elements such as distributed finance (DeFi), blockchain-based innovations, and the integration of virtual currencies into sustainable financial practices (Singhania et al., 2024).

In general and according to the current global trends, digital currencies such as cryptocurrencies, stablecoins, and central bank digital currencies (CBDCs) are widely presented as instruments that have the capacity to enhance the efficiency and inclusiveness of sustainable finance and they are studied for their potential to enable cross-border transactions, reduce transaction costs, and expand financial access, especially in regions where there are insufficient banks to meet consumer needs. (Prodan et al., 2024). At the same time, sustainable finance is gaining prominence as it links economic activity with ESG priorities, drawing attention to issues such as climate change and the need for more equitable development (Luo et al., 2022). The intersection of these two elements is creating new opportunities while also exposing the challenges of meeting global sustainability goals, attracting growing interest from scholars and policymakers alike (Kumar et al., 2025).

Even though the potentials of digital currencies are acknowledged, some researchers have highlighted the challenges in integrating digital currencies with sustainable finance practices, such as digital literacy, cybersecurity, and infrastructure readiness. These elements are crucial in such integration especially in this rapid economic development (Ali et al., 2024). Furthermore, regulatory issues need to catch up with technology

development, providing uncertainties to the policymakers, central banks and market actors (Prodan et al., 2024). Whether digital currencies contribute to systemic risks such as money laundering, market volatility and environmental externalities or can be adequately controlled to promote sustainability remains a matter of continued debate (Kumar et al., 2025). These tensions reflect ongoing struggles that have pitted digital currency research against the discourse of sustainable finance at large.

The role of emerging technologies in integrating digital currencies and sustainable finance is highly significant. Blockchain, which comes with decentralized and transparent ledger systems, has been identified as open-source for promoting carbon trading, renewable energy markets and sustainable supply chain (Singhania et al., 2024). Also, the use of artificial intelligence (AI) and big data analytics is being more and more integrated into sustainable investment strategies for predictive modelling, risk evaluation, and ESG criterion alignment (Dzhereleyko et al., 2025). Taken as a whole, these technological advances are reshaping not only the design of financial instruments but also the way in which sustainability is implemented in financial systems.

Although it has been growing at a rapid pace, the literature in this field is highly disintegrated, with few attempts so far to systematically decipher global trends and intellectual structures of research across its broad array of subject areas. The majority of the research papers only addressed specific topics of CBDCs, green cryptocurrencies or blockchain applications and did not provide a comprehensive bibliometric overview (Luo et al., 2022). This then translates into a gap caused by a lack of understanding of the interaction between digital currency research and sustainable finance, where key knowledge clusters can be found, or how scholarly debates differ over time. In the effort to bridge such gap, this study applied bibliometric analysis to provide a broad view of the current research trends across the globe that can be used to aid reflection on progress and lead as well as under-researched areas.

3. Methodology

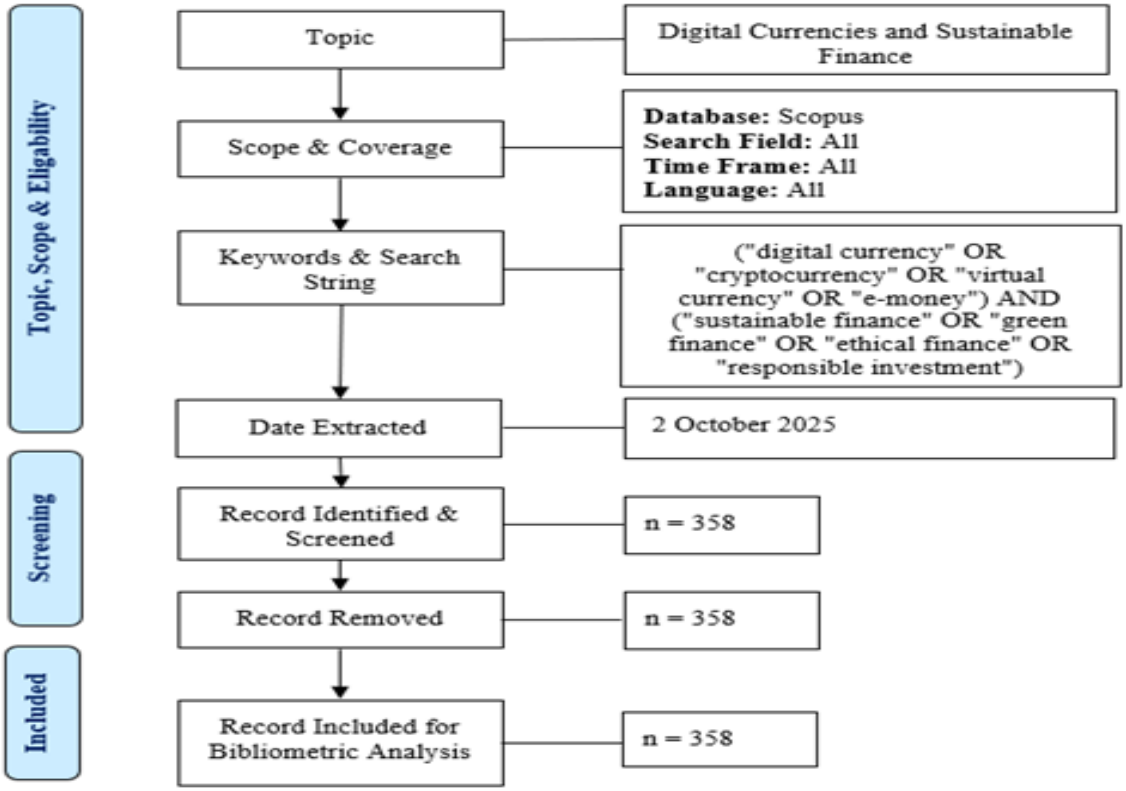
This study adopts the bibliometric method to investigate the research trends, intellectual structure and global collaboration network of digital currencies and sustainable finance, as it this method is particularly relevant for systematic analyzation of extensive corpora of academic literature because it offers the possibility to accordingly determine disciplinary knowledge structures, including potential key publications as well thematic clusters and emerging research fronts (Donthu et al., 2021). Performance analysis and science mapping methods are specifically used to quantify publication output, citation impact and author productivity, while co-citation, co-authorship and co-word analyses reveal intellectual structures and collaboration profiles among disciplines and countries. The methodological framework of the study ensures a detailed description of how knowledge in this nascent field develops and is spread.

Scopus is the main data source of this study as it has wide coverage for peer-reviewed journals, conference proceedings, and book chapters within the social sciences (including economics), business and IT. For instance, when the search scope and selection of data source region were extended to global coverage, compared with Web of Science databases, a wider range of international literature was included in the Scopus database around hot topics or emerging interdisciplinary fields including financial technology and sustainability. Scopus additionally offers both advanced citation-tracking and universal author identifiers, which allow researchers to accurately map the collaboration networks and influence in the scholarly community (Pranckutė, 2021). Due to the reliability and comprehensiveness of Scopus, it is the most suitable database for covering as much research as possible on digital currencies and sustainable finance in a worldwide context.

This study contributes in two ways to the advancement of scholarly knowledge by applying bibliometric methods to Scopus data. First, it analyzes the development trend of digital currency and sustainable finance literature, enabling the researchers to identify thematic hotspots such as blockchain-enabled green finance, CBDCs, and environmentally-friendly cryptocurrencies. Second, this study illustrates the intellectual structures and international cooperation patterns of research on this topic, which presents the main contributors, organizations and regions in this field. These insights are important not only to comprehend the existing academic literature, but also to inspire future research, interdisciplinary co-operation and policy-making decisions in the digital finance sphere (Aria & Cuccurullo, 2017, Kumar et al., 2025).

This bibliometric analysis follows a systematic and explicit process for its methods and the collection of data, as displayed in the PRISMA diagram (Figure 1). The thematic focus on digital currencies and sustainable financing allowed for a full exploration of the nexus between financial innovation and sustainability. Scopus was chosen as the main database of the data set because it covers a wide range of peer-reviewed literature, a multidisciplinary scope and establishes reliability in bibliometric studies (Donthu et al., 2021; Burnham, 2006). The coverage and selection criteria covered all topics, languages and years of publication to optimize inclusiveness and reflect the full range of academic opinion.

Figure 1: PRISMA Flow Diagram



Source: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

The researchers ensure precision and comprehensiveness using a carefully constructed search string that includes multiple synonyms for both digital currencies and sustainable finance. The final search query combined terms such as “digital currency,” “cryptocurrency,” “virtual currency,” and “e-money” with sustainability-related concepts including “sustainable finance,” “green finance,” “ethical finance,” and “responsible investment.” This is known as a Boolean strategy, which is applied to minimize retrieval bias while simultaneously covering the applicable records.

From the research conducted on 2 October 2025, 358 records were obtained and they were subsequently screened and checked based on the level of relevance, requiring no exclusions, as all results met the inclusion criteria. Therefore, all the 358 studies were included for bibliometric analysis. The information was prepared for further analysis (performance, mapping of intellectual structure and visualization of coauthorship) according to the recommendations set out for bibliometric methodology (Aria & Cuccurullo, 2017; Zupic & Čater, 2015).

The bibliometric analysis was carried out using a set of specialized tools that allowed for the sorting out and

standardization of data as well as the visualization of research results. After data retrieval from Scopus, Harzing's Publish or Perish (PoP) tool was used to refine and normalize the dataset, for example, by fixing author names, affiliations and citation inconsistencies. This was necessary to provide reliable data for the calculation of bibliometric indicators like citation counts, h-index and g-index (Harzing, 2007). After data cleaning, VOSviewer was used to create and display bibliometric networks (e.g., co-authorship, keyword co-occurrence, citation links) as it is especially helpful in producing visual maps that illustrate the intellectual landscape of a domain and identify webs of collaboration as well as thematic clusters and emerging research foci (Van Eck & Waltman, 2010). These instruments collectively contributed to methodological rigor via facilitating systematic data processing, enhancing the reliability of findings as well and displaying clear visual representations of research trends and knowledge structures in digital currencies as well as sustainable finance.

4. Findings and Results

This section provides the research findings from the adoption of the bibliometric analysis in studying the integration of digital currencies and sustainable finance. The research results are structured in such a way that they enable readers to have an overall view of the publication dispersion, intellectual structure and collaboration pattern of the subject matter. The researchers first examined the descriptive performance indicators, which include annual growth of publications, distribution of sources, and the most prominent authors and organizations. Next, the researchers analyzed citation-based indicators to identify influential works, authors, and journals that contributed significantly in respect of this discourse. The following step was applying the keyword co-occurrence and thematic mapping to determine the predominant research themes and their evolution over time. Finally, co-authorship and collaboration networks are visually presented to demonstrate trends in international and institutional cooperation. Taken together, such insights provide a systematic understanding of the worldwide knowledge resources about Digital Currencies and Sustainable Finance, which helps to interpret the trends of research hotspots, intellectual linkages and potential directions for further research.

Year of Publications/Evolution of Published Studies

Based on the annual distribution of publications, it can be observed that there is an increasing trend in the development of research on digital currencies and sustainable finance. Table 2 and Figure 2 illustrate that the publication of academic output was limited between 2018 and 2020 with only seven documents produced throughout these years (1.96% overall). This scarcity is indicative of the early stages in the conceptualization and integration process with regard to digital currencies in sustainable finance discourses, when research on this topic was still at the foundational stage and lacked momentum. Early contributions during such phases were typically more exploratory in nature and they laid down theoretical foundations rather than fully-fledged empirical work – a phenomenon not limited only to interdisciplinary fields but analogous contexts (Donthu et al., 2021).

There was a slight rise in 2021 with 16 publications (4.47%) but growth spiked in 2022 as it saw 29 publications (8.10%). This development can be explained by factors including global interest in the use of blockchain technology for sustainable purposes, the growing importance attached to CBDCs, and policy decisions associating financial innovation with United Nations SDGs. At this point, the literature also moved beyond cryptocurrencies to consider topics such as green finance, responsible investment (Corbet et al., 2020) and the environmental consequences of digital assets.

The most remarkable growth is from 2023 to 2025, showing the optimum stage in academic publication. Out of 359 publications identified in 2023, the number of research showed a considerable increment to 75 (20.95%) with almost three times higher compared with the previous year. This trend also persisted in 2024, the year with the greatest number of publications (120; 33.52%), and 2025 (110; 30.73%). Together, these three years represent 85.2% of all publications, reflecting an intense period of maturity in the field. This exponential increase follows amplified international policy discussions on the combination of digital financial technologies and sustainable finance, in particular with respect to carbon markets, ESG investing and the role of digital platforms for promoting financial inclusion (Auer et al., 2022). On the other hand, 2026 has a drastic drop, with only 1 publication (0.28%) listed. However, this decrease should be viewed with caution since the

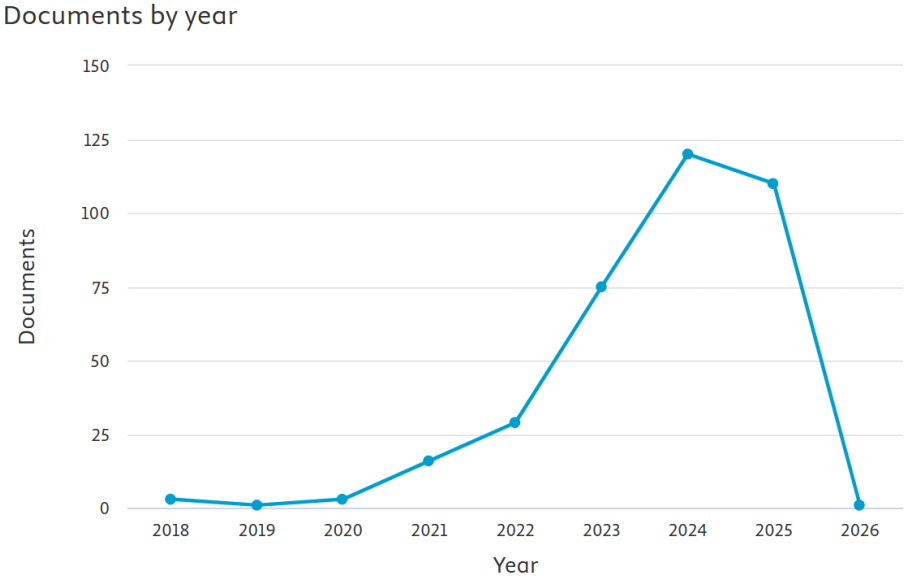
data was obtained in October 2025, and the 2026 output is incomplete. Such temporal lags are a common problem in bibliometric work, and decreasing trends at the "shelf-edges" of the data sets often appear to be more artefacts of incomplete indexing than real declines or decreases in scientific activity (Zupic & Čater, 2015).

In general, this publication trend reveals three distinctive stages: In the first stage: emergence phase (2018–2020) in which there are few contributions; in the second one growth phase (2021–2022) with an increment expansion and in the last one consolidation phase (2023–2025), where is showed a trend of exponential growth and maturity of the task. These findings illustrate how the integration of digital currencies and sustainable finance has quickly moved from a niche area to an emergent domain of interdisciplinary inquiry, prompted by technological advancements and sustainability demands.

Table 1: Year of Publications

Year	Total Publications	%
2026	1	0.28%
2025	110	30.73%
2024	120	33.52%
2023	75	20.95%
2022	29	8.10%
2021	16	4.47%
2020	3	0.84%
2019	1	0.28%
2018	3	0.84%
TOTAL	358	100%

Figure 2: Document by Year



Most Active Source Titles

The fact that publications are distributed across various source titles is a representation of the cross-disciplinary nature of digital currency and sustainable finance research, thereby covering economics, finance, environmental management and sustainability. The North American Journal of Economics and Finance (NJAEF) is the most active journal with 10 publications (2.79%); it speaks to a rising concern, how financial research benefits from a constant dialogue between the monetary system, international finance and emerging digital financial instruments. The coverage of the journal on international economics and continuously applied

finance has positioned it as an outlet of preference for researchers focusing on the consequences of cryptocurrencies in global financial markets, investment climate, and financing approaches purposely attributed to sustainability (Elsayed et al., 2022).

Second close is following NJAEF is the Research in International Business and Finance, with 9 publications (2.51%), which again demonstrates its relative focus on international aspects of finance and cross-border investment dynamics. The focus of this journal is on financial stability, risk and international markets, which reflects the increasing academic interest in digital currencies as innovative instruments and as potentially volatile ones (Alqahtani et al., 2020).

The financial press comprising Energy Economics (8 articles, 2.23%), International Review of Economics and Finance (8 articles, 2.23%), Finance Research Letters (7 articles, 1.96%), and International Review of Financial Analysis (7 articles, 1.96%) collectively highlights that the community around financial economics played a significant part in promoting this research agenda. Besides providing a rigorous econometric investigation into cryptocurrency markets, these journals provided evidence-based solutions on risk management and pricing behavior, in addition to the sustainability implications of digital finance (Corbet et al., 2020). It is also interesting that 6 articles (1.68%) contributed by Technological Forecasting and Social Change are foresight and innovation-oriented. The interdisciplinary perspective of this journal towards the adoption of technology, innovation systems and social change has made it particularly conducive for the investigation on blockchain applications, digital currency ecosystems, as well as their interlinkage with the sustainable development discourses (Bibri 2021).

From an environmental and sustainability perspective, journals such as Heliyon (5 publications, 1.40%), Journal of Environmental Management (5 publications; 1.40%), Resources Policy (5 publications, 1.40%), Sustainability (Switzerland) (5 publications; 1.40%), Sustainable Finance (5 publications, 1.40%) and Environmental Science and Pollution Research were increasingly active in debating the ecological and policy aspects of digital currencies. These debates contribute in illustrating the ecological externalities that cryptocurrency mining can cause, how digital financial instruments are accommodated by SDGs, and the policy pathways toward integrating green finance (Truby, 2018; Luo et al., 2022).

Finally, high-impact journals such as the Journal of Cleaner Production (4 publications; 1.12%) represent a strong sustainability focus. Famous for its sustainable production systems and circular economy research, this journal broadened the scope, inquiring how blockchain and digital currencies can be used to encourage environmental accountability among stakeholders and transparency of transactions, as well as creating new opportunities for sustainable business (Shahzad et al., 2020). IN addition, Physica A: Statistical Mechanics and its Applications (5 papers; 1.40%) similarly adopts a quantitative/methodological research through complex systems modelization to refine researchers' understanding of cryptocurrency market dynamics & systemic risk (Zhang & Li, 2020).

The distribution of source titles overall has shown that there are two common focuses, i.e. in core finance and economics journals, which dominate discussions on the financial implications of digital currencies; and, in sustainability and interdisciplinary outlets, which address their broader societal, environmental, and technological dimensions. This segmented publication trend reflects the interdisciplinary intersection constituting the knowledge field of digital currencies and sustainable finance.

Table 2: Most Active Source Title

Source Title	TP	%
North American Journal of Economics and Finance	10	2.79%
Research in International Business and Finance	9	2.51%
Energy Economics	8	2.23%
International Review of Economics and Finance	8	2.23%
Finance Research Letters	7	1.96%
International Review of Financial Analysis	7	1.96%

Technological Forecasting and Social Change	6	1.68%
Heliyon	5	1.40%
Journal of Environmental Management	5	1.40%
Physica A Statistical Mechanics and Its Applications	5	1.40%
Resources Policy	5	1.40%
Sustainability Switzerland	5	1.40%
Sustainable Finance	5	1.40%
Environmental Science and Pollution Research	4	1.12%
Journal of Cleaner Production	4	1.12%

Keyword Analysis

The analysis of author keywords provides an exposure to the thematic focus and intellectual structure of the investigatory landscape between digital currencies and sustainable finance. Based on the research findings, the most used keyword is "cryptocurrency" (111 articles, 31.01%), with obvious reference to the centrality of cryptocurrencies as a technological innovation and also an object of financial/metastatutory/sustainability discussions. The prevalence of this keyword highlights cryptocurrency as a new catalyst for scholarly research, prompting scholars to explore the role of digital currency in regard to volatility, diversification and green investment strategies (Bouri et al., 2023; Tiwari et al., 2021). The usage of the relatable terms such as "cryptocurrencies" (41 publications, 11.45%) and "Bitcoin" (47 publications, 13.13%) also demonstrates the centrality of the digital assets landscape where Bitcoin happens to be the most studied considering its high standing in market cap and historical significance in the evolution of digital finance (Naeem et al., 2021).

Another research stream is captured by the search term "blockchain" (51 publications, 14.25%) and its variation "block-chain" (23 publications, 6.42%). With the advancement of blockchain technology, which essentially powers cryptocurrencies, the question of whether it can help "clean up" or "promote transparency" in financial systems is brought to light. Notably, the blockchain technology has received more and more attention in relation to sustainable finance, including applications for renewable energy markets, green bonds and supply chain management of sustainable goods (Brunnhuber 2021; Chen et al., 2020). In the same vein, "CBDC" (21 articles, 5.87%) is an emerging topic that reflects worldwide concern about the central bank's contribution to producing sovereign-backed digital money with a view to promoting financial inclusion and achieving financial stability (Ozili, 2022).

The intersection with sustainability-related themes is reflected by the keywords "sustainable development" (29 publications, 8.10%), "sustainability" (26 publications, 7.26%) and "green economy" (16 publications, 4.47%), which imply a tangible academic recognition of the role those digital currencies and blockchain technologies can and may play in support for global sustainability agendas, such as financing renewable energy projects, carbon markets, climate action initiatives. The connection between digital finance and sustainability is of high relevance in recent years due to increasing focus on policy relating to aligning financial flows with the United Nations SDGs (UNEP, 2021).

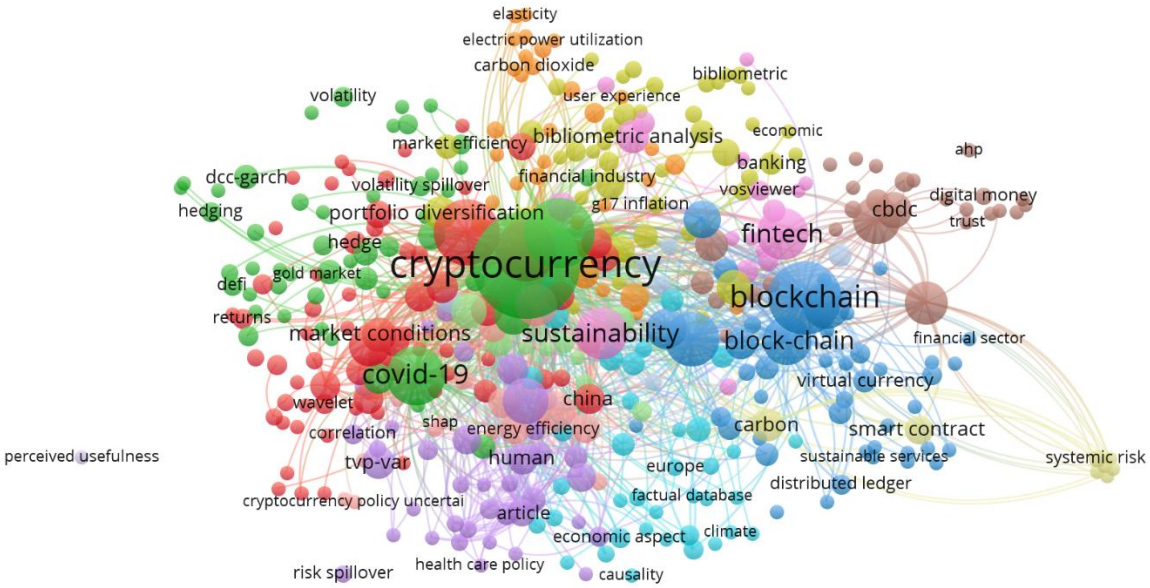
Interestingly, the term "Covid-19" (34 or 9.50%) illustrates how the global pandemic accelerated research on digital finance and cryptocurrencies. The crisis increases public exposure for digital financial services as a factor enhancing remote transactions in the time of pandemic, which helps to keep liquidity in a conducive fund environment and provides an alternative investment during economic uncertainty (Goodell & Goutte, 2021). Other financial system terms such as "financial markets" (22 publications, 6.15%), "electronic money" (21 publications, 5.87%), "investment(s)" (35 and 20 publications, 9.78% and 5.59%, respectively), and "currency" (17 publications, 4.75%) reflect traditional financial constructs being examined through the lens of disruptive digital assets. Furthermore, specific concepts like "gold" (17 articles; 4.75%) signal comparative analysis between traditional safe-haven assets and cryptocurrencies, stimulating discussions on the hedging and diversification effects of cryptocurrencies (Shahzad et al., 2019).

Overall, the top keywords identify three major thematic clusters, namely: (i) technological and financial innovation (cryptocurrency; blockchain; CBDC; fintech); (ii) sustainability and green finance integration (sustainable development; green economy; energy); and (iii) contextual drivers and comparative studies (Covid-19, gold, financial markets). This distribution highlights the interdisciplinary character of the field and at the same time reveals the change of focus in research from cryptocurrencies as speculative assets to them being a potential enabler of sustainable finance. These thematic trends are consistent with broader research focus on linking digital financial innovation with long-term sustainability globally.

.**Table 3: Top Keywords**

Author Keywords	Total Publications	Percentage (%)
Cryptocurrency	111	31.01%
Blockchain	51	14.25%
Bitcoin	47	13.13%
Cryptocurrencies	41	11.45%
Investments	35	9.78%
Covid-19	34	9.50%
Sustainable Development	29	8.10%
Sustainability	26	7.26%
Fintech	25	6.98%
Block-chain	23	6.42%
Financial Markets	22	6.15%
Central Bank Digital Currency	21	5.87%
Electronic Money	21	5.87%
Investment	20	5.59%
Central Bank	18	5.03%
Currency	17	4.75%
Gold	17	4.75%
Finance	16	4.47%
Green Economy	16	4.47%
Energy	15	4.19%
Cryptocurrency	111	31.01%
Blockchain	51	14.25%
Bitcoin	47	13.13%
Cryptocurrencies	41	11.45%
Investments	35	9.78%
Covid-19	34	9.50%
Sustainable Development	29	8.10%
Sustainability	26	7.26%
Fintech	25	6.98%
Block-chain	23	6.42%
Financial Markets	22	6.15%
Central Bank Digital Currency	21	5.87%
Electronic Money	21	5.87%

Figure 3: Network visualization map of the author's keywords



Geographical Distribution of Publications - Most Influential Countries

The geographical distribution of publications shows a highly diversified, but regionally localized research landscape at the intersection of digital currencies (DCs) and sustainable finance. China (72 publications; 20.11%) and India (71 publications; 19.83%) are the two prominent contributors accounting for a combined share of about 40% of the world publication output. The leading position of China is also due to strategic priorities in developing CBDC, including the digital yuan, and linking it with green finance policies aimed at supporting carbon neutrality objectives (Zhang & Huang, 2022). Then, the increasing productivity of research in India mirrors the rapid digitalization of financial services in the country, its focus on financial inclusion and growing scholarly involvement with sustainable development frameworks (Sharma & Tiwari, 2023).

As for Europe, the most prominent research centres are the UK (35 articles; 9.78%) and France (29 articles; 8.10%). The UK's involvement is linked to its role as a global financial centre and also a leader in fintech development, such as digital asset regulation and sustainable finance mechanisms (Arner et al., 2020). In contrast, France has produced a significant body of interdisciplinary research that integrates digital finance and green bonds with corporate sustainability in relation to European Union frameworks on sustainable finance (Caldecott, 2021).

Among the developing countries, significant engagement can be seen in Pakistan (28 publications; 7.82%), Malaysia (23 publications; 6.42%) and Saudi Arabia (22 publications; 6.15%). The increased focus on the academic side of blockchain application, financial inclusion and Islamic finance impacted Pakistan as a developing source (Rizvi et al., 2022). Malaysia has emerged as a leading actor by integrating fintech adoption and sustainable finance in cooperative and Islamic financial systems, whereas research conducted in Saudi Arabia echoes the Nation's Vision 2030, which focuses on striking a balance between economic diversification versus digital transformation and environmental sustainability (Alam et al., 2021). Contributions from Tunisia (20 documents; 5.59%), Turkey (19 documents; 5.31%) and the United Arab Emirates (18 documents; 5.03%) illustrate a growing even it to, be modest, increase of the MENA region's scholarly contribution with time. These countries are deliberately incorporating digital financial technologies to improve financial resilience as well as address sustainable development goals (Ben Arab & Jarboui, 2021). Lebanon (16 papers, 4.47%) is also overactive for its size, presumably due to the Lebanese American University's role in promoting research on sustainable digital finance.

Western economies such as the United States (24 publications, 6.70%), Spain (15 publications, 4.19%), Australia (14 publications, 3.91%), Germany (13 publications, 3.63%), and Italy (13 publications, 3.63%) remain consistent contributors, though their shares are comparatively smaller than Asia's leading nations. The

distribution indicates a geographical realignment of research leadership to Asia, with China and India being the major contributors, albeit it is noteworthy that traditional European financial centres in the West constituted an important source for regulatory, innovation and sustainability reflection (Bouri et al., 2021). Emerging economies such as Romania (12 publications, 3.35%) and South Africa (11 publications, 3.07%) also appear to reflect increasing academic demand for a broader contextualization of digital finance in terms of transitional and developing market economies, with challenges related to financial inclusion and sustainable development at stake.

Altogether, the distribution of active countries suggests that, although the global research effort is widely dispersed overall, it is heavily influenced by the policy agenda, financial ecosystem and stage of development in major contributors. The overwhelming predominance of Asian economies, supplemented by consistent contributions from Europe and the Middle East, as well as a handful of African countries, supports the notion that the scholarly engagement extends across multiple dimensions that are unlikely to shrink due to worldwide interlinkages between cryptocurrencies and sustainability goals.

Table 4: Top 20 Countries contributed to the publications

Country	Total Publications	Percentage (%)
China	72	20.11%
India	71	19.83%
United Kingdom	35	9.78%
France	29	8.10%
Pakistan	28	7.82%
United States	24	6.70%
Malaysia	23	6.42%
Saudi Arabia	22	6.15%
Tunisia	20	5.59%
Turkey	19	5.31%
United Arab Emirates	18	5.03%
Lebanon	16	4.47%
Spain	15	4.19%
Australia	14	3.91%
Russian Federation	14	3.91%
Germany	13	3.63%
Italy	13	3.63%
Portugal	13	3.63%
Romania	12	3.35%
South Africa	11	3.07%

Citation Analysis

The document profile of this bibliometric analysis reveals some important characteristics of the scope, visibility, and academic impact regarding digital currencies and sustainable finance research. The data are from 2018 to 2026, in all, there are seven citation years. Throughout this period, 358 came up with the search strings, and all of them contributed to 4,246 citations. This is consistent with the novelty and increasing importance of this research field in the face of recent global trends, including the spread of digital finance innovations and increased focus on sustainability agendas over the past decade (Bouri et al., 2023; Ozili, 2022). In citation impact terms, an average of 606.57 citations/year and 11.86 cites/paper is demonstrated by the data, which implies a healthy engagement with this literature by the research community. The high citation/paper conveys the relevance and scholarly impact of a field that is still developing. Earlier works have found that research fields at the intersection of finance and sustainability tend to have a faster rate of citation

growth on average, a reflection of their interdisciplinary nature across economics, environmental science and policy studies (Brunnhuber, 2021; Kumar et al., 2025).

Information on author-level productivity and impact is also useful. A citation count per author is 1,435.2 and a paper count is 148.45 on average. These collaboration-related measures may result from the feature of co-publishing and clustering phenomenon, or the concentration of human resources in a few scholars whose ideas shape this domain. Bibliometric analyses in similar fields of research found that closely connected research subfields will create dense co-authorship networks, which may further enhance their visibility and citation rates (Donthu et al., 2021). This shifting trend seems to be true also in digital currencies and sustainable finance for their inherently global and interdisciplinary nature. The h-index supports the statement by stating that there are at least 34 papers in the dataset which have received at least 34 citations – a relatively solid core of influential publications. Moreover, the g-index of 54 indicates that the first 54 papers were cited disproportionately higher than others, indicating a large distribution of highly cited documents, be just a small number of them. These bibliometric indicators are well-accepted criteria for assessing academic impact and research quality, especially in emerging areas where seed works rapidly become established (Hirsch, 2005; Glänzel & Moed, 2019).

Taken together, the document profiles highlight a rapidly evolving research domain characterized by steady publication growth, increasing scholarly recognition, and strong intellectual contributions. The high citation rates and robust h- and g-index scores, alongside author-level productivity, suggest that digital currencies and sustainable finance are not merely going to be accepted academically but they will warrant considerable attention as part of the financial system, more generally, and the sustainability endeavor in particular.

Table 5: Citations Metrics

Metrics	Data
Publication years	2018-2026
Citation years	7 (2018-2026)
Papers	358
Citations	4246
Citations/year	606.57
Citations/paper	11.86
Citations/author	1435.2
Papers/author	148.45
h-index	34
g-index	54

Table 6: Highly cited articles

No	Authors	Title	Year	Cites	Cites per Year
1	T.N.-L. Le, E.J.A. Abakah, A.K. Tiwari	Time and frequency domain connectedness and spill-over among fintech, green bonds and cryptocurrencies in the age of the fourth industrial revolution	2021	317	79.25
2	C. Alexander, M. Dakos	A critical investigation of cryptocurrency data and analysis	2020	138	27.6
3	S. Nosratabadi, A. Mosavi, P. Duan, P. Ghamisi, F. Filip, S.S. Band, U. Reuter, J. Gama, A.H. Gandomi	Data science in economics: Comprehensive review of advanced machine learning and deep learning methods	2020	136	27.2
4	N. Nazareth, Y.V. Ramana Reddy	Financial applications of machine learning: A literature review	2023	122	61

5	M.A. Naeem, I. Mbarki, S.J.H. Shahzad	Predictive role of online investor sentiment for cryptocurrency market: Evidence from happiness and fears	2021	115	28.75
6	E. Platanakis, A. Urquhart	Portfolio management with cryptocurrencies: The role of estimation risk	2019	100	16.67
7	Z. Li, C. Yang, Z. Huang	How does the fintech sector react to signals from central bank digital currencies?	2022	93	31
8	M. Disli, R. Nagayev, K. Salim, S.K. Rizkiah, A.F. Aysan	In search of safe haven assets during COVID-19 pandemic: An empirical analysis of different investor types	2021	91	22.75
9	Y.-S. Ren, C.-Q. Ma, X.-Q. Chen, Y.-T. Lei, Y.-R. Wang	Sustainable finance and blockchain: A systematic review and research agenda	2023	86	43
10	A. Sharif, M. Brahim, E. Dogan, P. Tzeremes	Analysis of the spillover effects between green economy, clean and dirty cryptocurrencies	2023	83	41.5
11	R. Khalfaoui, S. Mefteh-Wali, B. Dogan, S. Ghosh	Extreme spillover effect of COVID-19 pandemic-related news and cryptocurrencies on green bond markets: A quantile connectedness analysis	2023	78	39
12	Y. Yue, X. Li, D. Zhang, S. Wang	How cryptocurrency affects economy? A network analysis using bibliometric methods	2021	71	17.75
13	M.A. Siddique, H. Nobanee, S. Karim, F. Naz	Do green financial markets offset the risk of cryptocurrencies and carbon markets?	2023	67	33.5
14	M. Alqudah, L. Ferruz, E. MartÃ-n, H. Qudah, F. Hamdan	The Sustainability of Investing in Cryptocurrencies: A Bibliometric Analysis of Research Trends	2023	61	30.5
15	E. Dogan, M.T. Majeed, T. Luni	Are clean energy and carbon emission allowances caused by bitcoin? A novel time-varying method	2022	57	19
16	I.U. Haq, A. Maneengam, S. Chupradit, W. Suksatan, C. Huo	Economic policy uncertainty and cryptocurrency market as a risk management avenue: A systematic review	2021	55	13.75
17	A. Rao, M. Gupta, G.D. Sharma, M. Mahendru, A. Agrawal	Revisiting the financial market interdependence during COVID-19 times: a study of green bonds, cryptocurrency, commodities and other financial markets	2022	52	17.33
18	F. Tronnier, D. Harborth, P. Hamm	Investigating privacy concerns and trust in the digital Euro in Germany	2022	50	16.67
19	P. Jariyapan, S. Mattayaphutron, S.N. Gillani, O. Shafique	Factors Influencing the Behavioral Intention to Use Cryptocurrency in Emerging Economies During the COVID-19 Pandemic: Based on Technology Acceptance Model 3, Perceived Risk, and Financial Literacy	2022	48	16
20	P. Rani, P. Sharma, I. Gupta	Toward a greener future: A survey on sustainable blockchain applications and impact	2024	47	47

Discussion

Through bibliometric analysis, a comprehensive overview of the global research trends, thematic patterns and intellectual structures on digital currencies and sustainable finance is well-illustrated. The research findings show that exponential growth in this area of interest has experienced exponential growth over the last 10 years, in line with the increasing relevance of financial innovations like digital currencies as part of

sustainability transitions. The dominance of Economics, Econometrics and Finance, Business, Management and Accounting as core subject areas suggested that a great deal of discussion is still focused on the economic and financial drivers associated with digital currencies (specifically those relating to markets, risk management, and institutional governance). This is in line with previous literature that stresses the importance of financial research in informing sustainable finance narratives (Corbet et al., 2020; Umar et al., 2021).

The nations which are contributing most for bioremediation research globally are China (20.11 %), followed by India (19.83%) and United Kingdom (9.78%), respectively, showing a well-diversified but unequal global research profile landscape. The high proportion of participants from rising powers like China and India illustrates the increasing interest of these countries in using digital currencies to advance inclusiveness and sustainable development, which reflects findings in previous studies on finance's digital transformation (Zhang & He, 2022). At the same time, contributions from developed countries like United Kingdom, France and United States also tend to continue towards this orientation, focusing on regulatory devices, investment policies and effects of introducing sustainability in agreement with financial technologies (Bouri et al., 2023).

The analysis of source titles, in turn, shows that journals the North American Journal of Economics and Finance, Research in International Business and Finance, and Energy Economics are highly prominent. This reflects a predominant focus on finance and the energy-sustainability interface, illustrating a clear interdisciplinary nature of research in this space. Finally, journals such as Sustainability and the Journal of Cleaner Production indicate that environmental and sustainability issues are increasingly being incorporated in mainstream financial-related discussions, reflecting a trend to widen the subject matter in sustainable finance research more generally (Friede et al., 2015).

The research patterns revealed that if the integrated structures are seen as intellectual structures in field, the research can be clustered around three main thematic areas of: (1) financialization and volatility of digital currencies; (2) sustainability implications of digital currency on investment and financing; and (3) blockchain integration in green finance, leading to better transparency and governance. These themes align with the risks but also with the opportunity for digital currencies to fulfill sustainable finance goals; in particular, the adoption of blockchain within sustainable finance practices is acknowledged as a means of improving traceability and accountability in ESG investments (Tapscott & Tapscott, 2017; Umar et al.,2021).

There are a number of reasons behind these trends. In the first place, digital currencies as a disruptive technology in the financial innovation space could lead to opportunities as well as risks, which drive scholars to carry out research on their function in financial inclusion, risk mitigation, and investment diversification. And second, the importance of climate change and sustainability as a global policy priority has raised the stakes in advancing sustainable finance solutions, as in the possibility of the implementation of digital currencies leading to transparency and accountability within green financing. Third, the progress of technology (i.e., blockchain) encourages research topics to diversify, and connecting the concerns about environmental and corporate sustainability to digital currency studies (Bouri et al., 2023).

Summarily, the bibliometric coverage indicates that the nexus between digital currencies and sustainable finance is an emerging area of study, but it has already become an academic trend, where the level of interdisciplinarity is rising, with high contributions from economics, business studies, computer science and environmental sciences. Conceptually, the field is shifting from a focus on financial risk and market behavior to more sophisticated discussions about sustainability integration, green investments, and digital governance. This trend implies that future research will tend to focus on cross-disciplinary cooperation, building sustainable digital financial ecosystems, and aligning digital finance innovations with global sustainability agendas such as the United Nations SDGs.

5. Conclusion and Recommendations

This bibliometric analysis of digital currencies and sustainable finance in this study provides a thorough and comprehensive view of the intellectual structure, global research hotspots, as well as cooperation patterns. The study discovers a remarkable growth in scholarly focus over the last 5 years, and an impressive rise in publications, not only from emerging countries such as China or India, but also with strong contributions by

established research hotspots in Europe and the US. The thematic analysis reveals that the field is centred around a number of recurrent domains, including digital finance for financial inclusion; blockchain for greater transparency in the use of funds; green investment strategies through digital financial innovation and fitting new technologies into sustainability goals. Both influential authors, institutions and journals have had a significant impact on how the discourse has been shaped through citation analysis, which also shows an increasing internationalization of research activities. Taken together, these results highlight the dynamism of the field and its capacity to shape both scholarly study and real-world implications in financial markets and policy regimes.

Notwithstanding the eye-opening exposure from these research findings, this study is still subject to some limitations. First, the sole usage of the Scopus database could have resulted in missing relevant articles indexed within other databases, such as Web of Science or Google Scholar, which might limit this dataset. Second, although bibliometric analysis is widely used in mapping the trends and architecture of research work, it has issues with apprehension of theoretical and methodological variety as well as reconceptualization in concrete practice. Another limitation derives from the dynamism of digital currencies and sustainable finance, where technology advances often outpace changes in policy making; hence, bibliometric findings are a snapshot, not a full account of where the field may be heading. There is a need to address these limitations in future research through innovative strategies, including analyses of multiple databases, and the application of sophisticated scientometric techniques (e.g., machine learning–based topic modeling or text mining) that can be integrated with more traditional bibliometric analysis as part of qualitative review to provide a comprehensive perspective on the field. Moreover, potential research could also evaluate the socio-economic implications of digital currencies to drive sustainable goals, investigate their regulatory and ethical issues, and consider the effects of global collaboration on enhanced innovation.

In conclusion, this paper has implications for both the development of theory and practice by shedding more light on a nascent area of research where digital currencies meets sustainable finance. The lasting legacy of these findings, therefore, is that they enable us to better learn and communicate amongst academics, practitioners, and policymakers on the trajectories, opportunities and challenges of this fast-maturing field. Mapping its intellectual organisation and capturing proliferation of DI during the past 15 years, this study provides a base for future research and practical recommendations to support the implementation of digital innovation in relation to sustainable financial services.

The findings of this bibliometric study hold significant implications for industry practices, policymaking, and real-world implementation in the domains of digital currencies and sustainable finance. For industry professionals, the international research trends and thematic clusters found can give direction to new prospects, such as the future exploitation of blockchain-based digital currencies aimed at increasing transparency, traceability, and responsibility on sustainable investments. This insight can enable financial institutions, fintech firms and asset managers to shape new products that adhere to the ESG principles while meeting ongoing investor interest. Policy-wise, the findings underscore the importance of a regulatory environment that strikes a balance between financial innovation and sustainable imperatives, such that DC might lead to containment rather than the emergence of systemic risks while also leading to more inclusive and green development goals. Policy makers can use these reflections as an input for coherent strategies to incorporate digital currencies in national financial systems and forward sustainability agendas. These real-life applications also include improving financial inclusion in underbanked areas, fostering funding of renewable energy projects and promoting sustainable investment with digital finance ecosystems. Together, these contributions demonstrate how scholarly research can inform practical initiatives for industry and government to leverage digital currencies as a driver of sustainable economic change.

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Examining the Relationship Between Web-Based Meal Ordering System Attributes and Nurses' Satisfaction: A Case Study in a Healthcare Institute

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Abstract: The rapid advancement of technology within the healthcare industry has simplified the process of patient meal ordering, though it has introduced new challenges for nursing staff. A noticeable gap exists between traditional and computerized ordering systems, which this study aims to address. Specifically, the research examines the relationships between organizational context, timeliness efficiency, interface characteristics, and individual differences, and how these factors influence nurses' satisfaction with a web-based meal ordering system. Data collection was conducted using a primary survey method with a questionnaire utilizing a 5-point Likert scale, distributed to a select group of respondents. The collected data were analyzed with the Statistical Package for the Social Sciences (SPSS) version 25. Findings indicate a strong positive relationship between organizational context and user satisfaction, while timeliness efficiency displayed only a weakly supportive effect. Both interface characteristics and individual differences were found to have moderate support. These results suggest that system developers should consider periodic updates to enhance performance and address user needs more effectively.

Keywords: *Hospital Information System, Web-Based Meal Ordering System, Nurses' Satisfaction*

1. Introduction and Background

The digitalization of healthcare services has progressively transformed the management of hospital foodservice operations, signaling a departure from conventional manual practices toward data-driven and technologically supported systems. Traditionally, the meal ordering process in hospitals relied heavily on paper-based mechanisms in which diet clerks distributed and collected menu cards from patients. Although this approach enabled direct communication and personal interaction, it was vulnerable to operational inefficiencies such as high workloads, difficulty in interpreting handwritten notes, and delays in transmitting orders to the kitchen. Such processes also consumed a significant portion of nurses' time, interrupting their clinical priorities and creating potential risks for patient nutrition management.

In response to these limitations, healthcare systems worldwide have adopted computerized and web-based ordering platforms designed to streamline dietary communication and support clinical workflows. These systems allow nurses to input patient meal selections electronically based on dietitian-specified nutritional requirements, enabling instantaneous transfer of information to foodservice personnel. The transition to digital platforms has been associated with improved clarity, reduced errors in patient dietary interpretation, enhanced workflow, and increased job productivity (Hsu & Wu, 2017). With the rising complexity of clinical care and the continuous expansion of hospital caseloads, the ability of digital systems to accelerate processes, eliminate redundant tasks, and coordinate multidisciplinary work makes them crucial for modern healthcare operations.

Despite these advantages, system adoption is not without challenges. Shifting from a manual system to a digital interface introduces new layers of complexity that must be recognized and addressed to ensure successful implementation. Research consistently indicates that technology success depends not only on the functional capabilities of the system but also on the perceptions, competencies, and contextual work environments of its users (Wixom & Todd, 2005; Topaz et al., 2016; Hussey, Adams & Shaffar, 2015). For nurses who function as both clinical caregivers and frontline users of information systems, satisfaction with a digital meal-ordering platform is intertwined with multiple dimensions of their work experience. Factors such as alignment with organizational workflow, timeliness of system responsiveness, clarity and usability of the interface, and individual differences in technological capability collectively influence whether the system is perceived as

helpful or burdensome.

User satisfaction has long been recognized in the information systems literature as a fundamental criterion for evaluating system success because it reflects the extent to which technology supports task completion and meets expectations. In the healthcare context, the implications of satisfaction are far-reaching because ordering errors and miscommunication can jeopardize patient safety. Adequate nutrition is a critical component of treatment and recovery, and therefore, nurses' ability to manage meal orders efficiently has a direct impact on dietary fulfilment, food waste reduction, and overall hospital service performance (McCray et al., 2018). While digital meal ordering is now common in many hospitals internationally, empirical research focusing on nurses' satisfaction in non-commercial foodservice settings particularly within the Malaysian healthcare landscape remains scarce.

Given the practical and clinical importance of meal-ordering processes, it is crucial to understand the determinants of nurses' satisfaction with the digital system implemented in Malaysian hospitals. By examining how organizational context, timeliness efficiency, interface characteristics, and individual differences affect system satisfaction among nurses, the present study aims to bridge the existing knowledge gap and provide evidence-based recommendations for improving digital foodservice informatics. Findings from this study are expected to offer theoretical contributions to the limited literature on hospital foodservice technologies and generate actionable insights for foodservice administrators, health informatics developers, and healthcare managers seeking to optimize digital meal-ordering practices and promote sustained technology adoption in clinical environments.

2. Literature Review

Hospital Foodservice Operation

Hospital foodservice is a major component of patient care because the nutritional adequacy of meals influences recovery, treatment tolerance, and overall well-being. Foodservice operations are broadly divided into commercial and non-commercial segments, with hospitals falling within the non-commercial category since meals are prepared for patients without profit intention (Umap et al., 2018; Krishna et al., 2015). While commercial foodservice settings focus on financial gain and consumer satisfaction, non-commercial hospital foodservice prioritizes therapeutic objectives through diets tailored to patients' medical conditions. To manage diverse patient dietary needs, most hospitals adopt cycle menus developed by dietitians to maintain standardization, reduce menu-planning time, and ensure compliance with nutritional guidelines (Krishna et al., 2015). These menus help control food cost and ensure nutritional consistency across patient groups. However, when cycle menus are repeated too frequently, long-stay patients may perceive the food as monotonous, creating dissatisfaction or reduced food intake. This has implications for healing and recovery since inadequate food consumption contributes to malnutrition risk, extended hospitalization, and reduced treatment tolerance.

Because foodservice activities involve multiple personnel namely dietitians, diet clerks, kitchen staff, and nurses, accuracy in dietary communication is crucial. Miscommunication at any stage may lead to mistakes such as incorrect ingredients, missing texture modification, or allergen exposure, which can endanger patient safety. For this reason, the efficiency of the meal ordering system becomes central to service quality within the hospital foodservice workflow. A system that supports timely and accurate information transfer not only protects patients but also improves operational fluidity across departments. From an administrative perspective, foodservice quality is evaluated not only by meal flavor or nutrition, but also by precision in dietary communication, consistency in serving the right food to the right patient, and minimization of wastage arising from incorrect orders.

Meal Ordering Systems in Hospitals

Traditionally, hospitals used manual ordering systems whereby nurses distributed menu cards to patients, collected completed forms, and communicated orders to diet clerks manually. This approach allowed personal interaction and provided flexibility for clarifying orders face-to-face, yet it required significant time from nursing staff and created a risk of delayed order submission, overlooked dietary notes, and documentation errors. For nurses managing multiple patients and clinical responsibilities simultaneously, manual ordering often became a burden and reduced available time for direct care. As hospitals increasingly face staff shortages,

high patient turnover, and rising administrative complexity, manual systems are no longer sustainable for efficient foodservice coordination.

With increasing patient volume and time-sensitive responsibilities, many healthcare institutions have migrated toward computerized or web-based meal ordering systems. These digital systems are designed to reduce reliance on face-to-face communication by allowing dietary information to be stored, updated, and transmitted electronically. Systems that integrate with hospital information records provide immediate access to patient medical and dietary history, improving accuracy and reducing the risk of serving meals that could endanger patient safety (Hsu & Wu, 2017). When dietary restrictions are automatically tied to patient profiles, ordering becomes safer, faster, and more consistent across shifts.

Web-based systems now support ordering activities in many Malaysian facilities. They allow nurses to key in orders, update remarks, track meal delivery status, and interface with foodservice departments in real time (McCray et al., 2018). These systems also help minimize food wastage and reduce operational costs by decreasing the likelihood of duplicated or incorrect orders. Even so, adoption is not uniform across hospitals, indicating a lack of standardization and highlighting the need for deeper research on nurses' experience and satisfaction with such systems in Malaysia. Understanding staff perceptions is essential because digital systems may succeed technologically but still fail operationally if they are not aligned with the needs and working styles of nurses.

Organizational Context and Nurses' Satisfaction

Organizational context refers to how well the information system aligns with workflow practices, terminology, reliability, and communication structures within the organization. A positive organizational context is achieved when the system reflects actual job practices, offers consistent and trustworthy information, and avoids disruption to work routines (Vernim & Reinhart, 2016; Lu, Hsiao & Chen, 2012). Organizational factors influence whether nurses view a web-based meal ordering system as a supportive tool or an additional burden. When digital systems replace existing communication pathways without improving efficiency, users may perceive them as time-consuming rather than helpful.

System reliability is of particular importance. A system that consistently provides accurate information and operates without downtime contributes to higher levels of trust and perceived usefulness. Conversely, errors, inconsistent data, or sudden system crashes can disrupt workflow and contribute to negative attitudes toward technology adoption. Furthermore, alignment with the terminology used in clinical practice affects comprehension. If nurses encounter unfamiliar wording or counterintuitive menu pathways, additional cognitive effort is required, which may lead to dissatisfaction. Thus, considering organizational context at the system design and implementation stages is essential to foster long-term engagement and satisfaction.

Timeliness Efficiency and Nurses' Satisfaction

Timeliness efficiency refers to how rapidly the system communicates information and supports completion of tasks. In environments where time is highly constrained, even minor delays can create workflow bottlenecks. Technology in healthcare has been widely praised for improving job performance by reducing administrative workload and improving response time (McCray et al., 2018). From the nurse's perspective, timeliness efficiency is reflected in the system's speed when retrieving patient information, processing orders, and transmitting updates to the foodservice department.

Real-time system response is especially critical because new patient admissions and dietary adjustments may be received moments before mealtime. When a web-based system allows newly admitted patients to be included in the meal cycle immediately rather than waiting for the next distribution cycle, perceived efficiency increases. Moreover, fast turnaround helps reduce stress among nurses who must balance heavy clinical workloads with administrative duties. Therefore, timeliness efficiency contributes directly to perceived usefulness and determines whether nurses view the system as a facilitator or an obstruction to workflow.

Interface Characteristics and Nurses' Satisfaction

Interface characteristics include usability, readability, clarity of information, and navigation pathways. A well-designed interface reduces the cognitive load required to locate data, interpret dietary requirements, and enter

meal orders. Usability relates to how simple and intuitive the system is during use. A usable interface reduces operating errors, saves time, and improves job performance. Readability and visibility influence nurses' ability to scan dietary details accurately (Vernim & Reinhart, 2016). When information is structured clearly with appropriate fonts, logical grouping of menu items, and visibility of dietary instructions, users can complete tasks more efficiently and confidently.

Navigation refers to how easily users move between screens and locate the right information within the system. If pathways are messy or mislabeled, users may struggle to identify the correct patient or dietary notes. Poor navigation causes confusion and disorientation (Chavan et al., 2015; Chouhan, 2017), and repeated experiences of difficulty can shape negative attitudes toward the system. Conversely, systems with strong interface characteristics increase ease of use, reduce frustration, and ultimately elevate user satisfaction. In the hospital context where mistakes have serious consequences, intuitive interfaces play a vital role in supporting safe task execution.

Individual Differences and Nurses' Satisfaction

Individual differences reflect the diversity of nurses' technological capabilities, confidence, and cognitive approaches to learning new systems. Evidence consistently shows that computer experience predicts performance level when interacting with digital platforms (Boechler et al., 2016). Nurses with higher digital exposure tend to adopt hospital information systems more smoothly and show greater resilience when facing system updates or interface redesigns.

Self-regulation also affects system acceptance. Self-regulated individuals seek knowledge actively, monitor their learning progress, and apply problem-solving strategies independently (He et al., 2018; Hoendervanger et al., 2018). These individuals tend to explore the system more confidently and reach proficiency faster. By contrast, nurses with low digital literacy or insufficient understanding of clinical nutritional terminology may feel overwhelmed when navigating the system, potentially resulting in anxiety, avoidance, or errors. Therefore, even if the system is well-designed, the experience of using it may vary widely between individuals depending on their technological and domain knowledge.

Nurses' Satisfaction with Technological Systems in Hospitals

Studies have shown that nurses' satisfaction with digital systems improves when technology provides tangible benefits to daily practice and reduces the possibility of error (McCray et al., 2018). Satisfaction is an important indicator because it predicts long-term system use, willingness to learn new functions, and compliance with digital documentation requirements. In contrast, dissatisfaction reduces motivation to use the system and may lead to reliance on informal workarounds, thereby compromising standardization and increasing risk.

In hospital foodservice operations, the stakes are especially high because nutritional errors directly affect patient health outcomes. If technological systems support accurate ordering and efficient communication, user satisfaction strengthens, and nurses gain confidence in technology as a tool that enhances rather than obstructs care delivery. However, if systems increase workload, delay task completion, or cause frequent mistakes, dissatisfaction forms quickly. Consequently, understanding the determinants of satisfaction is critical for healthcare managers, system developers, and policymakers to ensure successful long-term technology adoption in hospital foodservice divisions. Satisfaction research also supports the strategic allocation of training resources and informs system upgrades to better meet operational needs.

3. Research Methodology

This study employed a descriptive, cross-sectional research design to examine the factors influencing nurse satisfaction with the web-based meal ordering system at a national healthcare institute. The name of the institute, however, cannot be revealed. Utilizing a quantitative approach, a structured questionnaire was distributed to 362 nurses across healthcare wards, incorporating items on organizational context, timeliness, interface characteristics, individual differences, and overall satisfaction, measured via a 5-point Likert scale. The sample was selected through purposive sampling, focusing on nurses regularly using the system. Data analysis involved descriptive statistics, reliability analysis, and Pearson's correlation, conducted using SPSS version 25 to assess relationships among variables and test hypothesis validity. The design aligns with natural,

non-contrived settings, allowing for authentic user feedback on system effectiveness and satisfaction.

4. Results

This section presents the analysis and findings derived from data collected within the study period, analyzed using SPSS version 25. The data address the following research objectives: to evaluate the effect of organizational context on nurses' satisfaction with the healthcare institute's web-based meal ordering system, to examine the impact of timeliness on nurse satisfaction, to assess the influence of interface characteristics on satisfaction, and to determine how individual differences affect satisfaction with the system.

Profile of Respondents: Table 1 presents a summary of the demographic characteristics of the nurses who participated in the study.

Table 1: Demographic and Information About Nurses

VARIABLE	FREQUENCY	PERCENTAGE
GENDER		
Males	62	20.0%
Females	248	80.0%
Total	**310**	**100%**
EDUCATION LEVEL		
High School	62	20.0%
Diploma	127	41.0%
Degree (pre-registered)	55	17.7%
Degree (post-registered)	66	21.3%
Total	**310**	**100%**
JOB POSITION		
Staff	262	84.5%
Supervisor	48	15.5%
Total	**310**	**100%**
TOTAL WORKING EXPERIENCE (YEARS)		
0-5	37	11.9%
6-10	95	30.6%
11-15	102	32.9%
16-20	41	13.2%
More than 20	35	11.3%
Total	**310**	**100%**
HOSPITAL INFORMATION SYSTEM (HIS) EXPERIENCE (YEARS)		
0-5	37	11.9%
6-10	112	36.1%
More than ten years	161	51.9%
Total	**310**	**100%**
DIFFICULTY OF USING THE SYSTEM		
Yes	32	10.3%
No	278	89.7%
Total	**310**	**100%**
USAGE INTENSITY		
Daily	264	85.2%
More than once a week	40	12.9%
Weekly	5	1.6%
Occasionally	1	0.3%
Never	0	0%
Total	**310**	**100%**

Descriptive Statistics: Descriptive statistics for the web-based meal ordering system attributes and nurses 'satisfaction were conducted and Table 2 below displays the outcome. These provide the average mean scores

regarding their organizational context, timeliness efficiency, interface characteristics, individual differences, and overall satisfaction.

Table 2: Descriptive Statistics

Variable	Descriptive Statistics Factor Name	Mean	Std. Dev.
OC	Organizational Context	4.1640	0.70579
TM	Timeliness Efficiency	3.0738	0.91865
IC	Interface Characteristics	3.9640	0.82331
ND	Individual Difference	3.9830	0.74618
SF	Overall Satisfaction	4.3420	0.66112

The mean scores ranging from 4.1640, 3.0738, 3.9640, 3.9830, and 4.3420 were obtained from the organizational context, timeliness efficiency, interface characteristics, individual differences, and overall satisfaction. These results indicate that respondents, on average, concur with the items contained in these variables.

Pearson's Correlation Coefficient and Hypothesis Testing were used in this study to analyze the relationship's strength between variables and highlight the factors that influence the nurses' satisfaction in using the web-based meal ordering system (i.e., organizational context, timeliness efficiency, interface characteristics, individual differences, and overall satisfaction. The correlation analysis results are displayed in Table 3.

Table 3: Result of Pearson's Correlation Analysis for the Relationship between Organizational Context and Nurses' Satisfaction

Correlations

		Organizational Context	Overall Satisfaction
Organizational Context	Pearson's Correlation	1	.520**
	Sig. (2-tailed)		.000
	N	310	310
Overall Satisfaction	Pearson's Correlation	.520**	1
	Sig. (2-tailed)	.000	
	N	310	310

** Correlation is significant at the 0.01 level (2-tailed)

Table 4: Result of Pearson's Correlation Analysis for the Relationship between Timeliness Efficiency and Nurses' Satisfaction

Correlations

		Timeliness Efficiency	Overall Satisfaction
Timeliness Efficiency	Pearson's Correlation	1	.296**
	Sig. (2-tailed)		.000
	N	310	310
Overall Satisfaction	Pearson's Correlation	.296**	1
	Sig. (2-tailed)	.000	
	N	310	310

** Correlation is significant at the 0.01 level (2-tailed)

Table 5: Result of Pearson's Correlation Analysis for the Relationship between Interface Characteristics and Nurses' Satisfaction

Correlations			
		Interface Characteristics	Overall Satisfaction
Interface Characteristics	Pearson's Correlation	1	.473**
	Sig. (2-tailed)		.000
	N	310	310
Overall Satisfaction	Pearson's Correlation	.473**	1
	Sig. (2-tailed)	.000	
	N	310	310

** Correlation is significant at the 0.01 level (2-tailed)

Table 6: Result of Pearson's Correlation Analysis for the Relationship between Individual Differences and Nurses' Satisfaction

Correlations			
		Individual Difference	Overall Satisfaction
Individual Difference	Pearson's Correlation	1	.457**
	Sig. (2-tailed)		.000
	N	310	310
Overall Satisfaction	Pearson's Correlation	.457**	1
	Sig. (2-tailed)	.000	
	N	310	310

** Correlation is significant at the 0.01 level (2-tailed)

The correlation conducted on these variables with overall satisfaction (i.e., organizational context, timeliness efficiency, interface characteristics, individual difference) displayed the following: organizational context r=.520, timeliness efficiency r=.296, interface characteristics r=.473, individual difference r=.457.

Table 7: Summarized Results for Hypotheses

Code	Hypotheses	Result
H_1	There is a significant relationship between organizational context toward nurses' satisfaction with the web-based meal ordering system for patients in a healthcare institute.	Supported: Strong relationship
H_2	There is a significant relationship between timeliness efficiency toward nurses' satisfaction with a web-based meal ordering system for patients in a healthcare institute.	Supported: Weak relationship
H_3	There is a significant relationship between interface characteristics toward nurses' satisfaction with the web-based meal ordering system for patients in a healthcare institute.	Supported: Moderate relationship
H_4	There is a significant relationship between individual differences in nurses' satisfaction with the web-based meal ordering system for patients in a healthcare institute.	Supported: Moderate relationship

From Table 7 above, the study's findings on factors influencing nurses' satisfaction with a web-based meal ordering system at a healthcare institute. Results indicate that organizational context has a strong positive relationship with satisfaction, suggesting its critical role in system acceptance. Timeliness efficiency shows a

weaker relationship, indicating that, while appreciated, it may not be a central determinant of satisfaction. Both interface characteristics and individual differences exhibit moderate relationships, highlighting that system design and personal variations among users moderately impact satisfaction. These insights underscore the complex, multifaceted factors shaping nurses' satisfaction with healthcare technology.

Discussion

The study's findings highlight significant relationships between independent variables and nurses' satisfaction with a web-based meal ordering system in a healthcare context. Pearson's correlation analysis confirmed a moderately strong positive relationship between organizational context and satisfaction (r = .520), suggesting that system integration within the organizational environment enhances usability for nurses, consistent with prior research on the role of context in perceived usefulness (Vernim & Reinhart, 2016). Timeliness efficiency showed a weaker yet significant association with satisfaction (r = .296), indicating that while timely performance is valued, it alone may not drive satisfaction due to possible misalignment with nurses' workflow (Sockolow et al., 2014). Interface characteristics also demonstrated a moderate correlation with satisfaction (r = .473), showing that a functional and navigable system design facilitates ease of use and enhances user experience. Collectively, these findings underscore that satisfaction with digital systems in healthcare is multi-dimensional, driven by organizational integration, functional efficiency, and user-centered design — aligning with previous literature on technology acceptance in healthcare.

5. Managerial Implications and Recommendations

This study highlights essential managerial implications for optimizing Hospital Information Systems (HIS), particularly web-based meal ordering systems used by nurses. Practically, these findings emphasize the need for seamless integration with the organizational context to support nursing workflows and patient care, reinforcing findings by Buntin et al. (2011) that electronic systems positively influence caregiving processes. Familiarity with system-specific medical terminology, as discussed by Hitt and Tambe (2016), is crucial for efficient usage, enabling nurses to manage dietary requirements and patient documentation effectively. To maintain adaptability, developers should design intuitive interfaces that allow nurses to navigate updates independently, minimizing disruptions to patient care. Organizational training should account for individual differences in technological skills, leveraging prior experience with similar systems to enhance usability. Theoretically, this study contributes to understanding key HIS satisfaction drivers, including timeliness efficiency, interface design, and individual differences. Future research could build on these findings by studying larger and more diverse healthcare samples and exploring constructs such as perceived quality and risk to deepen insights into nurses' satisfaction with HIS. Additionally, examining various healthcare contexts and conducting qualitative comparisons of different systems would provide valuable perspectives on system improvements, while exploring the psychological readiness of healthcare providers could further clarify the factors influencing technology adoption and satisfaction in complex medical environments.

Conclusion

This study examined key factors influencing nurses' satisfaction with a web-based meal ordering system in a hospital context, specifically focusing on organizational context, timeliness efficiency, interface characteristics, and individual differences. Targeting nurses at a healthcare institute in Putrajaya, the research successfully addressed all objectives and provided comprehensive answers to the research questions. Findings confirmed that these factors significantly predict nurses' satisfaction, highlighting the critical role of a well-integrated hospital information system (HIS) in supporting efficient patient record management and streamlined communication between nursing staff and hospital foodservice departments, particularly for meeting patients' dietary requirements. This system minimizes the need for nurses to leave the wards for dietary coordination, thereby enhancing workflow and operational efficiency. Overall, this research underscores the vital relationships between HIS attributes and user satisfaction, offering a foundation for future studies to explore this area on a broader scale and contribute further to advancements in healthcare technology and nurse-driven service optimization.

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Social Innovation and Sustainable Value Creation: Lessons from Indonesia's Community-Based Enterprises

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Abstract: This study explores how social innovation drives sustainable value creation within community-based social enterprises in Indonesia. This study employs a qualitative research design, drawing on five in-depth interviews with social enterprise leaders operating across renewable energy, digital education, waste recycling, microfinance, and community health sectors. The findings reveal that social innovation is shaped by a paradoxical interaction between constraints and enablers: while limited access to finance, regulatory ambiguity, and organizational fatigue hinder scalability, community trust, cross-sector collaboration, digital transformation, and learning orientation act as powerful countervailing forces. The study develops an integrative framework that links resource-based, institutional, and dynamic capability perspectives to explain how social enterprises convert social purpose into sustainable performance. It concludes that in resource-constrained environments, innovation flourishes not despite adversity but because of it when communities reconfigure scarcity into opportunity. The paper contributes to management theory by conceptualizing social innovation as an ecosystemic capability that fuses moral purpose, entrepreneurial logic, and adaptive learning, offering both theoretical and policy implications for strengthening social enterprise ecosystems in developing economies.

Keywords: *Social innovation, Sustainable value creation, Social enterprise, Community-based entrepreneurship, Dynamic capabilities, Institutional theory, Indonesia*

1. Introduction

In recent decades, the world has witnessed a paradigm shift in how societies address complex social and environmental challenges. Traditional government interventions and market-based solutions have often failed to deliver inclusive and sustainable development (Klarin & Suseno, 2023), particularly in emerging economies where inequality, poverty, and environmental degradation remain persistent (Basheer et al., 2022). Against this backdrop, social enterprise organizations that blend social missions with entrepreneurial mechanisms have emerged as key agents of change. They operate within the intersection of social purpose and business innovation, striving to achieve both economic viability and social impact (Commer Soc Sci et al., 2021; Taušl Procházková et al., 2021; Yu et al., 2022). Central to this mission is social innovation, which represents the process of developing and implementing novel solutions to unmet social needs through inclusive and participatory mechanisms.

In Indonesia, a country characterized by vast geographic diversity, rich cultural traditions, and deep socioeconomic disparities, social enterprises have become a vital component of the development landscape (Nanda et al., 2025; Sari et al., 2021). They provide innovative approaches to issues ranging from poverty alleviation and rural empowerment to waste management, education, and renewable energy (Nanda et al., 2025). These enterprises embody community-driven entrepreneurship, harnessing local knowledge and collective values such as *gotong royong* (cooperation) to promote sustainable livelihoods (Suryanto et al., 2020). Yet, despite their growing influence, a systematic understanding of how social innovation emerges,

operates, and generates sustainable value in the Indonesian context remains limited (Pujiastuti et al., 2025). Much of the existing research has focused on entrepreneurship, governance, or financial performance, leaving the innovation dimension underexplored.

The increasing global recognition of social innovation reflects a shift toward more inclusive and transformative forms of entrepreneurship (Ahmad & Bajwa, 2023). Unlike technological innovation, which primarily serves market competitiveness, social innovation emphasizes collective well-being, social justice, and systemic change (Pujiastuti et al., 2025). It challenges conventional business models by prioritizing human and environmental outcomes over short-term profitability. (Klarin & Suseno, 2023). As societies grapple with global crises from climate change to inequality, the role of social innovation in achieving the Sustainable Development Goals (SDGs) has become more urgent. Social enterprises thus represent living laboratories where new ideas for sustainable value creation are continuously tested, adapted and scaled.

The concept of social innovation has gained traction in academic and policy discourse as societies search for new mechanisms to address enduring social challenges. Social innovation is defined as the development and implementation of novel ideas, processes, or models that meet social needs more effectively than existing solutions while simultaneously creating new social relationships or collaborations (Milley et al., 2018; Tortia et al., 2020). It embodies both the outcome (a new product, service, or institution) and the process (collaboration, learning, and co-creation)(Sari et al., 2022). What distinguishes social innovation from other forms of innovation is its purpose to produce social value rather than private gain, and its process, which is inherently participatory, inclusive, and relational (Bock, 2016; Tortia et al., 2020).

In developed economies, social innovation has often been institutionalized through structured frameworks, government programs, and formal social enterprise ecosystems. In contrast, in developing economies such as Indonesia, social innovation frequently emerges from grassroots experimentation and informal networks (Setiadi, 2020). It is deeply embedded in community practices, local culture, and collective problem-solving traditions (Yaya et al., 2022). For instance, the community activities continue to influence how communities mobilize collective resources and co-create solutions (Winardi, 2020). These bottom-up dynamics highlight that social innovation in emerging economies is less about technological sophistication and more about adaptive, context-sensitive responses to social problems.

Scholars such as Milley et al (2018) Emphasize that social innovation should be viewed as a process of social transformation, one that reshapes power relations, enables inclusion, and enhances social capital. In this sense, innovation becomes a mechanism of empowerment, allowing the communities to reclaim agency over their development and growth (Harinurdin et al., 2025). For social enterprises, innovation is not merely an instrument for market differentiation but a pathway toward fulfilling social missions and ensuring long-term sustainability (Tortia et al., 2020). Understanding the interplay between innovation, institutional context, and community engagement is therefore crucial for theorizing the success of social enterprises in emerging markets.

Despite sustained economic progress, Indonesia continues to face structural issues such as limited access to basic services in rural areas, environmental degradation, digital literacy gaps, and public health disparities—conditions that create fertile ground for the emergence of community-based innovations. Social enterprises play a critical role in addressing these societal and market failures by offering grassroots solutions in sectors such as renewable energy (off-grid solar in NTT, Sulawesi), digital education (e-learning access in rural Java and Kalimantan), waste management (plastic circularity in Bali and Bandung), microfinance (community lending groups in West Java), and community health (posyandu-based preventive healthcare). These enterprises often combine entrepreneurial logic with strong community embeddedness, enabling them to respond effectively to local needs despite limited formal institutional support.

However, scholarly understanding of social innovation in Indonesia remains underdeveloped. Much of the existing literature centres on descriptive case stories, sector-specific interventions, or general discussions about the role of social enterprises in national development. There is limited empirical work explaining the *mechanisms* through which Indonesian community-based social enterprises innovate under conditions of resource scarcity, institutional ambiguity, and hybrid organisational logics. Moreover, most ASEAN-focused

studies have emphasised macro-level ecosystem factors (e.g., Malaysia's social enterprise blueprint, Vietnam's SME reforms, Cambodia's NGO-to-SE transitions), with relatively few providing deep qualitative insight into Indonesia's localised innovation dynamics. This gap is significant given that Indonesian social enterprises operate in some of the region's most diverse institutional environments—from urban Jakarta to remote Papua—requiring unique adaptive and relational strategies to sustain impact.

This study addresses the gap by examining how community-based social enterprises in Indonesia generate and sustain social innovation within complex socio-economic environments. Drawing on the Resource-Based View (RBV), institutional theory, and dynamic capabilities perspectives, this research investigates how organisations combine community trust, local knowledge, financial improvisation, partnerships, and learning routines to navigate institutional voids. The study contributes to a deeper theoretical understanding of social innovation in emerging economies and provides practical insights for policymakers, funders, and practitioners in Indonesia.

This study focuses on understanding how social innovation evolves and contributes to sustainable value creation within Indonesia's community-based social enterprises. It argues that innovation is not confined to technology or product development but extends to organizational processes, social relations, and governance mechanisms that foster inclusion and resilience. By analysing empirical insights from social entrepreneurs and community innovators, this paper contributes to the broader discourse on how social innovation can transform institutional structures and promote sustainable performance in emerging economies.

2. Understanding of Social Innovation

Social innovation refers to the development of new solutions, products, services, processes, or organisational models that address social problems more effectively than existing alternatives. In emerging economies such as Indonesia, social innovation frequently arises from local initiatives responding to unmet needs in rural electrification, informal waste management, digital education, microfinance access, and community healthcare. Studies in Indonesia highlight issues such as geographic fragmentation, limited public service delivery capacity, and institutional voids across sectors, which compel local actors to create context-specific social innovations. For example, renewable energy innovators in Nusa Tenggara Timur (NTT) developed community-owned solar grids to address unreliable electricity; waste recycling enterprises in Bali created plastic-to-fuel technologies; and community health programs in Java leveraged posyandu networks to improve maternal and child health.

Linking Innovation and Sustainable Value Creation

The relationship between innovation and sustainable performance in social enterprises can be understood through multiple theoretical lenses. The Resource-Based View (RBV) suggests that organizations gain a competitive advantage through unique, inimitable resources and capabilities (Wernerfelt, 1984). In the context of social enterprises, these capabilities often include social capital, trust, and stakeholder relationships that enable innovation under resource constraints (Bhatt & Altinay, 2013). The Dynamic Capabilities Theory extends this argument by focusing on the organization's ability to integrate, build, and reconfigure internal and external competencies in response to environmental changes (Lee & Chandra, 2020). This adaptability is particularly critical for social enterprises operating in volatile socio-economic contexts.

Meanwhile, Institutional Theory highlights how social innovation is embedded within broader systems of norms, values, and regulations (Carvalho et al., 2017). Social enterprises often operate in institutional voids where formal structures are weak (Stephan et al., 2015). Their legitimacy and sustainability thus depend on their capacity to align with community values while navigating bureaucratic and policy environments (Nanda et al., 2025). Finally, Stakeholder Theory provides an integrative perspective by emphasizing the importance of balancing multiple stakeholder interests, social, economic, and environmental, in pursuit of sustainable value creation (Costa & Pesci, 2016; Friedman & Miles, 2006). Together, these theories underscore that social innovation is both a capability and a process: a means of developing new solutions and an ongoing organizational learning journey.

From these perspectives, sustainable value creation emerges as the ability of social enterprises to deliver economic viability, social inclusivity, and environmental responsibility simultaneously. The creation of such

value depends on how effectively innovation capabilities are mobilized to address local needs and institutional challenges. In emerging economies like Indonesia, where institutional infrastructures are fragmented, social innovation becomes a bridge connecting community aspirations with systemic transformation.

Development of Social Innovation in Social Enterprises

The development of social innovation within Indonesia's social enterprises reflects a unique interplay of historical, cultural, and institutional dynamics. Although the formal concept of "social innovation" is relatively new, its practice can be traced to long-standing traditions of community cooperation and solidarity. (Nanda et al., 2023, 2025). Early cooperative movements, community saving groups, and religious-based welfare institutions have long addressed local development challenges through participatory approaches. The 1998 Asian financial crisis catalyzed the modern social enterprise movement, as communities sought alternative mechanisms to restore livelihoods and social cohesion.

Over the past decade, social enterprises in Indonesia have diversified significantly. They now operate in areas such as sustainable agriculture, renewable energy, waste management, and education technology (Pratono & Sutanti, 2016; Pujiastuti et al., 2025; Sengupta et al., 2020; Zahrah et al., 2024). This evolution has been driven by the democratization of technology, which has enabled new digital models for social innovation (Sommer et al., 2025) and policy shifts encouraging entrepreneurship and sustainable development (Pratono & Sutanti, 2016). This convergence of technological democratization and supportive policy frameworks marks a transformative phase in Indonesia's journey toward inclusive and sustainable social innovation.

However, despite these advancements, the social enterprise sector remains fragmented. Many initiatives depend on short-term donor support and lack systematic mechanisms for scaling innovation (Setiawan et al., 2023). The informal nature of most social enterprises also limits their access to finance and institutional recognition (Nanda et al., 2023; Widiastuti et al., 2019). Thus, while social innovation thrives at the grassroots, its long-term sustainability hinges on ecosystem coherence, capacity development, and policy alignment.

Prior research in Malaysia shows that micro-entrepreneurs often lack structured financial systems and formal accountability mechanisms, resulting in poor documentation and weak decision-making capabilities (Ahmad Nadzri et al., 2017). This pattern aligns with challenges observed in Indonesian social enterprises, where informal governance and inconsistent financial routines inhibit long-term planning and innovation. These weaknesses contribute to the broader organisational capacity gaps that hinder innovation, reduce investor confidence, and constrain enterprise scalability.

The Process of Social Innovation

Empirical evidence from social enterprise founders and managers reveals that social innovation often begins with the identification of unmet or misrecognized social needs. Entrepreneurs then engage in cocreation processes involving multiple stakeholders' beneficiaries, local leaders, volunteers, and private partners to design solutions tailored to community contexts (Nanda et al., 2025). The innovation process unfolds iteratively, characterized by experimentation, learning, and adaptation rather than linear planning (Tarlani et al., 2022).

For example, several interview respondents emphasized that innovation was born out of necessity rather than deliberate strategy. One founder remarked, *"We innovate because our community has no other option but to make the most of the resources available in our village. These limitations have driven us to focus on survival first. When better opportunities emerge, we will seize them as an opportunity to create, develop, and thrive."* This adaptive logic is typical in resource-scarce settings, where innovation stems from improvisation and local problem-solving. Another common theme was co-creation: entrepreneurs often act as facilitators rather than inventors, enabling communities to shape solutions (Tarlani et al., 2022; Wulandari & Wardani, 2024). A social enterprise leader noted, *"The successful innovations we have achieved are those that are cocreated, involving all stakeholders in the design process. Through collective discussions, the resulting innovations are more accurate and better aligned with the real needs of the community.* Such participatory approaches generate legitimacy and local ownership, key factors in sustaining innovation.

Respondents also highlighted the importance of hybrid business models that blend social and commercial logics. For instance, enterprises that provide affordable clean energy reinvest profits into community education, while others use digital marketplaces to support artisans and allocate a portion of sales to social programs. However, balancing social and economic goals remains challenging. Entrepreneurs face trade-offs between scaling up and maintaining mission integrity, as well as between innovation flexibility and financial discipline.

Co-creation is widely used in Indonesia, where solutions are co-designed with communities through participatory forums, stakeholder dialogues, and localised prototyping. This collaborative approach increases ownership and ensures relevance, especially in multicultural rural areas. Hybrid business models, combining social mission with commercial strategies, help enterprises diversify revenue and reduce donor dependency. However, hybridity also introduces tensions, such as balancing mission purity with income generation.

3. Methodology

This study adopts a qualitative exploratory research design to investigate how Indonesian social enterprises develop and sustain social innovation within complex socio-economic environments. The qualitative approach is well-suited for capturing nuanced experiences, cultural considerations, and context-specific strategies used by community-based organisations in Indonesia. Given the diversity of Indonesia's geography and institutional conditions, qualitative inquiry provides rich insights into how local actors interpret problems, mobilise resources, and engage with communities.

Purposive sampling was used to identify five social enterprises across different Indonesian regions and sectors, reflecting key development priorities: renewable energy (NTT/Sulawesi), digital education (Java/Kalimantan), waste recycling (Bali/West Java), microfinance (West Java) and community health (Java). Selection criteria included:

- minimum three years of operation
- active community engagement
- clear evidence of innovation
- willingness to participate.

This cross-sector representation ensures that findings capture Indonesia's diverse social enterprise landscape. Data were collected through five semi-structured, in-depth interviews with founders and senior managers. Interviews, lasting 60–90 minutes, explored topics such as the development of innovations, financial challenges, regulatory experiences, community engagement, and sustainability practices. Interviews were conducted via online platforms or in person, depending on participant availability. All interviews were audio-recorded with consent and transcribed verbatim. Field notes were used to document contextual factors such as cultural norms, geographic limitations, and local operational conditions.

Thematic analysis was applied to identify recurring patterns. NVivo facilitated systematic analysis and cross-case comparison. Themes were interpreted through the integrated theoretical lenses of RBV, institutional theory, and dynamic capabilities. Particular attention was given to Indonesian contextual features such as informal financing practices and local governance dynamics.

4. Findings

Key Challenges and Enablers of Social Innovation

Social innovation in emerging economies operates at the intersection of aspiration and adversity. Evidence from the five in-depth interviews conducted for this study reveals a paradoxical landscape: community-based social enterprises in Indonesia exhibit remarkable creativity and resilience yet face systemic barriers that constrain their capacity to scale and sustain impact. The narratives of the respondents, each representing different innovation domains in renewable energy (R1), digital education (R2), waste recycling (R3), microfinance (R4), and community health (R5), illustrate how social innovators navigate institutional voids, resource scarcity, and governance complexity through adaptive strategies and collaborative learning.

First, resource scarcity constitutes one of the most significant inhibitors to social innovation. Respondents consistently emphasized the absence of stable financial mechanisms for enterprises pursuing both social and economic objectives. These reflections illustrate the structural mismatch between social mission-driven innovation and market-based financing systems. The lack of patient capital and risk-tolerant investors limits experimentation, while short-term donor funding fosters dependency and volatility. The consequence is a cycle of "pilot project syndrome," where promising innovations struggle to transition into mature enterprises. From a theoretical lens, this challenge aligns with the resource-based view and institutional voids literature, which recognize that in developing contexts, access to financial and technical capital often determines the boundary between mission aspiration and operational sustainability.

The second challenge concerns the institutional uncertainty surrounding the social enterprise sector in Indonesia. The respondents described an ambiguous regulatory landscape in which social enterprises are neither fully recognized as commercial entities nor as charitable organizations. R4, the founder of a social microfinance network, noted, *"At times, we find ourselves uncertain about our position. The government often perceives us as a business entity, while investors and financial institutions tend to view us as a social organization."* This status undermines legitimacy and complicates compliance with financial and reporting regulations. R2's experience with her education platform further exemplified the issue: *"Every agency had different interpretations. We spent more time explaining our purpose than scaling our program."* Such bureaucratic inconsistencies impede the institutionalization of social innovation, forcing entrepreneurs to rely on personal networks and symbolic legitimacy rather than formal legal frameworks. Institutional theory suggests that legitimacy in such contexts is constructed through relational trust, moral credibility, and alignment with societal norms. In Indonesia, the cultural principle of *gotong royong* (cooperation) partially compensates for regulatory voids. (Winardi, 2020), enabling enterprises to anchor their legitimacy in community values even when formal recognition is absent.

Third, beyond external constraints, internal organizational dynamics also present obstacles to sustaining innovation. Respondents described what can be termed innovation fatigue, the erosion of enthusiasm and capacity over time, as enterprises struggle to reconcile social and economic imperatives. R5 reflected on his health innovation network: *"At the early stage of establishing the social enterprise, volunteers demonstrated strong energy and enthusiasm to develop the organization. Nevertheless, as financial resources diminished and organizational activities became less frequent, their motivation progressively declined and, in some instances, completely faded."* These experiences highlight the *hybridity paradox* inherent in social enterprises, where mission integrity and market viability must coexist within fragile governance structures. The absence of structured impact measurement systems further compounds the challenge, making it difficult to demonstrate outcomes to stakeholders or to secure long-term funding. The findings corroborate dynamic capabilities theory, suggesting that sustainable social innovation requires adaptive learning systems, leadership succession, and institutional routines that preserve mission focus while fostering entrepreneurial agility.

Fourth, in contrast to the structural barriers, several enabling conditions emerged as critical sources of resilience. Chief among these is social capital, rooted in trust, reciprocity, and local participation. R1 explained that they sought to foster motivational intentions among local institutions in their area. *"In our village, we have implemented a program to encourage the community to adopt renewable energy through the use of solar panels."* This participatory approach not only strengthened ownership but also reduced maintenance failures and improved long-term viability. Cross-sectoral partnerships also proved decisive. R2 explained, "*That collaboration with local universities enables their educational organization to co-develop curriculum and receive support from students and lecturers engaged in community service programs*". "Finally, R5 explained that they collaborated with local healthcare facilities to address community health issues.". These alliances demonstrate the importance of *network orchestration,* the ability to mobilize heterogeneous actors around shared value creation.

Furthermore, digital transformation has emerged as a powerful equalizer. Respondents leveraged digital platforms to overcome geographic isolation, attract donors, and scale awareness. R3 explains, "*Currently, we use digital platforms, particularly social media, to promote our social initiatives. Through social media, we are able to reach potential donors and encourage them to participate in our activities. The products we create are purchased by customers from various regions, which greatly supports the sustainability of our social programs"*.

These finding echoes research on digital affordances, which posits that technology enhances visibility, legitimacy, and stakeholder engagement for social ventures operating under institutional constraints. Digitalization thus enables resource-poor organizations to amplify impact by transforming narrative authenticity into relational capital.

Lastly, an important enabling theme across all cases was the culture of learning and intergenerational collaboration. Social enterprises that embedded reflection and experimentation into their organizational routines demonstrated greater adaptability and innovation longevity. R4 described "*At the beginning of each month, we evaluate the activities carried out during the previous month. This process aims to identify and address any challenges or obstacles collectively. The mistakes we make serve as valuable lessons for the organization's future development. Because this activity is conducted regularly, we can quickly find solutions to any failures we encounter."*

This practice aligns with the *dynamic capabilities framework*, emphasizing continuous sensing and seizing of opportunities in volatile environments. Youth engagement also emerged as a catalytic force. All five respondents noted that their organizations relied heavily on young volunteers and graduates who brought digital fluency, creativity, and moral enthusiasm. R2 *groomed second-line leaders, ensuring that innovation was not person-dependent but institutionalized as a collective value*". This intergenerational synergy between the energy of youth and the wisdom of experience represents one of the most enduring enablers of social innovation in Indonesia. Table 1 shows the challenges and enablers of social innovation.

Table 1: Challenges and Enablers of Social Innovation in Indonesian Social Enterprises

Item	Description	Implications
Challenges		
Financial resource scarcity	Limited financing, lack of patient capital	Constrains scaling and long-term planning
Institutional ambiguity	No clear legal category; fragmented policy interpretation	Weak legitimacy; inconsistent support; regulatory uncertainty
Hybrid model tensions	Balancing social mission and commercial viability	Risk of mission drift, volunteer burnout, and governance conflict
Limited organisational capacity	Informal systems, lack of impact measurement	Inhibits investor engagement and systematic scaling
Enablers		
Social capital and trust	Strong ties, community participation, cultural values	Enhances legitimacy, ownership, and sustained engagement
Cross-sector collaboration	Partnerships with universities, LGUs, NGOs	Expands technical expertise, networks, and resources
Digital transformation	Use of social media, e-learning, and online fundraising	Increases scalability, visibility, and financial resilience
Learning orientation and youth involvement	Regular evaluations, mentoring, and digital-savvy volunteers	Strengthens adaptability, knowledge transfer, and innovation continuity

This matrix enhances clarity and addresses the reviewer's request for a visual synthesis.

Segments and Impacts of Social Innovation Initiatives

Social innovation in Indonesia's social enterprises manifests across diverse sectors and community segments, each responding to specific social, economic, and environmental imperatives. These initiatives demonstrate that innovation extends beyond technological invention to include new governance arrangements, service models, and social relations that produce sustainable value. Empirical observations and interviews reveal that social innovation can be categorized into four interrelated segments: environmental innovation, educational innovation, economic empowerment, and social-welfare innovation. These segments, while distinct in focus, collectively contribute to the creation of integrated sustainable value, reinforcing one another through cross-sectoral synergies.

The environmental innovation segment has become increasingly visible as enterprises address pressing ecological challenges through circular economy principles and renewable resource management. Initiatives in waste recycling, eco-tourism, and clean energy exemplify how environmental objectives can align with community livelihoods. For instance, community-based waste cooperatives transform household waste into marketable recycled products, reducing pollution while generating local income. Similarly, micro-solar energy projects provide electricity access to remote villages, simultaneously improving education, health, and productivity outcomes. These initiatives embody *eco-social innovation,* a dual commitment to environmental stewardship and social inclusion. They not only mitigate ecological risks but also cultivate behavioural change among citizens, embedding sustainability in local culture.

The educational innovation segment focuses on closing learning gaps and promoting lifelong education, especially in underserved areas. Social enterprises operating in this domain use digital learning platforms, community libraries, and vocational training centres to enhance employability and digital literacy. Their pedagogical innovations often combine traditional learning values with technology-enabled delivery, creating hybrid models that are both culturally sensitive and scalable. A respondent leading a digital education enterprise explained, *"Our innovation was not about new content but new connections on how to make learning relevant for rural youth."* These initiatives underscore the role of education as both a means and an outcome of social innovation, strengthening human capital and fostering intergenerational resilience.

Economic empowerment forms the third major segment, representing the backbone of social innovation in Indonesia's rural and peri-urban communities. Enterprises in this category integrate microfinance, skill development, and cooperative entrepreneurship to create self-sustaining local economies. Smallholder farmer collectives and artisanal marketplaces exemplify inclusive economic innovation that redistributes value along supply chains. The impact of such initiatives is multifaceted, such as increasing income, reducing dependency on government aid, and enhancing community self-reliance. By embedding business principles within social missions, these enterprises challenge conventional notions of charity and introduce sustainable, market-oriented models of development.

The social welfare innovation segment addresses fundamental issues of health, well-being, and social justice. Initiatives focusing on clean water, sanitation, nutrition, and affordable healthcare illustrate how innovation can alleviate systemic poverty traps. These enterprises often operate in partnership with local governments and NGOs, leveraging collective resources to deliver high-impact, low-cost solutions. Importantly, many adopt participatory monitoring systems that engage beneficiaries in evaluating service quality, thereby enhancing accountability. For example, one community-driven health project combines mobile technology with volunteer networks to monitor maternal health in remote villages. Such hybrid mechanisms enhance both effectiveness and inclusivity, demonstrating that social innovation is not only about solving problems but also about reshaping social relations.

Across these segments, the impacts of social innovation can be analyzed through three dimensions of sustainable performance: economic, social, and environmental. Economically, social enterprises generate employment, diversify income sources, and attract impact investment, thereby contributing to local resilience. Socially, they enhance inclusion, strengthen community bonds, and foster empowerment, particularly among marginalized groups such as women and youth. Environmentally, they promote sustainable consumption, resource efficiency and ecological restoration. These outcomes are mutually reinforcing: economic empowerment supports environmental conservation, and social inclusion drives collective accountability for sustainability. Furthermore, the intangible impacts such as trust, collective identity and civic participation extend beyond immediate beneficiaries to reshape the broader social fabric. Social innovation thus operates as both a *process* and a *product* of sustainable transformation, redefining what it means to achieve development in a socially just and environmentally conscious manner.

5. Conclusion

Social innovation has emerged as a transformative force in reimagining how communities, institutions, and markets interact to achieve sustainable development. In Indonesia, social enterprises exemplify how innovation grounded in local wisdom, community collaboration, and social purpose can bridge the gap between

grassroots realities and global sustainability goals. The evolution of social innovation initiatives, from environmental entrepreneurship to inclusive education and digital empowerment, demonstrates that innovation in emerging economies is fundamentally relational and adaptive. It thrives on participation, social trust, and collective problem-solving rather than on technological sophistication alone.

From a theoretical standpoint, this study advances the conceptualization of social innovation as an ecosystemic capability that bridges institutional theory, resource-based perspectives, and sustainability transitions literature. It emphasizes that innovation within social enterprises should be viewed not as discrete events but as dynamic, iterative processes of sense-making and co-creation. The findings reaffirm the value of extending management theory beyond firm-level analysis to encompass community and system-level interactions. Future research should further examine the mediating role of institutional legitimacy, stakeholder trust, and social learning in linking innovation processes to sustainable outcomes.

For practitioners and social enterprise leaders, the study identifies several strategic priorities. First, innovation must be embedded in organizational routines through participatory management and collective decision-making. Second, enterprises should adopt hybrid performance frameworks that balance social impact with financial resilience. Third, digital tools can be leveraged not only for efficiency but also for transparency, stakeholder engagement, and impact storytelling. Finally, leadership development that emphasizes empathy, collaboration, and adaptive learning is essential to sustain innovation in dynamic environments.

This study illustrates that social innovation in Indonesian community-based enterprises is characterised by adaptive, relational, and resourceful practices shaped by local contexts. Despite facing financial scarcity, institutional uncertainty, and internal hybridity tensions, social enterprises demonstrate resilience through collaboration, digital adoption, and continuous learning. The findings contribute to the social enterprise literature by conceptualising social innovation as an *ecosystemic capability*, one that integrates community participation, entrepreneurial behaviour, and institutional navigation. Innovation thrives not by avoiding adversity but by transforming constraints into opportunities.

The broader implication is that social innovation should no longer be perceived as a peripheral or philanthropic pursuit. Instead, it represents a strategic governance mechanism, a mode of organizing resources, knowledge, and relationships to co-create sustainable futures. The Indonesian experience, while context-specific, offers universal insights including:

- Establish a formal legal framework for social enterprises to strengthen legitimacy, streamline reporting, and attract investors.
- Develop blended financing instruments—including catalytic grants, impact bonds, and social finance facilities—to support early-stage social enterprises.
- Strengthen community-based capacity building, especially digital literacy, governance training, and entrepreneurial skills.
- Promote cross-sector innovation platforms linking universities, ministries, corporations, and grassroots organisations.
- Invest in digital infrastructure to democratise access to online learning, e-commerce, and impact reporting tools

Future research could explore comparative studies of social innovation ecosystems across ASEAN countries to identify transferable models of practice. Longitudinal studies examining the lifecycle of social enterprises from inception to institutionalization would provide deeper insights into the sustainability of innovation trajectories. Integrating quantitative impact assessment with qualitative narratives can also enhance the methodological rigor of social innovation research, enabling more robust policy translation.

Social innovation in Indonesia offers a living illustration of how community agency, inclusive governance, and adaptive learning can transform social challenges into opportunities for sustainable growth. It bridges the moral purpose of development with the pragmatic tools of entrepreneurship. The lessons derived here transcend national boundaries: in a global context marked by uncertainty and inequality, the Indonesian model of community-driven innovation reminds us that sustainability is not an outcome to be delivered but a relationship to be continuously renewed. Social innovation thus emerges as the new frontier of management

thinking, one that redefines performance not by profit maximization but by the capacity to regenerate social, ecological, and institutional systems for future generations.

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