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Editorial

I am pleased to present Volume 4, Issue 1 of the UCP Journal of Business Perspectives. This issue brings together a timely collection of systematic reviews and empirical studies that address contemporary concerns in financial technology, investment behavior, macroeconomic stability, artificial intelligence, and sustainable supply chain transformation.

The first article, “Antecedents and Outcomes of Fintech Adoption Led to Sustainable Performance: A Systematic Literature Review,” provides a comprehensive synthesis of Fintech adoption and its contribution to sustainable performance. By identifying key antecedents, mediators, moderators, and outcomes, the study highlights how Fintech can support social, economic, and environmental sustainability while also clarifying future research directions in technology adoption.

The second article, “The Impact of Financial Literacy, Financial Behavior and Income on Investment Decision among Young Omanis,” shifts attention to individual financial capability and demonstrates the importance of financial literacy, disciplined financial behavior, and income in shaping investment decisions among youth. This study offers useful implications for educators, policymakers, and financial institutions seeking to strengthen financial awareness and responsible investment practices.

The third article, “Role of Inflation in Economic Growth of Country: A Global Perspective,” examines the complex and nonlinear relationship between inflation and economic growth. It shows that moderate inflation may support economic activity, whereas high and unstable inflation can weaken purchasing power, investor confidence, and macroeconomic stability, thereby emphasizing the need for adaptive and evidence-based policy frameworks.

The fourth article, “Artificial Intelligence Adoption in Sustainable Supply Chain Management: A Systematic Literature Review and Future Research Agenda,” explores how AI applications, including machine learning, predictive analytics, automation, and data-driven decision-making, can improve forecasting, logistics, inventory planning, resilience, traceability, and sustainability outcomes. At the same time, it identifies important challenges related to data quality, capability gaps, integration complexity, governance, and implementation cost.

The fifth article, “Impact of Digital Ambidexterity on Circular Supply Chain through Sustainable Operational Excellence and Supply Chain Resilience,” extends the sustainability discussion by showing how digital ambidexterity can enhance sustainable operational excellence and supply chain resilience in manufacturing firms, while offering strategic insights for circular supply chain management.

Collectively, these studies underscore the importance of integrating digital innovation, financial awareness, macroeconomic policy, artificial intelligence, and supply chain capabilities to foster resilience, competitiveness, and sustainable growth in an increasingly complex business environment.

We sincerely thank the authors for their valuable contributions, the reviewers for their insightful feedback, and the editorial team for their continued commitment to maintaining high academic standards. We invite scholars and practitioners to build on these insights and contribute to responsible innovation and sustainable development.

Dr. Muhammad Athar Siddiqui
Editor-in-Chief
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Antecedents and Outcomes of Fintech Adoption Led to Sustainable Performance: A Systematic Literature Review

Sahiba Anwer^{1*}, Khawar Hussain¹

ABSTRACT

The systematic literature review focuses on Fintech adoption and sustainable performance to fill this theoretical research gap in the literature. Adopting the TCCM research design, the study establishes the antecedents, mediators, moderators, and outcomes of Fintech adoption while detailing its sustainability implications. The review integrates 29 peer-reviewed manuscripts from 2019 to 2024, with social influence and performance expectancy. The findings establish Fintech as an important driver of improvement in the sustainability performance of social, economic, and environmental metrics. The identified methodological trends reflect the ongoing dominance of the TAM and UTAUT frameworks. The perceived technological advancements of Fintech and sustainability use the TAM most often because it is associated with technology acceptance. Despite that, the conceptual confusion between Fintech and Fintech adoption is addressed in this study. However, the current study defines areas for future paradigms, such as the moderating role, including new theoretical perspectives, and directions for further research. Together with this knowledge synthesis, the Fintech-based approaches reported in this manuscript enhance the development of academic accounts and applications for attaining sustainability.

Keywords: Fintech Adoption, Sustainable Performance, Environmental Performance, Social Performance, Economic Performance, Systematic Literature Review, Future Research Agenda.

1. INTRODUCTION

Today's world is experiencing immense growth in technological developments due to concerns about sustainability (Arner et al., 2020; Atayah et al., 2023). In recent years, there have been a few technological developments aimed at addressing sustainability concerns. One example of this convergence of innovative technology and sustainability practices is the rise of financial technologies, known as "Fintech", which has become an upcoming force in the financial industry

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(Hammadi et al., 2019; Arner et al., 2020; Vergara & Agudo, 2021; Atayah et al., 2023; Rambaud & Pascual, 2023). Particularly, "Fintech" refers to using technological innovations to provide users with financial services (Deng et al., 2019; Dwivedi, Alabdooli, & Dwivedi, 2021). In terms of efficiency and consumer experience, Fintech companies perform much better than traditional or old financial institutions. Fintech developments have gone through four stages over time (Arner, Barberis, & Buckley, 2017; Arner, Buckley, Charamba, Sergeev, & Zetzsche, 2022). The first stage includes analogue financial services, which are considered a part of Fintech 1.0 (1866-1967). The second stage includes digitization that occurs during Fintech 2.0 (1968-2008), propelled by advancements in digital technologies for communication and transactions. Beginning in 2009, Fintech 3.0 brings with it a great enhancement in advanced economies, such as the use of smartphones, digital cryptocurrencies, and digital services. Finally, Fintech 3.5 anticipates the adoption of these technologies in emerging nations, promoting growth and financial inclusion, and becomes a more attractive field for researchers.

Understanding its enhancement and significance, numerous previous studies have examined Fintech and sustainability from a variety of angles, including the adoption of green banking with sustainability (Tara & Singh, 2019) and the effect of Blockchain in banks (Ji & Tia, 2022). Fintech adoption for green banking disclosure (Bose, Khan, Rashid, & Islam, 2018) and sustainable banking (Yan, Siddik, Yong, Dong, Zheng, & Rahman, 2022). The majority of empirical research, however, has concentrated on discrete or isolated elements (Fintech or sustainability) or both (Guang-Wen & Siddik, 2023; Nenavath, 2022). Gomber, Kauffman, Parker, and Weber (2018) define Fintech as financial technology to enhance the efficiency of financial institutions. However, Chen, Wu, and Yang (2019) define Fintech adoption; there is a difference between Fintech and Fintech adoption. According to Chen et al., users adopt financial technologies and attach them to their daily usage process to enhance the ease of their work and efficiency. Despite that, the body of research on both perspectives of Fintech and sustainability is still fragmented and understudied. As a result, researchers like Ellili (2022) have emphasized the importance of performing review studies to portray Fintech and sustainability from an industry perspective in a comprehensive and sophisticated manner. However, the adoption of these technologies that augment sustainable performance is not well comprehended. Therefore, a comprehensive summary of important concepts and their relationships will act as a guide for further study (Ellili, 2022). As technological advancements are increasing, the adoption of Fintech is also increasing.

Nowadays, technologies are adopted by individuals, so it is necessary for further research to deeply examine the effect of Fintech adoption on sustainable performance. Financial technologies are considered most important for the development and also for the sustainable environment. Meanwhile, financial innovation or technology makes it possible and may lead to new business models,

applications, procedures, or goods that have a significant impact on financial markets, institutions, and the delivery of financial services (Pashang & Weber, 2021). Fintech has attracted a lot of buzz and scholarly attention in recent years (Vergara & Agudo, 2021; Zarrouk et al., 2021). It can also be crucial in achieving SDGs (Deng et al., 2019). After studying the emerging concept of Fintech adoption, the current study conducts a systematic literature review on how Fintech adoption leads to sustainable performance and presents the summarized work of the last six years on this specified topic. This review tries to fill these research gaps in this SLR that employed the Theory-Context-Characteristics-Methodology (TCCM) paradigm introduced by Paul and Rosado-Serrano (2019) to fully grasp the Fintech adoption that leads to sustainable performance. Three main factors led to the selection of the TCCM (framework). To identify this framework, the study should answer the following questions: What are the antecedents and outcomes of adopting Fintech that lead towards sustainable performance (2019-2024)? Which theories support the impact of financial technology adoption on sustainable performance? What are the methodologies that are used in the adoption of Fintech to enhance sustainability? Lastly, to define the future directions for future researchers. The succeeding sections in this paper are organized as follows: the research approach defined in the methodology section; after that in the result section the current paper defines the innovative technology that affects multiple dimensions; gives proof of the discovered connections and describes the connection using a variety of theoretical frameworks. The TCCM approach is defined after the methodology section, which elaborates on the theories, context, and characteristics connected with the technology adoption. In the last section, the practical and policy implications, limitations of this study, and further directions will be discussed.

2. LITERATURE REVIEW

The concept of sustainability originated in the 20th century, and various researchers define it. Publications on "sustainability" have grown significantly over the previous 20 years to the extent that "sustainability science" is mostly viewed as a separate field (Kates et al., 2001; Komiyama & Takeuchi, 2006; Schoolman, Guest, Bush, & Bell, 2012; Kajikawa, Tacoa, & Yamaguchi, 2014). Three related "pillars" are used in one particularly common definition of "sustainability." Authors define it as a 'pillar' (Basiago, 1999; Pope, Annandale, & Morrison-Saunders, 2004; Gibson, 2006; Waas, Hoge, Verbruggen, & Wright, 2011; Schoolman et al., 2012; Moldan et al., 2012; Boyer et al., 2016), many authors describe it as 'dimensions' (Stirling, 1999; Lehtonen, 2004; Mori & Christodoulou, 2012; Carter & Moir, 2012), and it is defined as 'components' by these authors (Pisani, 2006; Zijp et al., 2015). Because of the rise of the Sustainable Development Goals (SDGs) and digital transformation, innovative adoption and sustainability are the main topics of this study. Technology and sustainability are becoming hot topics for governments to guarantee high SDG

compliance as well as for researchers to study the effects of digitization. The previous ten years have seen a significant evolution in financial technologies due to advances in digitalization (Ellili, 2022).

The first academic study on Fintech was conducted in 2015, yet the word "Financial" was first proposed in the early 1990s (Puschmann, 2017). Since 2000, Fintech has gained momentum when the concept of mobile banking was introduced. Financial services were accessible through mobile banking and mobile banking platforms (Ullah & Khan, 2024). The government and SBP (State Bank of Pakistan) have developed many policies to enhance the adoption rate of technologies in Pakistan. This study focused on Fintech adoption, which is somewhat a conceptual confusion between Fintech and the Fintech adoption. There is a difference between the concepts of Fintech and the Adoption of Fintech. The term Fintech is referred to as "Innovative technology", which is utilized to increase the efficiency of financial services by using technology that includes Blockchain and mobile banking. Financial institutions use these technologies with financial services to increase their accessibility (Gomber et al., 2018).

However, the adoption of innovative technologies is defined by Chen et al. (2019); financial institutions and individuals adopt innovative technologies and integrate them with their daily usage services through the factors of ease and trust. Despite that, the current study conducted an SLR on the summarization of the last six years' work that was published on the topic of Fintech adoption towards sustainable performance.

First, it builds the current state of knowledge on the attaining of innovative technology research and their current research focus on top contributing publishers, frequently used keywords like "Fintech", "adoption", "Fintech adoption", "Fintech", and most cited authors; second it outlines theories of a contemporary and historical nature to the organizations and countries that have been involved in Fintech research, major precursors and methods that are most often used. The most frequently studied theories include UTAUT, UTAUT2, TAM, and ecological modernization theory that support the adoption of new and innovative technologies, despite that it is also supported by the previous studies which were conducted by the researchers (Almaqtari et al., 2024; Igamo et al., 2024; Almashhadani et al., 2023; Siddik et al., 2022; Nugraha et al., 2022; Hasan et al., 2021; Setiawan et al., 2021; Singh et al., 2020; Dwivedi et al., 2021). Third, knowledge gaps in the research area and the potential for future research are also shown. Fourth, it identifies research gaps and suggests directions for future inquiry. The current study provides insights into technology adoption. The objective of the existing study is to identify the moderators and mediators that can be studied in Fintech through a systematic literature review. The systematic review of Fintech adoption is based on the 29 scholarly articles whose information has been thoroughly examined to determine the antecedents and outcomes of Fintech adoption.

3. METHODOLOGY

3.1 Research Approach

The current study aimed to define an integrated framework that encompasses financial technology adoption. To attain this framework, the current study performed a systematic literature review (SLR) since this technique provides a deep analysis of the relevant studies on this topic as well as possessing the ability to identify further untested ideas. Furthermore, using an explicit and systematic methodology to assess a stream of material improves the standards of the evaluation process and results (Tranfield et al., 2003). We applied an inductive research methodology to the final sample of articles for content analysis.

3.2 Description of the Review Process: Data Collection

Different kinds of databases were utilized for data collection, including Scopus, Google Scholar, and Web of Science. Google Scholar is considered one of the largest databases; however, Web of Science and Scopus are comprehensive databases. For the first search, different keywords and terms were used independently, and Boolean operators like "AND" and "OR" were combined with the keywords "Fintech", "financial technology", "green technology", "Fintech adoption", "Financial technology adoption", "innovative technology adoption".

3.3 Description of the Inclusion Criteria

For this study to incorporate the identified papers had to meet specific requirements. To perform this systematic literature review, the current study selected articles that were published from 2019 to 2024. Additionally, since these are thought to offer reliable data and hence have the most influence in the area, the publications had to be published in peer-reviewed journals with an impact factor (Podsakoff et al., 2005); however, the articles must be in the English language and contain research related to Fintech adoption.

3.4 Data Extraction Procedure

The initial step of the sample data included an examination of the irrelevant data. According to this, the abstracts of the articles were evaluated in light of the inclusion criteria. After reviewing the abstract, if it still appeared similar/relevant, the introduction, methodology portion, and discussion sections were then read and concluded, including any impacts of Fintech adoption on the given variables.

A flow chart showing the selection procedure for articles to be included in this review is shown in Figure 1. Step 1 identified 105 articles (Google Scholar: 85; Scopus: 20). In Step 2, the sample was reduced by 10 articles because of duplication. In Step 3, the abstracts of the articles were reviewed according to the criteria; after reviewing, 48 articles were excluded because they were irrelevant to the study. In

Step 4, the introduction, methodology, and discussion sections were reviewed thoroughly according to inclusion criteria, which led to a further 11 articles being excluded because of lower impact factors. In the last step, after the exclusion, 36 articles were found to be relevant to the current study's questions. Moreover, when the final process was determined, 7 articles were removed because they were not specifically relevant to the perspective of Fintech adoption. After this last filter, 29 articles remained that satisfied all inclusion requirements.

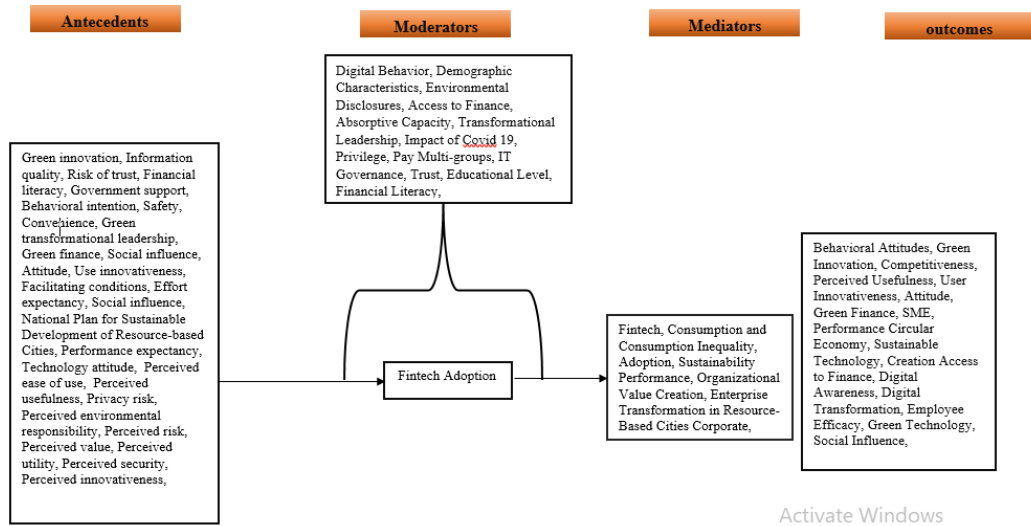


Figure 1. PRISMA Flow Chart — Article Selection Procedure

4. FINDINGS

Table 1 Theories used in Fintech Adoption

Theory	Articles (N)	References
UTAUT	7	Chan et al., (2022); Tariq et al., (2024); Sharma et al., (2024); Almarshhadani et al., (2023); Kurniasari et al., (2023); Xie et al., (2021); Singh et al., (2020).
UTAUT2	2	Idrees et al., (2024); Hassan et al., (2024).
TAM	9	Almaqtari et al., (2024); Igamo et al., (2024); Almarshhadani et al., (2023); Siddik et al., (2022); Nugraha et al., (2022); Hasan et al., (2021); Setiawan et al., (2021); Singh et al., (2020); Dwivedi et al., (2021).
TPB	2	Aggarwal et al. (2023); Liu et al. (2023).
Resource-based view (RBV)	1	Serdarusic et al. (2024).

Practice-based view (PBV)	1	Hidayat-ur-Rehman et al. (2023).
Ecological modernization theory (EMT)	1	Siddik et al. (2023).
EMT and AMO theory	1	Siddik et al. (2023).
Dynamic capabilities theory (DCT)	1	Siddik et al. (2023).
TRA	1	Roh et al. (2022).
Macroeconomic theory	1	Yang et al., (2022).

Table 1 describes the theories used in previous studies from 2019 to 2024. The most recommended and studied theory is the Technology Acceptance Model (TAM) which is used in 9 articles: Almaqtari et al. (2024), Igamo et al. (2024), Almashhadani et al. (2023), Siddik et al. (2022), Nugraha et al. (2022), Hasan et al. (2021), Setiawan et al. (2021), Singh et al. (2020), and Dwivedi et al. (2021). These studies show that TAM is the most used study and has a higher effect on technology adoption. However, the second most used theory is the Unified Theory of Acceptance and Use of Technology (UTAUT). The researchers Chan et al. (2022), Tariq et al. (2024), Sharma et al. (2024), Almashhadani et al. (2023), Kurniasari et al. (2023), Xie et al. (2021), and Singh et al. (2020) describe in their studies that UTAUT has a greater effect on innovative technology adoption.

4.1 Characteristics

A construct's characteristics are its constituent parts and how they relate to other relevant factors (Paul, Khatri, & Duggal, 2023). In addition to the results, we include a summary of the domain's antecedents, moderators, and mediators.

Table 2 *Antecedents of Fintech Adoption*

Variables	Article (N)	References
Social influence	8	Almashhadani et al. (2023); Xie et al. (2021); Kurniasari et al. (2023); Hassan et al. (2024); Sharma et al. (2024); Idrees et al. (2024); Chan et al. (2022); Tariq et al. (2024).
Performance expectancy	7	Xie et al., (2021); Kurniasari et al., (2023); Hassan et al., (2024); Sharma et al., (2024); Idrees et al., (2024); Chan et al., (2022); Tariq et al., (2024).

Effort expectancy	7	Xie et al., (2021); Kurniasari et al., (2023); Hassan et al., (2024); Sharma et al., (2024); Idrees et al., (2024); Chan et al., (2022); Tariq et al., (2024).
Trust	5	Nugraha et al., (2022); Roh et al., (2024); Tariq et al., (2024); Hasan et al., (2021).
Perceived risk	4	Almashhadani et al. (2023); Xie et al. (2021); Chan et al. (2022); Tariq et al. (2024).
Facilitating conditions	4	Tariq et al., (2024); Idrees et al., (2024); Hassan et al., (2024); Xie et al., (2021).
Financial literacy	4	Nugraha et al. (2022); Kurniasari et al. (2023); Siddik et al. (2023); Igamo et al. (2024).
Perceived ease of use	3	Hasan et al. (2021); Almashhadani et al. (2023); Hasan et al. (2021).
Perceived usefulness	3	Igamo et al., (2024); Hasan et al., (2021); Almashhadani et al., (2023).
Government support	2	Nugraha et al. (2022); Igamo et al. (2024).
Perceived value	1	Xie et al. (2021).
Safety	1	Hasan et al., (2021).
Technology attitude	1	Singh et al. (2020).
Green innovation	1	Liu et al. (2023).
Perceived environmental responsibility	1	Liu et al. (2023).
Green finance	1	Guang-Wen et al. (2023).
Green transformational leadership	1	Siddik et al. (2023).
Information quality	1	Aggarwal et al. (2023).
Perceived innovativeness	1	Hassan et al., (2024).
Perceived security	1	Hassan et al., (2024).
Convenience	1	Sharma et al., (2024).
Behavioral intention	1	Sharma et al., (2024).

In Table 2, the variable represents the core focus of most studies in the sample. The references indicate substantial scholarly interest in understanding the adoption of Fintech technologies across various contexts. Studies like Dwivedi et al. (2021) and Yan et al. (2022) have explored the factors influencing Fintech uptake, while others such as Siddik et al. (2023) and Guang-Wen et al. (2023) have delved into regional or sectoral adoption patterns. Overall, Fintech adoption remains the

central theme in this body of literature, reflecting its importance in the financial technology domain. The table summarizes key determinants influencing Fintech adoption, reflecting a comprehensive blend of factors from social and psychological influences to performance expectations and risk perceptions. The highest number of references associated with Fintech adoption underscores its centrality to the research, while the recurring appearance of social influence (8 articles). The studies by Almashhadani et al. (2023) and Xie et al. (2021) show that social factors play a critical role in encouraging adoption. Performance expectancy (7 articles): key studies like Xie et al. (2021) and Kurniasari et al. (2023) have examined how performance-related expectations influence the decision-making process, suggesting that users are more likely to adopt Fintech. Effort expectancy (7 articles): studies by Xie et al. (2021) and Kurniasari et al. (2023) indicate that Fintech solutions that are user-friendly and require less effort to navigate are more likely to be adopted. This signals that users' perceptions of ease and benefit are pivotal in adopting Fintech technologies. Trust (5 articles): Nugraha et al. (2022) and Roh et al. (2024) have emphasized that users need to trust the technology, the institutions providing the Fintech services, and the security of their data. Risk (4 articles): Tariq et al. (2024) and Hasan et al. (2021) highlight the potential concerns users have regarding the uncertainty or negative consequences associated with Fintech adoption. This analysis helps to structure future research by focusing on these core variables and understanding how they interrelate to impact the Fintech adoption process.

Table 3 *Outcomes of Fintech Adoption*

Variables	Articles (N)	References
Consumption and consumption inequality	1	Yan et al., (2022).
Sustainability performance	12	Dwivedi et al. (2021); Yan et al. (2022); Liu et al. (2023); Kurniasari et al. (2023); Siddik et al. (2023); Tian et al. (2023); Hidayat-ur-Rehman et al. (2023); Almaqtari et al. (2024); Serdariusic et al. (2024); Rehman et al. (2024); Hidayat-ur-Rehman (2024).
Corporate carbon emission	1	Wang et al., (2024).
Environmental performance	2	Guang-Wen et al. (2023); Siddik et al. (2023).

Different types of outcomes are defined in Table 3. These articles explore different factors driving the adoption of Fintech, such as technological readiness, trust, ease of use, and social influence, but also delve into sector-specific and region-specific adoption trends. The high number of articles underscores that Fintech adoption is both a broad and complex subject encompassing various contexts and dimensions, which makes it a major focus for researchers. Sustainability

performance is another highly researched area, appearing in 12 articles. This is notable because it connects the Fintech industry with environmental, social, and governance (ESG) concerns, reflecting a growing interest in how Fintech innovations contribute to sustainable business practices. Studies like those by Dwivedi et al. (2021) and Liu et al. (2023) investigate how Fintech can enable or enhance sustainability by promoting efficient resource usage, reducing carbon footprints, or fostering socially responsible investments. The variable "Consumption and Consumption Inequality" referenced by Yan et al. (2022) highlights a more niche area of research. Wang et al. (2024) focus on Fintech's impact on corporate carbon emissions, exploring how Fintech innovations contribute to reducing emissions and promoting environmentally sustainable practice.

Table 4 *Mediators of Fintech Adoption*

Variables	Articles (N)	References
Behavioral attitudes	2	Singh et al. (2020).
Competitiveness	3	Dwivedi et al. (2021); Hidayat-ur-Rehman et al. (2023); Rehman et al. (2024).
Perceived usefulness	1	Nugraha et al. (2022).
User innovativeness	1	Nugraha et al. (2022).
Green innovation	3	Yan et al. (2022); Guang-Wen et al. (2023); Siddik et al. (2023).
Attitude	1	Roh et al. (2022).
Fintech adoption (FTA)	7	Liu et al., (2023); Aggarwal et al., (2023); Almashhadani et al., (2023); Igamo et al., (2024); Serdarusic et al., (2024); Hassan et al., (2024); Tariq et al., (2024).
Green finance	3	Yan et al. (2022); Liu et al. (2023); Rehman et al. (2024).
SME performance	1	Kurniasari et al. (2023).
Circular economy	2	Siddik et al. (2023); Hidayat-ur-Rehman et al. (2023).
Access to finance	1	Siddik et al. (2023).
Digital awareness, digital transformation	1	Serdarusic et al. (2024).
Social influence	1	Chan et al., (2022).

Table 4 shows that Fintech adoption as a mediator has a stronger influence on the sustainability performance in the presence of other variables. According to these researchers, Liu et al. (2023), Aggarwal et al. (2023), Almashhadani et al. (2023), Igamo et al. (2024), Serdarusic et al. (2024), Hassan et al. (2024), and Tariq et al. (2024), Fintech is playing a crucial role in environmental, social, and economic

performance. The other factors have a lower mediating effect; future researchers can adopt this variable in their model to examine the influence.

Table 5 *Moderators of Fintech Adoption*

Variables	Articles (N)	References
Digital behavior/transformation, demographic characteristics	2	Singh et al. (2020); Rehman et al. (2024).
Access to finance, absorptive capacity	1	Siddik et al. (2023).
Transformational leadership	1	Hidayat-ur-Rehman et al. (2023).
Impact of COVID-19	1	Almashhadani et al. (2023).
Privilege pay	1	Aggarwal et al. (2023).
Multi-groups	1	Igamo et al., (2024).
IT governance	1	Almaqtari et al., (2024).
Trust	1	Hassan et al., (2024).
Educational level	1	Idrees et al. (2024).
Financial literacy	1	Chan et al., (2022).

Table 5 of this study clearly shows that the moderators are not purposively explored in this topic. The digital innovation variable is rarely used in two studies: Singh et al. (2020) and Rehman et al. (2024). This lower influence of the moderating variable provides a great opportunity for future researchers to utilize the moderating effect in their studies to find out the strength of the moderator in the causal relation.

4.2 Context

In a study, "context" refers to the particular circumstances and social or economic environment in which the study is carried out (Lim, Yap, & Makkar, 2021). In addition to outlining the trends of international research collaborations in this field, we categorized the studies under review according to the countries in which they were carried out from 2019-2023. Twenty-one countries were linked to articles about Fintech, technology adoption, and sustainability. China, India, and the United Kingdom were the most productive of these, accounting for 19% and 10% of all publications, respectively. The United Kingdom (5), India (4), China (4), and the United States of America (4) had the most international research collaborations.

Table 6 *Research Strategies Used in Fintech Adoption*

Research Strategy	Article N	References
Survey	27	Singh et al., (2020); Dwivedi et al., (2021); Xie et al., (2021); Roh et al., (2022); Liu et al., (2023); Kurniasari et al., (2023); Setiawan et al., (2021); Hasan et al., (2021); Siddik et al., (2023); Guang-Wen et al., (2023); Tian et al., (2023); Siddik et al., (2023); Hidayat-ur-Rehman et al., (2023); Aggarwal et al., (2023); Almashhadani et al., (2023); Igamo et al., (2024); Almaqtari et al., (2024); Serdarusic et al., (2024); Hassan et al., (2024); Sharma et al., (2024); Idrees et al., (2024); Chan et al., (2022); Tariq et al., (2024); Rehman et al., (2024); Hidayat-ur-Rehman (2024); Nugraha et al., (2022); Siddik et al., (2022).
Econometric model	1	Yan et al., (2022).
National Tax Survey Database (NTSD)	1	Wang et al., (2024).

Table 6 depicts that 27 studies out of 29 used the survey strategy. The following researchers: Singh et al. (2020), Dwivedi et al. (2021), Xie et al. (2021), Roh et al. (2022), Liu et al. (2023), Kurniasari et al. (2023), Setiawan et al. (2021), Hasan et al. (2021), Siddik et al. (2023), Guang-Wen et al. (2023), Tian et al. (2023), Siddik et al. (2023), Hidayat-ur-Rehman et al. (2023), Aggarwal et al. (2023), Almashhadani et al. (2023), Igamo et al. (2024), Almaqtari et al. (2024), Serdarusic et al. (2024), Hassan et al. (2024), Sharma et al. (2024), Idrees et al. (2024), Chan et al. (2022), Tariq et al. (2024), and Rehman et al. (2024) used the survey strategy in their studies.

Table 7 *Research Philosophies Used in Fintech Adoption*

Research Philosophy	Article N	References
Positivism	26	Singh et al., (2020); Dwivedi et al., (2021); Xie et al., (2021); Roh et al., (2022); Liu et al., (2023); Kurniasari et al., (2023); Setiawan et al., (2021); Hasan et al., (2021); Siddik et al., (2023); Guang-Wen et al., (2023); Tian et al., (2023); Siddik et al., (2023); Hidayat-ur-Rehman et al., (2023); Aggarwal et al., (2023); Almashhadani et al., (2023); Igamo et al., (2024); Almaqtari et al., (2024); Serdarusic et al., (2024); Hassan et al., (2024); Sharma et al., (2024); Idrees et al., (2024); Chan et al., (2022); Tariq et al., (2024); Rehman et al., (2024).

Table 7 illustrates that other researchers typically do not include this final part of our synthesis in systematic literature reviews. Our research details the theoretical frameworks that the writers have employed to bolster the literature on sustainability performance. Twenty-six of the 29 reviewed studies addressed the research topics of Fintech adoption using a positivist methodology. Five papers, however, are not clearly defined. As a result, the philosophical perspective that spatiality literature occupies within the corpus of knowledge is understood, and future scholars are guided to employ various philosophical lenses as well.

Table 8 *List of Journals Used in Fintech Adoption*

Journal	Articles N	Reference
Journal of Open Innovation: Technology, Market, and Complexity	7	Idrees et al. (2024); Sharma et al. (2024); Almaqtari et al. (2024); Igamo et al. (2024); Hidayat-ur-Rehman et al. (2023); Nugraha et al. (2022); Setiawan et al. (2021).
Management Decision	1	Singh et al. (2020).
International Journal of Global Business and Competitiveness	1	Dwivedi et al. (2021).
Journal of Theoretical and Applied Electronic Commerce Research	1	Xie et al. (2021).
Asia-Pacific Journal of Business Administration	1	Rehman et al. (2024).
Global Business Review	1	Hasan et al., (2021).
Journal of Banking and Finance	1	Yan et al., (2022).
Systems	1	Siddik et al. (2022).
Electronic Commerce Research	1	Roh et al. (2022).
Sustainability	2	Kurniasari et al. (2023); Liu et al. (2023).
Environmental Science and Pollution Research	2	Guang-Wen et al. (2023); Siddik et al. (2023).
Journal of Innovation and Knowledge	1	Siddik et al. (2023).
Journal of Cleaner Production	1	Siddik et al. (2023).
Cogent Economics and Finance	1	Aggarwal et al. (2023).
Cogent Social Sciences	1	Almashhadani et al. (2023).
Economies	1	Serdarusic et al. (2024).
Business Strategy and the Environment	1	Wang et al., (2024).

Journal of Financial Services Marketing	1	Hassan et al., (2024).
International Journal of Bank Marketing	1	Chan et al., (2022).
Heliyon	1	Tariq et al., (2024).

Antecedents		
Individuals' Behavior related Antecedents	Environment Related Antecedents	Economic Related Antecedents
Technological Attitudes (Responsiveness and Security) Fintech Adoption, Perceived Risk, Social Influence, Performance Expectancy, Effort Expectancy, Facilitating Conditions, Habit, Attitude Government Support, Financial Literacy Perceived Ease Of Use, Perceived Usefulness, Safety Trust User Innovativeness Social Influence Green Innovation, Perceived Environmental Responsibility	Sustainable performance Environmental sustainability Social sustainability	Economic sustainability performance
Outcomes		
Individuals' behavior-related Outcomes	Environment Related Outcomes	Economic Related Outcomes
Intention to use Fintech Intention to adopt Fintech Adoption attitude Actual behavior to adopt Actual usage of technology intention toward Fintech adoption actual adoption intention Fintech usage behavior use behavior towards Fintech adoption behavioral intention toward Fintech adoption actual behavior usage	Sustainable performance Actual behavior toward sustainable performance Intention towards performance Adoption behavior toward sustainability adopt agricultural Fintech products and services (BIAFPS) corporate carbon emission environmental performance	Economic Sustainable performance, Actual behavior toward economic performance Intention towards economic Access to finance Financial literacy rate

Figure 2. *Conceptual Framework for Reviewed Studies of Fintech Adoption*

5. DISCUSSION

This discussion section provides a summary of the review's findings. Due to the topic's novelty, one of the main or critical challenges in this critical review faced by the researchers is the number of articles about the connection between Financial technology adoption and sustainability performance. This study thoroughly examined the research on the causation between technology, such as Fintech adoption, and sustainable performance between 2019 and 2024. Three primary clusters were found in this review: sustainability performance. The three dimensions

— social, economic, and environmental performance — are the main focus of the current study. Furthermore, the findings highlight international partnerships in particular nations that aid researchers in identifying possible joint ventures for their upcoming studies and the most pertinent research methodologies to use.

In the updated discussion, we shall now clearly expound how each of the major factors, including perceived ease of use, trust, technological readiness, financial literacy, and regulatory environment, affects Fintech adoption. For example, we cite the positive influence of perceived ease of use on user intent, as noted in articles such as Venkatesh et al. (2022) and Zhou et al. (2021), which highlight the decreased cognitive barriers to action. We also comment on the fact that trust is especially important in situations where users are sensitive to the privacy of data and financial fraud, which is confirmed by results obtained by Alalwan (2022). The individual factors are now placed in context with theoretical arguments as well as empirical evidence to give the discussion a deeper level of interpretation.

We have included a comparative sub-section, which talks about how the adoption of Fintech changes based on culture and national contexts. We can compare, as an example, the results of high-trust economies such as Sweden and South Korea, where the speed of adoption is higher because of well-developed digital infrastructures and institutional trust (Lee et al., 2023), and emerging markets such as Pakistan and Nigeria, where the pace of adoption is slowed down by low financial literacy and regulatory uncertainty (Ahmed et al., 2021; Chukwu et al., 2022). These comparisons show that there is a big difference in the role of socio-economic factors, cultural uncertainty avoidance, and technological infrastructure. We think that such cross-contextual discussion gives a subtle insight into the dynamics of Fintech adoption.

Many previous studies have explored the relationship between these two phenomena from different perspectives, such as green technologies in the banking industry (Dwivedi, Alabdooli, Dwivedi, 2021), the green finance effect in banking and small and medium enterprises, and the technology effect on sustainable banking (Nugraha, Setiawan, Nathan, & Fekete-Farkas, 2022). Most of the studies focus on the SDGs in the banking industry. Sustainable performance has three exclusive dimensions that are equally important and have been less explored in previous studies. This systematic literature review adopts the TCCM approach to conduct a detailed review. Quantitative methods, especially questionnaires, are most commonly used in previous research. However, due to these technologies, environmental sustainability is increased by increasing investment in green bonds, and sustainability is also increasing.

This study addresses loopholes/gaps in the existing literature on Fintech and sustainable performance (SP) by providing organized, comprehensive data. To enhance the understanding of all relevant interactions between innovations in Fintech

and consequences for benchmarks of sustainable performance, the discussion of the paper focuses on key competitive attributes, including the publishing activity and authors.

Using content analysis, the research explores predictors, outcomes, and boundary conditions within the Fintech-Sustainable performance connection. Synthesizing the body of known knowledge about the contributions of Fintech to sustainability goals, this analysis discusses the past, present, and future of this industry. The frequency tables, which are made by the author of this review, describe all possible variables, including predictors, mediators, moderators, and outcomes.

6. THEORETICAL IMPLICATIONS

Theoretical implications are also supported by this study (Macchiavelli & Siri, 2022). As Fintech solutions often promote sustainable finance (e.g., green bonds), consumers' growing awareness of environmental issues may drive the adoption of Fintech solutions that align with sustainability goals. Technological Innovation: The theory emphasizes the role of technology in driving societal change, suggesting that innovations in Fintech, such as Blockchain for transparency or digital currencies for low-carbon footprint activities, can create a positive external environment for adoption. Fintech adoption, particularly in the context of sustainable finance (investing in eco-friendly projects, green Fintech), can contribute to achieving broader environmental and social goals, aligning with the SDGs (Sustainable Development Goals). As consumers embrace Fintech platforms that support ecological causes (e.g., sustainable investment options), this can lead to shifts in broader consumer behavior toward environmentally conscious financial decisions.

Our results have implications for Fintech adoption theory as they confirm and expand current adoption models (e.g., TAM, UTAUT) to the setting of modern Fintech ecosystems. In particular, we have found that the factors of trust and perceived risk become more prevalent adoption predictors than the classic ones, such as performance expectancy, especially in societies that are less digitally mature (e.g., Ahmed et al., 2021). Financial literacy is a moderating variable that multiplies or diminishes the impact of other drivers of adoption and has been insufficiently investigated in previous frameworks. The importance of regulatory support cannot be left in the background as an enabling factor, but should be brought to the forefront as a variable that impacts the perceived legitimacy and user trust in Fintech platforms. Such results narrow the gap in our theoretical comprehension of Fintech uptake by instating trust, financial literacy, and institutional relationships as the main, rather than marginal, variables.

We have now introduced a prospective theoretical lens by describing how all of the significant factors can define future adoption paths of Fintech. Trust: With the evolution of digital ecosystems, the domain of trust is expected to shift towards system-based trust, rather than interpersonal trust, which will demand that Fintech companies focus on algorithmic explainability and data control. Technological Readiness: As new technologies, such as blockchain, AI, and open banking APIs, emerge, the technological preparedness of users to embrace such technology will be of increased importance, and thus tech-skilling should take center stage in adoption theory. Financial Literacy: It is possible that in the future, Fintech models will include embedded financial education as an element of the user flow, and financial literacy becomes not only a prerequisite but a design variable. Regulatory Environment: With the growing adaptive regulatory sandboxes and decentralized financial systems, the theories on adoption in the future will have to consider dynamic regulatory models and participatory regulatory models. Cultural Norms: Cultural changes, particularly between collectivist and individualist cultures, can produce a redefinition of the parameters of social influence and risk aversion, which in turn might indicate the necessity to develop culturally-dependent adoption models.

7. PRACTICAL IMPLICATIONS

Policymakers and future researchers can explore this study, which is a summarized form of the previous literature on the topic of how Fintech adoption leads to sustainable performance. Through this literature review, the novel technologies that increase the performance of sustainability are highlighted. This is also beneficial for financial institutions for the enhancement of technologies to reduce environmental problems and increase investment in eco-friendly projects. Shareholders and stakeholders must adopt the technologies, which include Blockchain, AI (artificial intelligence), and IoT (Internet of Things), to increase financial access towards sustainable performance and reduce transaction costs. New technologies like blockchains, which are transparent, reduce waste, and enhance the transparency of resources through the inclusion of green bonds and investment in green projects. The government and policymakers can enhance and pay attention to the digital infrastructure and financial literacy, as also supported by the study of Qaiser and Fahad (2024).

According to our empirical evidence and cross-study synthesis, the following factors are what financial institutions need to be strategic about: Consumer Trust, Technological Readiness, Financial Literacy, Perceived Ease of Use, and Regulatory Transparency. These are key motivators of Fintech uptake and also systematic as well as consumer-facing challenges that institutions ought to proactively tackle. Consumer Trust: Banks ought to invest in AI-based fraud detection, real-time risk analytics engines, and safe cloud environments to improve the trustworthiness of online transactions. Institutions can adopt AI-powered chatbots and anomaly

detectors, and blockchain-powered audit trails to make their digital interactions transparent, consistent, and secure, thus strengthening trust. Technological Readiness: Banks and Fintech companies have to continuously upgrade their legacy systems, improve interoperability across digital platforms, and utilize low-code/no-code interfaces to hasten the time to market their services. Partnerships with technology startups and use of agile developmental structures would help increase flexibility and responsiveness to changes in the market. Financial Literacy: The interactive financial education modules need to be included by institutions as part of mobile banking applications and digital wallets. Awareness of interest rates and security, as well as digital savings tools, can be increased through gamified learning, micro-courses, and real-time prompts (e.g., during transactions). Perceived Ease of Use: The needs of users should be put at the center of the design. These incorporate multilingual provisions, user-friendly interfaces, and voice-activated commands to render the digital platform inclusive and user-friendly, particularly among low-digital-literacy people. Regulatory Transparency: Institutions are encouraged to get involved in open banking regulations, have clear terms-of-service disclosures, and work with regulators to co-create conditions in sandboxes where safe experimentation can happen and innovations can be publicly trusted.

8. LIMITATIONS AND RECOMMENDATIONS

In the framework of Fintech and sustainability performance, we primarily synthesize new ideas, contexts, traits, and approaches. We anticipate the review's conclusions will contribute to a broader understanding of the circumstances among scholars and practitioners. More precisely, mapping out the most widely accepted theories, settings, variables, methodologies, and documents and identifying possible future research topics that they should focus on may be helpful to academics in this discipline. Additionally, this will enhance their comprehension of how Fintech contributes to the development of sustainable performance. These recommendations are for both researchers and the government. First, in the future, researchers must introduce tokenized currency, that is, valuable, traceable tokens, including renewable energy investment. Second, create portfolios that should be personalized, and their profits utilized in eco-friendly projects. Third, sector-specific analysis of green bond effects on sustainability. Further, regional and cultural variations in how culture and economic structure affect the green market and technology in various regions. Lastly, regulatory frameworks or policy effects on sustainable performance or green markets.

The review includes several limitations in addition to the noteworthy theoretical and management consequences already discussed. Initially, the search query's titles, abstracts, and keywords contained general terms associated with sustainability and Fintech. The second limitation is that the study considers articles; future researchers can include books, dissertations, and case studies.

9. CONCLUSION

There are various amounts of research conducted on this contemporary trending topic; the research is conducted in different contexts, and different types of variables are studied. This study uses the SLR technique to investigate the variables found in the academic literature that affect the adoption or use of Fintech services. The results of this study show that several factors influencing Fintech adoption have been reported in the literature. The most commonly applied theories include TAM, UTAUT, and UTAUT2. Quantitative studies are more frequently used in 29 studies conducted by the SLR. Even other studies that are not part of this SLR used the quantitative methodology. This systematic review provides a summarized form of technology adoption, which was not previously available. Through this review, the researchers can easily understand the stage of the technology's effect on sustainable performance. This summarization makes this review different from previous empirically tested studies or detailed bibliometric analyses. According to the nature of the study, the positivist philosophy is used in most of the studies.

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The Impact of Financial Literacy, Financial Behaviour, and Income on Investment Decision among Young Omanis

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ABSTRACT

There are several connected financial factors. Thus, how financial knowledge, financial behavior, and wealth influence the investing decisions of young Omanis is an essential topic to address. Independence is based on investment, which leads to the growth of finances and the stability of the future. Investment, however, needs other necessary factors to make it effective. Financial literacy is an essential element that improves the level of an individual and makes him sail through the world and make the right decisions according to the correct financial tools. This, on the other hand, makes them able to make informed and error-free investments. Financial literacy of young Omani helps them to perceive every facet of life in a financial sense. Financial behavior involves the way people spend/savings and other financial aspects of their income. It is also a core element of successful and risk-averse investments since the provision of control over their actions gives people financial freedom. The most useful financial aspect that facilitates investment is income, which dictates the kind and magnitude of investment that an individual can make. Income is the most important element among the three elements discussed in this study. In addition, data were collected to support the study using quantitative research approaches, such as administering a questionnaire to elicit opinions on the influence of financial literacy, financial behavior, and income on Omani youth investment decisions. It was concluded that financial literacy, financial behavior, and income directly affect the investment decisions of Omani youth, as the availability of these elements in the responses enables them to choose investments in the best way. Omani youth, as observed through the data, still lack all of these elements, meaning there is a limitation in each element. Therefore, this means the urgent need to include all of these elements and incorporate them into the lifestyle of every individual in the youth category to achieve economic growth and prosperity and make investments for Omani youth successful and risk-free.

Keywords: Financial Literacy, Financial Behavior, Income, Omani Youth and Investment Decisions

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1. INTRODUCTION

The Sultanate of Oman has undergone significant development within the banking sector in recent years, and along with this has been a huge drive in economic diversification. This development has increased banking options in the nation and helped integrate technology-based finance services such as digital currencies and other innovative financial solutions. These milestones reflect the reform efforts of Oman to adapt to the financial transformation taking place globally, but they also have made financial decision-making more complex for people, especially young Omanis, who now have to make informed decisions regarding saving and investing in a rapidly changing financial environment (Sulatana, 2023).

Financial literacy is the ability to comprehend, utilize, and make decisions about personal financial situations. It is central to financial behaviour, and affects financial planning, spending, saving, and investment. An educated individual in financial matters is likely to have a better ability to manage financial resources, to allocate income to essential needs, and to minimize risk due to poor financial management (Abdeldayem, 2016). Despite Oman being considered a developing country, however, it has been found in earlier studies that many young people lack financial literacy. This financial illiteracy could lead them to ineffective money management and poor investment strategies.

Income, saving behavior, and investment behavior are highly related to financial literacy and financial behavior. Financial literacy is not enough if it's not accompanied by responsible financial behaviour. Even if a person knows very little about money, he or she could make an uninformed or inappropriate financial decision if that knowledge is not converted into appropriate financial actions. Income is also an important factor affecting investment decisions on investment since it dictates the amount of income that is available for investment. Investment may be out of the question for youth because they are in a different financial situation than they were when they were younger, such as their own personal consumption, family responsibilities, and the financial demands of everyday life. This can make investing seem unsafe and limit investment options due to limited income. Conversely, increased and stable income can enhance opportunities for investment and increase confidence and capacity to engage in financial markets among individuals (Maalouf & Sawaya, 2023).

So, it is crucial to investigate the impact of income, financial behaviour and financial literacy on investment decisions of young Omani investors. Knowing these relationships can be useful to Oman's response to changing global financial conditions and to minimise its future risks from bad financial planning and investment choices. The results can also help policymakers, teachers and financial institutions in creating awareness programs on financial literacy, responsible

financial behavior and improved financial management. Such programs can motivate youth to make responsible investment choices which could have a constructive influence on country development (Saleem & Khan, 2020).

Oman has experienced relatively low levels of development concerning investment awareness, financial behaviour, and financial education historically. But the recent economic and social changes have helped youth in Oman to become more aware of finances, have improved their financial habits, and have raised their level of income opportunities. These gains have not been swift enough or experienced by all groups. Financial awareness among young people is still quite low, and they still have problems in making effective investment decisions (Mubin et al., 2019). More recent research also indicates that financial literacy is still low among many young Omanis, and that this may be associated with sub-optimal financial habits including impulse spending and poor savings practices, which are not conducive to rational personal financial planning (Sultana, 2025).

A lack of financial skills and lack of good financial habits can make it hard for people to have financial stability and could make them vulnerable to risks they can't handle. Moreover, income is an important determinant in the capacity and desire to invest. Investment can be different among people depending on their income level, with investment being more feasible and more attractive when income is stable and adequate. The above are therefore important pillars which can be used to build individual financial security and social and economic development in general (Amini et al., 2025).

Financial literacy, financial behaviour and income are indeed key determinants of investments, yet studies on this aspect are limited in Oman context. Specifically, there is a pressing need for empirical evidence on the effects of these factors on the investment decision-making of Omani youths. This study is thus directed towards the analysis of financial literacy, financial behaviour, and income effect on investment decision-making of youth in Oman. The NCSI survey for 2024 found that 75% of people aged 18 to 29 save regularly at least a portion of their income. While this could be seen as a sign of saving behaviour, it may be considered as not enough when compared to the country's financial development objectives and international benchmark of financial awareness among youth (Mittal, 2022). This underscores the importance of improving financial education and awareness campaigns to have young Omanis play a more active role in society, particularly in saving, investing, and financial planning, in a responsible manner (Khan & Ahmad, 2021).

This study is important due to the role it aims to highlight for the Omani youth in the financial and investment sectors. Financial awareness and knowledge are vital to both help people manage their finances and to prevent them from taking

risks in terms of financial losses or failure to invest. By making robust investment decisions, young Omanis can create a solid financial future. On the other hand, lack of financial awareness and poor financial behaviour can have negative impacts on the financial and investment sectors of any nation (Khan & Ahmad, 2023).

The study has significance in various ways. First, it is targeted specifically at Omani youth and aims to improve their knowledge of financial literacy and financial behaviour. This can help them to reduce financial risks and establish a solid platform for making responsible investment decisions that are responsible. The financial development of the youth is linked with national development since they are the future and the energy of the nation. Secondly, its study is applicable in educational institutions. Financial knowledge and skills are key to the success of many young people; and the absence of financial awareness among many young people implies that financial knowledge and financial behaviour issues need to be incorporated into educational curricula. This would enable to give practical financial skills to the students, which would be helpful for their personal and professional lives. Third, the study is useful to financial institutions. The knowledge about saving and investment preferences of young Omanis will allow Financial Institutions to tailor their products and services to align with the needs and expectations of this group of young people. The study can also serve as a model to grasp the financial habits of young people in Oman and help institutions begin to navigate a more sophisticated and modern financial landscape. Lastly, this research is beneficial for future researchers. As the number of studies in this direction is small, the present study can add to the existing knowledge and motivate other researchers to study financial literacy, financial behaviour, income, and investment decision-making in Oman. This can encourage more research in this area and more scholarly and hands-on interest in youth financial development and its contribution to national economic growth (Arianti, 2018).

2. LITERATURE REVIEW

2.1 Financial Literacy

Financial literacy plays a central role in investment decisions made by young Omani nationals. It is the key driver of comprehension regarding the operations of the financial system and developments within the banking sector. It means that it determines one's capacity to comprehend financial terms and concepts pertaining to various financial decisions, such as investment decisions. It sets one's capacity to comprehend the investment process. Investing involves much more and cannot be conducted by anyone easily without knowledge and comprehension of the basics related to investing (Meskys et al., 2020). Those interested in investing in something must have adequate knowledge and understanding of the basics related to investment to evade various hurdles and difficulties arising out of various investment concepts and information. Financial literacy forms a critical determinant regarding one's

investment abilities and a fundamental driver. Low levels of financial literacy result in little knowledge and comprehension about investment decisions. Inadequate knowledge and comprehension related to investment decisions lead to poor investment decisions compiled with various financial hazards and risks (Mittal, 2022).

2.2 Financial Behavior

Financial behavior ranks as the main factor in making investment decisions. This is because an individual's actions dictate the right investment approach. This therefore means that saving ranks among the most valuable actions an individual can undertake, as it allows them to make an investment. Saving constitutes a valuable investment trait, resulting in high investment potential and valuable investment opportunities. In most instances, an individual with investment goals will approach savings with caution and have sufficient finances to undertake the investment journey. Optimal financial behavior, in terms of an individual's ability to distinguish between sound behaviors like saving, financial planning, and controlling spending, and unsound behaviors like financial extravagance, excessive spending, and a lack of financial planning, leads to financial risks that limit an individual's investment capacity. In other words, the sounder an individual's financial behavior, the more capable they are of engaging in sound investments without any future financial risks that could harm them (Nugroho et al., 2018).

2.3 Income Level

Income is a pivotal and constant element that fundamentally and centrally influences investment decisions. Its influence is so strong that it determines whether or not an individual will invest. Therefore, income is the foundation of the investment process, enabling individuals to obtain information regarding the various investment opportunities; it is income that determines the type or value of investment an individual should pursue and take risks in. It is generally accepted that the higher and more likely the income is to increase, the greater the investment opportunities. Even if the income is stable and high, investment opportunities still exist, but this requires careful consideration because a fixed income that cannot be increased may lead to miscalculations in investment processes (Meskys et al., 2020). If the income is fixed and only meets the individual's needs, and there is no other source of income, then this type of individual should not engage in investment processes, as their income is insufficient for any type of investment. Therefore, income is considered the primary determinant of an individual's ability to invest. It is clear that the higher the income and the more diversified its sources, the greater the investment opportunities, and conversely, the lower the income, the fewer the investment opportunities (Masini et al., 2012).

2.4 Investment Decision

Investment decisions are used as the option between two or more investment alternatives of investments, which can include buying fixed assets, stocks and bonds, or development of an already existing project. The decision is informed by an analysis of the returns and risk of each of the alternatives. Moreover, investment choices are also one of the most crucial financial choices that a person needs to make to guarantee a more secure future and present financial stability, ensuring that he or she is comfortable and lives without any financial hazards (Shintawati & Budidarma, 2023). The significance of investment choices to the youths is that they enable them to earn more profits and attain economic growth, enhance the competitiveness of the institutions, make the most out of the available financial assets, and help in ensuring financial stability in the long term. There are various types of investment decisions: short term investment, which are investments like the highly tradable securities that strive to get the liquidity and the quick returns; long term investment, which are those investments made on the purchase of machinery and equipment or the purchase of the large projects, which seek to get the sustainable future returns; real investments, which are the real estate and productive projects; and financial investment, which are the stocks, bonds and certificates of deposit. Investment is an essential element in life that helps people to have a good financial future (Maalouf et al., 2023).

2.5 Nexus of Financial Literacy, Financial Behavior, and Income on Investment Decisions

Financial literacy, financial behavior, and income on investment decisions: These fundamental elements are the determinants and motivators of optimal investment, as is commonly understood. They play a crucial role in enabling a country's economic development by considering each element and working to achieve it in order to make it viable for the country and optimally utilize the global economic driver (Shintawati & Budidarma, 2023). Financial literacy, according to global studies, is something that some advanced European countries include in their school curricula and give close attention to so that the individual is prepared from a young age. Therefore, we find that some Britons, Swiss, and Germans from the age of 7 and above have a good grasp of financial terms such as assets, inflation, and profit. Investment is also given high importance in terms of understanding the concept, meaning of investment, its implications, and how to make sound investments. Regardless of the fact that these countries are advanced in many fields other than financial management, this aspect is what has contributed to making them countries of global importance and high standing. There are also many countries in the world that give high importance to financial literacy in terms of establishing it from a young age, given that it is the basis for global economic advancement (Maalouf et al., 2023). Financial behavior, according to statistics, has a significant impact on investment decisions globally. An individual's behaviors, such as sound

or unsound spending, saving, and other financial practices, determine their financial orientation. The financial orientation of each individual in a given country is an economic driver; that is, an individual's behavior towards money can lead to various projects, businesses, and informed investments. Consequently, this is the catalyst for a country's economy, resulting in high growth and profits (Shintawati & Budidarma, 2023). Income varies from country to country, depending on the currency and the systems and laws followed by countries worldwide. There is no single standard for individual income globally. Therefore, we find that some countries have very high incomes from various jobs, which incentivizes investment compared to other countries where job income may be insufficient. In such cases, people resort to external work to increase their income and make it more attractive for various investments. We also note that income may be stable and sufficient to replace other sources, or it may be less so. Therefore, investment based on income varies from country to country depending on the sources of income (Eko, 2022).

2.6 Main Hypothesis

The hypothesis derived here is the direct relationship hypothesis between financial behavior and investment decisions. This means that the more sound and error-free financial behavior, the greater the investment opportunities. Furthermore, there is a positive influence between sound financial behavior and investment decisions.

The hypothesis derived here is that income level is directly related to sound investment decisions or investment opportunities. That is, the higher the income and the potential for further increases, the greater the investment opportunities. In addition, the positive correlation between them suggests that income is the primary driver of informed investment decisions.

3. RESEARCH METHODOLOGY

3.1 Research Design

Researchers typically select the techniques and methodologies used in any research project. The research design is defined as the article or document containing vital information about the project's details, including its techniques and methods. Furthermore, researchers and experts define the research design as the link and fundamental element that governs the project's progress. It brings together all the project's influencing elements and connects them through the relationships between these elements. Additionally, the research design is a structured framework that organizes the project in a unified manner, making it easier for the reader to understand the research components smoothly and without any complexity, leading to clear and positive results (Berman et al., 2020). A quantitative research strategy

was chosen based on the goals of the study. A questionnaire with several questions on the research aimed at youth will serve as the main source. Literature pieces, other websites, earlier publications, and print and e-books will all be considered secondary sources. The goal is to collect as much information and data as feasible for the research. As a result, just one approach was selected to investigate how financial behavior, income, and financial literacy affected Omani youth's investment choices (Chalmers & Cudwell, 2021). A thorough understanding of this influence on Omani youth's investment choices will be provided by the quantitative technique, which will produce numerous numerical figures and increase the study data's trustworthiness. Since the study includes variables such as financial literacy, financial behavior, and income, this methodology will facilitate the process of determining the degree of correlation and relationship between each of them.

3.2 Population of the Study

The study population consists of young Omanis aged 18 to 35, both male and female. Therefore, the sample is not random, as the study is limited to a specific nationality (Omani) and a specific age group, within a defined and unalterable scope. The study's focus is not on the entire population, but rather on a specific, limited range that cannot be broadened. A sample of 150 to 200 participants was selected, and this will be discussed later.

3.3 Sampling Technique and Sample Size

Simple non-random sampling is the best method for studying the impact of financial literacy, financial behavior, and income on investment decisions among Omani youth, given the limited scope of this research. Choosing simple non-random sampling in this study is the most appropriate and beneficial for achieving the desired results. This method allows the researcher to conduct a streamlined and efficient research process, facilitating the statistical analysis and making the analysis easier and more accurate without the need for subsequent review to ensure accuracy. Consequently, it produces an excellent report, both statistically and research-wise, and minimizes errors. Furthermore, it helps in drawing more accurate and objective conclusions. It also allows for precise representation of the target population without including any unintended or non-targeted groups, thus ensuring the study's narrow scope (Van Haute, 2021). This makes the study more objective, helps reduce biases, and guarantees the accuracy and reliability of the results at the end of the study. Several important factors must be considered when determining sample size, including the required confidence level, the acceptable margin of error, and the size of the population. The sample size must be sufficient to represent the target population and its diversity to meet all research requirements, such as the target age range. As mentioned previously, the sample size taken from the study population is

200 individuals. A sample size calculator was used, and the resulting sample size was 132.

3.4 Data Collection Techniques

Since the research methodology is based on only one approach, which is the quantitative approach, this is known as the "mono" method, which means relying on only one research method or approach and not combining them. The choice is between the quantitative or qualitative approach (Taherdoost, 2021). The quantitative research method was addressed through the questionnaire that will be distributed to the target group simultaneously to obtain responses and analyse them in relation to the research. The target group is Omani youth aged between 18 and 35 years, males and females. The questionnaire includes questions of a diverse nature and with clear differences to ensure the comprehensiveness of the study and the diversity of answers and opinions. All questions in the questionnaire will be closed because closed questions in the questionnaire are very clear and easy to ask individuals, thus enabling the collection of responses more quickly without the individual having to think deeply, which makes them unable to answer and thus delays obtaining the necessary responses. In addition to this primary source, several secondary sources were included, from which much important information related to the study was derived. These sources resulted in a highly significant understanding that encourages different perspectives and supports the study. Among these sources are previous international and local articles, as well as books and various websites that specifically address the factors influencing investment decisions among Omani youth.

3.5 Data Analysis Technique

This involves distributing a questionnaire to the target group, Omani youth, to determine the impact of financial literacy, financial behavior, and income on their investment decisions. Data collected via Google Forms will be entered into an Excel file to obtain numerical statistical results using specialized software such as SPSS/Excel and JASP for descriptive statistics. This will allow for several analyses, including graphical and descriptive analysis, regression, and correlation. The resulting tables will be arranged for both regression and correlation to provide error-free descriptive analysis results, ensuring the accuracy of the included statistical information, which is compiled according to sound statistical principles.

4. RESULTS

4.1 Descriptive Statistics

Table 1 *Descriptive statistics of key variables*

Statistic	Investment Decision	Income Level (IL)	Financial Behavior (FB)	Financial Literacy (FL)
Mean	2.6770	2.4482	2.5862	2.7044
Standard Error	0.0211	0.1138	0.1198	0.1203
Median	2.6737	2.4000	2.5000	2.5714
Mode	2.6000	2.4000	2.5000	2.8571
Standard Deviation	0.1137	0.6133	0.6452	0.6478
Sample Variance	0.0129	0.3761	0.4164	0.4197
Kurtosis	2.8928	1.1669	-0.1295	0.0920
Skewness	1.5075	1.3433	0.7669	0.8205
Range	0.4666	2.0000	2.5000	2.2857
Minimum	2.5333	1.8000	1.5000	1.7142
Maximum	3.0000	3.8000	4.0000	4.0000

The table shows findings of the descriptive statistical analysis of four key variables, which are investment decision, income, financial behavior, and financial literacy. The mean values were relatively close (ranging from 2.44 to 2.70), which means the average level of these factors in the sampled group was stable. Financial literacy had the best mean, and the dispersion measured by standard deviation was lower when compared to the investment decision variable because the other variables had a higher dispersion. The Skewness values are positive, indicating that the variables are shifted in a right direction and hence the majority of the responses are on the left side of the mean. The kurtosis values show the variance of the data distribution with the pointy (in the investment decision) to the slant, which creates a complete picture of the character and distribution of factors that determine the financial investment decisions of the sample.

On the issue of financial literacy and investment decision, we find that financial literacy reported the largest mean (2.70), more than the investment decision mean (2.67). This indicates that the sample has high financial literacy levels, and it is possible that there is a correlation between financial awareness and informed investment decisions, with financial literacy serving to support the process of enhancing the quality of investment decisions. Financial Behavior and Investment Decision: The standard deviation of financial behavior (0.64) was relatively high, thus showing a high degree of difference in financial habits among the sample. The

convergence of the means, however, points to the fact that disciplined financial behavior is directly connected with the stability of investment decisions; the more disciplined financial behavior, the more it is possible to follow long-term investment decisions. Income and Investment Decision: Income had the lowest mean (2.44) and the largest range (Range = 2) of the variables, meaning there is a disparity between the income levels. Having the standard deviation of the investment decision being very low (0.11), it can be concluded that the sample tries to take safe and homogeneous investment choices, disregarding their different incomes. This can imply that the urge to invest is present in all people despite income status, but low income could restrict the magnitude or nature of the investment.

4.2 Correlation

Table 2 *Correlation matrix of key variables*

Variable	Investment Decision	Income Level	F.B	F.L
Investment Decision	1			
Income	-0.4097	1		
Financial Behavior	0.2311	-0.3447	1	
Financial Literacy	-0.2180	0.2015	-0.3579	1

The table above displays the intensity and the trend of the relationship between both variables and the investment decision. Income has an average relationship of about -0.40 with the investment decision. This shows that changes in the level of income are the most strongly correlated factor with the decision to invest compared to the other factors statistically. There is a poor positive correlation of 0.23 between financial behavior and investment decision. There is a poor negative relationship between financial literacy and investment decision at -0.21. This regression study will explore the joint effect of these factors on investment decision. Model strength: The three variables provide a discussion of one of the most important determinants of investment choices: the influence of income. Considering the p-value of each variable, income was 0.0705. This is because in statistical analysis, the closer the value is to 0.05, the more significant it is. Income is the only variable that is close to having a real and clear effect on investment choice in this sample compared to financial behavior (0.76) and financial literacy (0.53).

According to the statistical findings, all the elements under study (income, financial behavior, and financial literacy) exhibit different extents of correlation with investment decisions. But income is the most dominant and determining factor in this analysis, as it has the highest direct correlation coefficient of -0.40. Moreover, the outcome of the regression proved it to be the closest variable to reach statistical significance, and the probability value was 0.07. This proves that financial capability

(income) has the greatest impact on the investment orientations of the sample as compared to financial knowledge or behavioural patterns, which proved weak and statistically insignificant in this model.

4.3 Regression

Table 3 Regression summary output

Regression Statistics	
Multiple R	0.436002
R Square	0.190097
Adjusted R Square	0.092909
Standard Error	0.108316
Observations	29

Table 4 ANOVA table

	df	SS	MS	F	Significance F
Regression	3	0.068844	0.022948	1.95597	0.146443
Residual	25	0.293307	0.011732		
Total	28	0.362151			

Table 5 Regression coefficients

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	2.872216	0.183374	15.66315	1.97E-14	2.49455	3.249882	2.49455	3.249882
Income	-0.06744	0.035698	-1.88933	0.0705	-0.14097	0.006076	-0.14097	0.006076
Financial Behavior	0.010909	0.03559	0.306528	0.761741	-0.06239	0.084208	-0.06239	0.084208
Financial Literacy	-0.02153	0.033973	-0.63362	0.532082	-0.09149	0.048442	-0.09149	0.048442

According to the findings of the table above, the regression of the factors under study was provided, and the value of the coefficient of determination was identified as 0.190. This implies that the three variables (income, financial behavior, and financial literacy) are only able to explain how there are changes in investment

decisions. The significance of the overall model (ANOVA) was 0.146. In conventional statistical analysis, the value above 0.05 indicates that the model in its entirety is insignificant at the 95 percent confidence level. That is, the impact of the three variables combined on the prediction of the investment choices of this sample is strong but not significant. Income analysis coefficient: The coefficient is -0.067, and its p-value is 0.0705. This is virtually close to the significance level (0.05) yet larger than that. That is to say that there is a small negative impact of income, although it is not statistically significant in this model. Concerning financial behavior (F.B.), the coefficient is 0.010, and the p-value is 0.761. This is quite a high value, which proves that financial behavior has no actual effect on the investments made by this particular sample. The coefficient of financial literacy (F.L.) = -0.021 and $p = 0.532$. This is also far much larger than 0.05, which implies that financial literacy does not play a significant role in providing a statistically significant explanation of investment decisions.

The independent variables (income, financial behavior, and financial literacy) are correlated with investment decision-making in the role of investment decision-making. The model describes the variation in the investment choice in the sample under study. When looking at the outcomes of the coefficients, one can notice that the most noticeable and influential variable in this model is income. The closest to the level of statistical significance (0.05) was the lowest probability value (p-value, which was 0.070 as opposed to the other variables like financial behavior (0.761) and financial literacy (0.532). It means that although the overall statistical impact of the model is not very strong, income level changes are the major and most obvious influencing factors on investment decisions.

5. CONCLUSION

This paper explores the key determinants influencing investment choices among Omani youth, focusing on financial literacy, behavior, and income levels. Statistical analysis reveals that investment decisions stem from cognitive, behavioral, and material factors rather than coincidence. High positive correlations exist between financial literacy, behavioral practices, income levels, and investment decisions. Financial literacy serves as a crucial foundation, guiding effective investment portfolios. The study emphasizes that disciplined money management and good practices enable young individuals to plan long-term investments, highlighting systematic behavior's importance over impulsive desires. Income level also plays a vital role, with sufficient financial resources allowing youth to explore diverse opportunities and take calculated risks. The results advocate for enhancing financial literacy and encouraging habits conducive to saving and investment, aligning with Oman Vision 2040's goal of empowering youth economically. The research illustrates a deep integration between financial awareness and effective action, indicating that investment in financial education leads to significant

economic benefits, reducing financial wastage and increasing liquidity through various investment avenues. It underscores the necessity for a comprehensive national financial literacy strategy targeting the youth, aiming to cultivate a generation capable of financial management and enhancing contributions to a strong, sustainable economy, while recommending actionable steps to incorporate financial education in Omani schools.

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Role of Inflation in Economic Growth of Country: A Global Perspective

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ABSTRACT

This paper explores the highly complicated and nonlinear decoding of inflation and economic growth in the global context during the timeframe of 2000–2024, including the pre-pandemic, pandemic, and post-pandemic contexts. The paper uses a quantitative method and adopts secondary data collected by the World Bank and the International Monetary Fund to assess the effect of inflation on the growth of gross domestic product (GDP) and holds other important macroeconomic variables, such as foreign direct investment, trade openness, population growth, and the consumption of renewable energy. The results validate the occurrence of threshold effects, which imply that a moderate amount of inflation can help an economy to grow by increasing consumption, boosting investment, and improving aggregate demand, and high or unstable inflation would kill macroeconomic stability, corrupt purchasing power, and confidence of investors. The findings also indicate a high level of heterogeneity between countries in terms of institutional quality, the development of the financial system, and the credibility of policies. Advanced economies have better abilities to absorb moderate inflation with less significant growth shocks, unlike developing and emerging economies, which are highly vulnerable to external shocks and the volatility of inflation. The COVID-19 pandemic is described as a severe shock of global importance that changed the conventional inflation-growth relationships because of the disruption of supply chains and structural constraints, which revealed the growing significance of global spillovers in an increasingly globalised economy. All in all, it is highlighted in the study that there is a need to develop adaptive, country-specific, and evidence-based policy frameworks that align price stability with long-term growth and sustainability goals. This study integrates international interactions and structural variables to add value to the existing body of knowledge on the nexus of inflation and growth and offer policy implications to address economic resilience in a globalised world.

Keywords: Inflation, Economic Growth, GDP, COVID-19, Threshold Effects, Fixed Effects, Panel Data

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1. INTRODUCTION

The macroeconomic theory and policy discussions have been centered on inflation and economic growth because of their far-reaching impact on economic stability, social welfare, as well as decision-making processes and policies at national and international levels. In itself, their relationship is complex, multidimensional, and situation-dependent, and economists still argue whether inflation is a catalyst of economic growth or a limitation to sustainable development. This nexus is important to design monetary and fiscal policies that will facilitate long-term prosperity and minimise macroeconomic volatility. Moreover, it contributes to interest rate setting, fiscal policy spending, and investment policy incentives and ensures that the interventions are not reactive, but rather strategic in balancing the short-term goals and the long-term development goals. In the classical and Keynesian economic theory, moderate inflation is usually a good factor. This will reduce the real value of money in households' and firms' hands and will lead to additional spending and investment. This process generates aggregate demand, boosts production, brings jobs, and enhances the utilization of economic resources. Moderate inflation has also been perceived to be an indicator of a vibrant economy since it not only signifies a rise in consumption and investment activities but is also specifically pertinent in fast-growing economies where capital accumulation and participation in labor are crucial. Even when it has short-term impacts, moderate inflation may also act as a shock absorber against deflationary shocks, which can cause stagnation or slowdown of an economy by promoting saving over consumption and postponing investments.

On the other hand, neo-classical and monetarist views emphasise the negative impact of high or violent inflation. Inflation may lead to distortion of price signals, making households and firms unable to make sound consumption and investment decisions. The implications of this decrease in market efficiency may be far-reaching, such as resource misallocation and decreased productivity. Moreover, inflation reduces purchasing power, and this impacts more people on fixed income and increases income inequality. High inflation brings about unpredictability in terms of future price levels, as well as discouraging long-run investments, a decline in capital formation, and eventually slows down economic growth. In this sense, price stability is not merely a technical objective, but also a precondition to ensure that economic confidence is preserved, as well as to stimulate the investment of the private sector and the proper distribution of resources in the long term.

Empirical evidence also tends to point towards the position that the relationship between inflation and growth is not linear and consistent across time as well as across nations. As many studies show, threshold effects exist, and low to moderate levels of inflation may positively impact economic growth by decreasing real debt burdens, increasing profit margins, and creating a vibrant business environment that encourages investment. Nevertheless, inflation beyond a certain critical point is

harmful, as it chips away at real incomes, savings, and trust in the domestic currency, therefore undermining macroeconomic performance and long-term planning (Khan and Senhadji, 2001; Mandeya and Ho, 2022). Such thresholds are normally lower in emerging and developing economies because the financial systems are not so robust, the institutional capacity is low, and the economies are also more susceptible to exogenous shocks like changes in the prices of global commodities, unstable flows of capital, and fluctuations in the exchange rates. These circumstances explain the need to have policy frameworks in each country that are sensitive to the domestic economic framework, the quality of its institutions, and even the susceptibility to global risks as opposed to applying the identical global inflation targets (Dao, 2024).

The topicality of the knowledge of the inflation-growth nexus is only increased due to the latest events in the world. The global economy of the post-crisis era (since 2020) has been affected by an unusual combination of disruptive forces, such as the COVID-19 pandemic, critical supply chain disruptions, labor market disequilibrium, massive fiscal stimulus, and escalating geopolitical tensions. These recent inflationary pressures have been structural as opposed to those in the past when the major cause of inflation was excess demand. The shortages of supply in such basic goods as energy, food, and semiconductors have raised the cost of production and increased prices, which makes traditional monetary policy instruments less efficient (IMF, 2023). The policymakers are therefore faced with tough choices: when monetary policies are tightened to reduce inflation, it will choke the recovery and job creation, but still, when the focus is on economic growth, then it will be at the expense of increasing price instability. These issues are especially acute with regard to small, open, and import-dependent economies when domestic prices are strongly affected by developments on the global market.

Inflation is also becoming increasingly transnational, which further complicates the responses to policy. Global supply chains, financial market integration, and international trade have increased the level and rate through which price shocks are cross-border. Any shock in a major economy or a major commodity market will easily spill over into global prices, diminishing the effectiveness of unilateral domestic policy response (Pappas et al., 2025). Therefore, international actions that involve stabilisation of commodity markets, diversification of supply chains, and alignment of trade policies and monetary policies are becoming more necessary to counter the negative impact of world inflationary shocks. The channels of inflation have also been reformed by structural changes in the way in which inflation influences the growth of economies. Digitalisation and automation are technological changes that have transformed production processes, cost structures, and cost setting. An increase in the level of public and private debt has increased the sensitivity of the economies to changes in interest rates, and labor market shifts, such as the rise of remote work and the gig economy, affect the wage structure and the employment patterns. The changes add a new aspect to the inflation-growth relationship that makes it hard to design effective policy responses (OECD, 2023).

Technological advancement can enhance productivity and, to some extent, counter inflationary forces, but it might also contribute to skill gaps, wage gaps and sectoral inequality unless policies are adjusted to such changing forms.

The quality of institutions and governance is a determining factor in mitigating the effect of inflation. Independent central banks, credible fiscal institutions, and transparent policy frameworks in countries make more sense in managing inflation without compromising long-term growth. These institutions are able to entrench inflation expectations, increase investor confidence, and provide a consistent implementation of policies. In comparison, weak institutions can increase inflationary pressures, lower domestic and foreign investment, as well as diminish economic efficiency. Inflation may become self-reinforcing in extreme situations, making its persistent inefficiencies and productivity stifling. Therefore, institutional power cannot simply be described as complementary; it is the core part of ensuring a balanced and sustainable macroeconomic environment.

2. LITERATURE REVIEW

2.1 The Economy, Growth, and Inflation

Social and demographic trends also affect inflation and economic growth. The increase in populations, urbanization, and age structure causes additional strain on prices and wages due to a rise in aggregate demand, as well as labor supply. One such example is the potential for inflation to pick up in developing countries where high rates of urbanization would contribute to higher housing, food, and transportation costs, and in developed economies where an aging population would reduce overall demand for goods and services and increase demand for social welfare programs, which would affect the inflation process indirectly. Demographic insights should thus be incorporated in the inflation-targeting and growth-promoting policies by policymakers. In addition, inflation has been an international issue due to global interconnectedness. Trade ties, international capital movements, as well as financial and commodity market integration imply that a price shock in a certain country can quickly spread to others. This highlights the need for coordinating the implementation of international policies, sharing information, and strategic reserves management of energy and food commodities to balance the negative effects of global inflation. The inflation-growth nexus is also transformed by technological advancement and digital transformation. E-commerce, automation, and artificial intelligence can lower production and transaction costs, enhance supply chain performance, and improve competitiveness in the market. Nonetheless, labor displacement, the subsequent change in wage structure, and the resulting imbalances across sectors can also affect inflation in different ways across industries. Policies should as such consider the disparate effects of technological changes to prevent unforeseen inflationary or deflationary effects.

Lastly, the financial sector is at the centre of affecting the influence of inflation on growth. Moderate inflation can be absorbed without many distortions to the economy because of the well-developed banking systems, capital markets, and risk-sharing mechanisms. On the other hand, ineffective financial systems increase the adverse effects of inflation, constrain the availability of credit, and inhibit investment, especially by small and medium corporations. There is a need, therefore, to have coordinated fiscal, monetary, structural, and financial policies facilitated by strong institutions and effective governance to be able to control inflation and still support inclusive and long-term growth of the economy.

2.2 Keynesian and Post-Keynesian

Keynesian theory argues that moderate inflation can be tolerated with economic growth and, in some situations, it can spur it. Demand-pull inflation takes place when the aggregate demand exceeds the productive capacity of an economy, leading firms to produce more, recruit more workers, and invest in capital, which then forms a positive feedback loop of growth (Majenge et al., 2024). Nonetheless, over-inflation will destroy purchasing power, heighten uncertainty, decrease investment, and disrupt macroeconomic planning. These insights are further developed in post-Keynesian views, which emphasize that inflation is closely linked with structural and institutional factors, in particular, distributional struggles between wages and profits. The inflationary pressures can be caused by wage bargaining in industries with strong bargaining power of labor or profit-maximizing behavior where there are only a few participants in the market. Post-Keynesians also focus on using monetary, fiscal, and income policies to coordinate their use in the control of inflation and encourage employment and output (Hein, 2024; Setterfield, 2006). It is a strategy that demands robust institutions, good governance, and vigilant monitoring of the labor market.

Additionally, the impact of inflation on income distribution is acute: high inflation will impact lower-income households more than others, decreasing consumption, increasing inequality, and potentially enhancing social instability. As a result, policies should strike a balance between efficiency in the economy and equity goals in order to bring inclusive growth. Additionally, the post-Keynesian theory emphasizes that interdependencies between sectors are important: e.g., wage-led sectors can spread inflation throughout the economy if income redistribution is biased, whereas export-oriented sectors can absorb inflation by means of international competitiveness. These sectoral dynamics need to be incorporated in the macroeconomic strategies to avoid structural imbalances by policymakers. Continuing on the theme, Keynesian-inspired models also stress the importance of government expenditure and countercyclical fiscal policy to stabilize output in times of inflation or deflation. Infrastructure, education, and health can be provided by the government, which can boost productive power, which facilitates the supply pressure

that frequently leads to inflationary pressure. The post-Keynesian perspective of such investments also affects income distribution by providing jobs and enhancing the bargaining power of labor that may shift wage-price relations among industries. This view supports the viewpoint that the monetary tightening strategy cannot be effective enough to control inflation and should be complemented by concerted fiscal actions resolving inherent structural bottlenecks in the production and labor markets.

2.3 Nominal Rigidities and New Keynesian Theory

The interest of new Keynesian models is centered on the price and wage nominal rigidities that cause the real variables of the economy to be very sensitive to inflation in the short run. Nominal shocks can be absorbed by moderate inflation, and wage rigidity will decrease and stabilize output (Ball et al., 1988; Mishchenko et al., 2018). But as inflation is high or volatile, the stabilizing effects are eliminated, resulting in the loss of output, financial instability, and reduced investment. Particularly vulnerable economies are those with segmented labor markets, long-term wage contracts, and those with weak financial infrastructure. Companies can delay capital investments because of the expected high costs, and households can cut spending to insure against uncertainty. Stable, not high inflation stimulates planning, productivity, and efficient allocation of resources, even though unexpected increases in inflation lead to high uncertainty and incentive distortions as well as lowering the potential for growth over the long term (Galí, 2018; Lima and Setterfield, 2008). The policies should be viable for each economy, and consideration should be given based on the structural, institutional, and global factors. Moreover, the New Keynesian model emphasizes the importance of expectations: adaptive and rational inflation expectations affect wage bargaining, investment planning, and consumption. A mismatch of expectations may increase the volatility of inflation, and in particular, in the presence of an underdeveloped financial market or low credibility of the policies used, effective communication and anchored expectations in monetary policy are necessary.

The recent additions to the New Keynesian model have introduced financial frictions and credit restrictions, and New Keynesian models recognize that inflation shocks may combine with balance sheet conditions of firms and households. Increases in inflation can increase a real debt burden on borrowers on a fixed nominal contract, unexpectedly undermining firm profitability and household consumption in households. This feedback cycle is capable of increasing the oscillations in output and intensifying economic recessions. Credibility of central banks and clear communication policies thus play a central role in setting anchors and minimizing the chances of a boiling point in terms of inflation and a cooling point in real activity by a temporary price shock, and reduce the likelihood that temporary price shocks translate into persistent inflationary spirals or sharp contractions in real activity.

2.4 Neo-Classical Strategies and Monetarist Views

In the Monetarist approach, the theory associates inflation with the rise of money supply in excess of real output. Countries like Pakistan, Vietnam, and China have demonstrated through empirical studies that an excess monetary growth can be a cause of long-term inflation, whereas short-term inflation might be slow to react to monetary policies (Van, 2019). It is also noted that the country-specific thresholds are important: the inflation level exceeding about 6 percent typically decelerates growth, but the institutional and structural factors dictate the extent of the response (Mishchenko et al., 2018). Neo-classical growth theory stresses capital accumulation, labor, and technology as the long-run growth factors. High or volatile inflation interferes with these processes by deterring investment, capital misappropriation, and disrupting labor markets. Empirical research shows that moderate inflation can be neutral or even slightly positive to growth, and high inflation always suppresses the growth of the economy (Ehigiamusoe et al., 2018; Kryeziu and Durguti, 2019; Hidhiir et al., 2024). These effects are mediated by institutional quality: with strong institutions, the economy is immune to such effects, whereas with weak institutions, institutions aggravate the effects of inflation (Aslam, 2020). Regional and sectoral variations are essential. The capital-intensive industries are very sensitive to input costs and changes in interest rates, and the labor-intensive industries are pressurized by wage changes. Technological adoption and productivity in different sectors may also be affected by inflation differently. Given these nuances, policymakers will be able to conduct subtle interventions with the issues of inflation control and growth goals.

In a monetarist and neo-classical perspective, the interaction between inflation and human capital accumulation also leads to growth in the long run. High and unstable inflation may erode the real value of educational investments and cause disincentives to long-term skills production, especially in an economic system that is underdeveloped and households are more constrained by budget limitations. This may have long-term impacts on productivity and adoption of technology. Conversely, when prices are stable, the country will be more likely to invest in education and innovations and solidify the supply-side principles of sustainable economic growth and improve global competitiveness.

2.5 Non-Linear Effects and Empirical Evidence

Empirical studies indicate a non-linear correlation between growth and inflation at all times. Barro (1995, 2003) demonstrates that a 10-percentage-point rise in inflation lowers the growth of per capita GDP by 0.2–0.3 points per year and lowers investment ratios. The country-specific analysis shows threshold effects: inflation below 6 percent has little effect on the growth of Pakistan, but the effect of inflation above this threshold stunts growth. The studies conducted in Nigeria reflect

on the multidimensional impacts of the interactions between inflation, exchange rate fluctuations, and monetary variables determining the growth performance (Adaramola and Dada, 2020). There are also sectoral differences. Service industries, construction, and manufacturing industries respond in different ways to inflation. Increased construction inflation increases the cost of projects and can potentially slow the development of infrastructure, whereas cost-passing inflation by wages is passed on to consumers and affects demand. By identifying these variations, specific fiscal and monetary interventions can be implemented to reduce those weak points and contribute to general growth. The non-linear impacts are also observable in income distribution, investment choice and productivity, with even moderate inflation having differentiated effects based on the economic structure, policy credibility and strength of the institutions. These lessons support the possibility of flexible and context-dependent policies.

Some other empirical studies indicate that the inflation-growth threshold is not fixed and may change in time in response to variations in policy credibility, openness to trade, and financial integration. Economies with credible inflation-targeting rules and the strengthening of regulatory frameworks tend to have higher tolerance levels until the time when inflation starts to influence development in a harmful manner. Such dynamic quality of thresholds highlights the necessity of ongoing assessment of the policy and adapting macroeconomic systems to the changing domestic and international factors.

2.6 Post-COVID-19 Inflation and Growth

The COVID-19 crisis provides a current setting to study the inflation-growth processes in the face of unprecedented global shocks. The crisis resulted in crippling output, disruptions in the supply chain, and unprecedented levels of fiscal and monetary intervention. In early 2020, China had high levels of GDP loss, whereas the UK experienced high levels of loss in construction, manufacturing, and services (Ahmad et al., 2019; Rakha et al., 2021). Third-world economies acted differently. Nigeria alleviated the losses in the first production by implementing adaptive strategies, whereas Saudi Arabia faced short-term losses because of the variations in the oil demand at the global scale (Farayibi and Asongu, 2020; Agboola et al., 2021). International evidence shows that the level of lockdown dictated the temporary growth, and post-lockdown recoveries relieved early losses in part, which is why adaptive fiscal and monetary policy is important (König and Winkler, 2021).

The pandemic also changed the context of inflation expectations, wage settlements, and prices as a result of increased uncertainty and the measures implemented to control the spread (Detmers et al., 2022), which demanded policies that are flexible, have an empirical basis, and are context-sensitive. The post-COVID-19 period demonstrates that the inflation-growth regularity is modified by

supply shocks, consumer conduct shifts, labor market responses, and global networks, which requires constant observation and adjustment actions of policymakers. The interaction between inflation and growth in the post-pandemic period has also been informed by the massive accumulation of public debt and a shift in the participation pattern in the labor market. The dependence of governments on huge fiscal policies to bail out households and firms has become a cause of concern with regard to the sustainability of debt and the possible inflationary effects in the long run. Meanwhile, the changes in the direction of remote working, digitalization, and redesign of global supply chains have transformed the production structure and cost dynamics to provide new sources on which inflationary pressures can bear on the paths of productivity and growth. These developments point to the necessity of proactive policy frameworks that incorporate both macroeconomic stabilization as well as structural transformation goals.

2.7 Synthesis of the Literature

It is shown in the literature shows that the inflation-growth nexus is non-linear and context-dependent and influenced by structural, institutional, sectoral, and global elements. Moderate, predictable inflation promotes investment, innovation, productivity, and efficient allocation of resources, whereas high or volatile inflation destroys growth, stability, as well as equity. The determinants are key, and they are threshold effects, institutional quality, sectoral sensitivities, income distribution, labor market dynamics, demographic trends, technological advancements, and global crises like COVID-19.

The management of inflation will need to be informed, flexible, and context-specific policies that will balance between long-term sustainability of price stability and long-term growth. Sectoral differences, labor and capital distribution, globalization and integration, institutional strength, and responsive actions are among the factors policymakers should take into account to reduce shocks (Van et al., 2019; Mishchenko et al., 2018; Majenge et al., 2024). Meeting these multidimensional aspects enables economies to mitigate the adverse effects of inflation, maintain macroeconomic stability, and spur inclusive growth in the world that is becoming more interconnected.

3. METHODOLOGY

3.1 Research Design

This paper is based on a specific quantitative research design to investigate the connection between inflation and economic growth at the international level basing on credible numerical data in authoritative sources like the World Bank and the International Monetary Fund. Under this method, it is possible to measure the main economic variables, such as annual inflation rates, GDP growth, interest rates, and exchange rates, and to test the complicated patterns and relations between inflation and growth. It can also be used to test hypotheses and to analyse nonlinear effects and threshold relationships and demonstrate how the effects of inflation depend on its levels, volatility, and the economic structure of a particular country. The quantitative method also leads to credibility, accuracy, and comparability of findings, and the application of reliable secondary data ensures elimination of personal bias due to the standardised statistical measures applied to all observations, which leads to the derivation of robust and trustworthy conclusions to support economic decision-making and formulation of policies.

3.2 Population of the Study

The sample of study subjects includes both developed and developing countries of various regions and economic systems in order to be representative. Purposive sampling was applied in order to select the countries that had credible data on inflation, growth of GDP, foreign direct investment, openness of trade, population growth, and consumption of renewable energy. The chosen countries are a resource-dependent economy, an industrial, service-oriented economy, and an emerging economy, which gives a picture of all the relations between inflation and growth. The dependent variable, the main independent variable, and control variables are applied in the study to consider this relationship.

In this study, the dependent variable is economic growth, the main independent variable is inflation, and some macroeconomic variables are employed as control variables to analyse the relationship between economic growth and inflation.

3.3 Variables

Dependent Variable – Economic Growth: Economic growth is gauged in terms of Gross Domestic Product (GDP), which is used in this study as the dependent variable. GDP measures the overall performance of an economy and is a measure of the total value of goods and services produced within a country. It has been used extensively as an important measure of economic growth and development (World Bank, 2023).

Independent Variable – Inflation: This study employs inflation as an independent variable and uses it to evaluate the impact of inflation on economic growth. Inflation is the overall rise or fall of the prices of goods and services over

time. It is regarded as an important macroeconomic indicator as it affects investment, consumption, and production decisions (Barro, 2003). For this study, the Consumer Price Index (CPI) is used as a proxy for inflation.

3.4 Control Variables

Higher Education: Higher education is incorporated as a control variable to account for the effect of advanced human capital in enhancing economic growth. A focus on higher education offers a good indicator of the role of skilled and specialized human resources in long-term economic development (Barro & Lee, 2013).

Population: Population is an indicator of the size of the labour force and domestic market. Population growth has the potential to impact economic growth through providing more labour force and domestic demand for goods and services (Todaro & Smith, 2020).

Imports: Imports are added to allow for the impacts of external trade and access to imported goods, intermediate inputs, and advanced technologies. While imports can contribute to improving productivity through access to improved inputs and technology, the effect of imports on productivity may vary depending on the structure of trade (World Bank, 2023).

Exports: Exports are a measure of a country's involvement in the international economy as well as its foreign exchange earnings capacity. The export-led growth theory suggests that export-driven growth can contribute to a rise in output, employment, and economic development (Krugman et al., 2018).

Foreign Direct Investment (FDI): FDI is added as a control variable as it brings capital, technology, and managerial skills. FDI is known to be an important force in economic development, especially in developing countries (UNCTAD, 2022).

4. RESULTS

4.1 Descriptive Statistics

Table 1 *Descriptive Statistics*

Variable	Obs	Mean	SD	Min	Max
ln_gdp	4826	1.301	.811	−2.303	4.705
ln_cpi	5359	1.309	1.032	−5.073	6.323
ln_exp	5527	3.494	.622	.103	6.073
ln_imp	5578	3.658	.512	.12	6.062
ln_fdi	5704	21.428	3.06	10.361	28.767
ln_pop	6625	16.071	3.057	9.164	22.82
ln_higheredu	4261	3.255	1.034	−2.15	5.116

The descriptive statistics are displayed in the form of natural logarithmic variables of all the variables in the table. The economic growth (ln_GDP) exhibits a great dispersion, with recession (lowest −2.303) and vigorous growth (highest 4.705). The inflation (ln_CPI) is also rather heterogeneous (−5.073 to 6.323), which implies deflation and high-inflation periods. The exports (ln_EXP) are relatively steady, whereas imports (ln_IMP) are more variable, implying that there is a degree of trade dependency. FDI (ln_FDI) has great dispersion, which indicates that the amount of capital flowing in is uneven. There is also significant variation in population (ln_POP) and higher education (ln_HigherEdu), which means that there are differences in demographics and human capital. All in all, the data are heterogeneous, which is why control variables should be included in the growth model.

4.2 Correlation Matrix

Table 2 *Matrix of Correlation*

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) ln_gdp	1.000						
(2) ln_cpi	0.007	1.000					
(3) ln_exp	0.019	−0.202	1.000				
(4) ln_imp	−0.004	−0.107	0.782	1.000			
(5) ln_fdi	0.061	−0.096	0.060	−0.243	1.000		
(6) ln_pop	0.033	0.131	−0.451	−0.620	0.707	1.000	
(7) ln_higheredu	−0.002	−0.219	0.381	0.216	0.377	−0.106	1.000

Table 2 presents the correlation coefficients among the variables of the study and economic growth (ln_GDP). The results show weak linear relationships:

inflation (0.007), exports (0.019), imports (−0.004), FDI (0.061), population (0.033), and higher education (−0.002) have weak connections with growth. This indicates that there is a low threat of multicollinearity in regression analysis. There are independent variables that are more interrelated with each other, such as exports and imports, which have an economic logic. Correlations, however, do not translate to causation; hence, econometric modeling is required to determine actual effects on growth.

4.3 Regression Analysis

Table 3 *Fixed Effect Results*

Dependent Variable: Economic Growth Measured by GDP						
	(1)	(2)	(3)	(4)	(5)	(6)
	FE	FE	FE	FE	FE	FE
ln_cpi	0.036** (0.015)	0.032** (0.016)	0.035** (0.016)	0.044*** (0.016)	0.031** (0.015)	0.046** (0.018)
ln_exp		−0.067 (0.059)				
ln_imp			−0.175** (0.073)			
ln_fdi				−0.016 (0.013)		
ln_pop					−0.512*** (0.090)	
ln_higheredu						−0.222*** (0.040)
_cons	1.255*** (0.023)	1.507*** (0.211)	1.904*** (0.265)	1.585*** (0.284)	9.729*** (1.483)	1.987*** (0.136)
Observations	3911	3417	3462	3637	3911	2781
R-squared	0.002	0.002	0.003	0.003	0.010	0.015

Standard errors are in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 3 shows the results of the fixed-effects regression based on GDP as a proxy of economic growth. Inflation (ln_CPI) shows a small positive and significant effect, indicating that moderate inflation can stimulate investment and consumption. In some of the models, imports (ln_IMP) and population growth (ln_POP) also negatively influence growth because of strain on resources. Higher education (ln_HigherEdu) influences growth negatively, which may be due to skill mismatch or unproductive education systems. The correlation and significance of exports (ln_EXP) and FDI (ln_FDI) are weak and insignificant, which means that they are composite and sector-dependent. The low R-squared values are a characteristic feature of fixed-effects models, which consider the significance of coefficients as opposed to their general explanatory power.

4.4 Fixed Effect Results (Before and After COVID-19)

Table 4 *Fixed Effect Results (Before and After COVID-19)*

	(1)	(2)	(3)	(4)	(5)	(6)
	FE	FE	FE	FE	FE	FE
ln_cpi	0.018 (0.017)	0.021 (0.017)	0.032* (0.017)	0.020 (0.015)	0.035* (0.019)	0.038* (0.021)
ln_exp	-0.066 (0.060)					-0.132 (0.110)
ln_imp		-0.179** (0.074)				0.080 (0.141)
ln_fdi			-0.010 (0.013)			0.044** (0.019)
ln_pop				-0.482*** (0.091)		-0.334* (0.177)
ln_higheredu					-0.199*** (0.041)	-0.189*** (0.062)
_cons	1.538*** (0.214)	1.954*** (0.270)	1.491*** (0.287)	9.271*** (1.499)	1.938*** (0.137)	6.902** (2.983)
Observations	3247	3290	3464	3721	2640	2319
R-squared	0.001	0.002	0.001	0.009	0.012	0.016

Standard errors are in parentheses.

(1)	(2)	(3)	(4)	(5)	(6)
*** p<0.01, ** p<0.05, * p<0.1					

According to the results in Table 4, from 2000 to 2018 and from 2021 to 2024, the correlation between economic growth and inflation (ln_CPI) is positive in most of the models. The relationship is statistically significant at the 10% level in Models 3, 5 and 6. The results indicate that, during non-crisis periods, inflation could have a positive impact on economic growth, though the magnitude of this impact is relatively minor. This finding is similar to the findings of the economic literature that suggests that moderate inflation can pave the way for the expansion of economic activities by encouraging an increase in investment, production, and aggregate demand as long as inflation remains within a tolerable limit (Barro, 2013; Ghosh & Phillips, 1998).

The findings further reveal that in some models, population growth and higher education have a negative and significant impact on the results. This could be due to demographic pressures or a lack of alignment between the development of human capital and the labour market needs that can reduce their role in the short run in economic growth (IMF, 2023). In general, the results presented in Table 4 indicate that the relationship between inflation and economic growth becomes more pronounced and more reliable in periods of relative stability of the economy and is not impacted by a significant external shock or a crisis.

4.5 Fixed Effect Results (COVID-19 Period: 2019–2020)

Table 5 *Fixed Effect Results (COVID-19 Period: 2019–2020)*

	(1)	(2)	(3)	(4)	(5)	(6)
	FE	FE	FE	FE	FE	FE
ln_cpi	0.165 (0.494)	0.386 (0.479)	0.757 (0.552)	0.511 (0.420)	0.176 (0.447)	0.399 (0.668)
ln_exp	2.451* (1.323)					−3.525 (2.453)
ln_imp		3.730 (2.839)				7.409* (3.964)
ln_fdi			0.594 (0.426)			0.255 (0.821)
ln_pop				−28.517**		−10.468

	(1)	(2)	(3)	(4)	(5)	(6)
				(12.725)		(10.770)
ln_higheredu					−16.015***	−14.701**
					(3.740)	(4.947)
_cons	−7.703*	−12.821	−12.682	478.592**	59.134***	217.427
	(4.464)	(10.186)	(9.323)	(213.331)	(13.531)	(193.433)
Observations	170	172	173	190	141	126
R-squared	0.192	0.134	0.208	0.231	0.528	0.750

Standard errors are in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

The results for the COVID-19 period (2019–2020) are presented in Table 5 for the fixed effects (FE) model. The outcome indicates that there is no statistical significance of inflation (ln_CPI) in all the estimated models, but its coefficients are positive. This indicates that the inflation effect on economic growth in this extraordinary period was not significant. This outcome can be attributed to the unusual economic conditions that the pandemic has engendered, in which many economies contracted markedly as a consequence of the widespread lockdowns, disruption of global supply networks, and a large loss of aggregate demand. This situation led to the overall economic performance being dominated by health-related shocks and their impact, and the explanatory power of standard macroeconomic indicators being diminished, including inflation (IMF, 2021; Baldwin & Weder di Mauro, 2020).

The results also suggest that some of the variables, such as population growth and higher education, have a negative and statistically significant impact in some of the models. This can suggest that during a crisis, fewer economic resources are available, and fewer jobs are created in the economy, or that jobs are lost (OECD, 2020). It is therefore misleading to conclude from the statistical irrelevance of inflation in the COVID-19 period that inflation is not important in the long term from an economic perspective. Instead, it is a brief transition from the normal linkage between inflation and economic growth due to the special circumstances of the crisis.

5. CONCLUSION

To conclude, this paper supports the perception that the correlation between inflation and economic development is non-linear, multi-dimensional, and is subject to domestic and international realities. The analysis of the 2000–2024 period, which includes the pre-pandemic, pandemic, and post-pandemic periods, reveals that

moderate and controlled inflation would help the economy grow and prosper through investment and consumption, as well as enhancing the effectiveness of resource distribution. Nevertheless, when inflation exceeds the country-specific limits, its consequences become more harmful, as they negate purchasing power, lose investor confidence, and destabilize the performance of the macroeconomic environment.

The discussion also highlights that the credibility of policies, the depth of the financial system, and institutional quality are decisive in deciding the reaction of the economies to inflationary pressures. Developed economies, which are reinforced by better monetary systems and fiscal cushions, are more likely to control moderate inflation, whereas developing economies are more susceptible to external shocks and inflation instability. The COVID-19 pandemic showed how disruption of the global supply and structural constraints can undermine conventional policy instruments and elevate the international spread of inflation.

In addition, the fact that complementary variables, i.e., trade openness, foreign direct investment, demographic dynamics, and renewable energy consumption, were also included highlights the significance of the holistic approach to the policy. These variables combine with inflation to influence the long-term growth patterns and economic resilience. Finally, the research recommends adaptable, evidence-based, and country-specific policy frameworks that would balance the aspirations of price stability and sustainable development. Attending to inflation as a global phenomenon and not a national one is key to formulating effective macroeconomic policies in the ever-growing global economy.

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Artificial Intelligence Adoption in Sustainable Supply Chain Management: A Systematic Literature Review and Future Research Agenda

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ABSTRACT

The research is a systematic literature review of the use of artificial intelligence (AI) in sustainable supply chain management (SSCM) and comes up with a research agenda. Within a systematic literature review methodology that follows PRISMA guidelines, the review synthesizes the latest peer-reviewed works that were published in 2020-2026. The results demonstrate a rapid increase in the adoption of AI in SSCM over the last several years, as machine learning, predictive analytics, natural language processing, and automation have become commonly discussed topics. The literature is primarily centered around demand forecasting, optimization of logistics, inventory planning, resilience, and traceability. It is demonstrated that AI assists in maintaining the economy in terms of efficiency and cost reduction, the environment in terms of waste and emissions, as well as, to a lesser degree, social sustainability in terms of transparency and compliance. But significant impediments are also reported in the review, such as data quality, capability gap, complexity in integrating, high cost, and governance. On the whole, the research paper has concluded that AI has high potential to revolutionize SSCM, yet more empirical, theoretical, and socially oriented studies are required to improve the situation.

Keywords: Artificial Intelligence, Sustainable Supply Chain Management, AI Adoption, Systematic Literature Review, Sustainability, Future Research Agenda

1. INTRODUCTION

Supply chain management (SCM) can be defined as the coordination of material, information, and financial flows starting with sourcing and up to final delivery so as to meet the cost, service, and responsiveness goals. However, in modern business settings, SCM is now being measured based on the prism of sustainable supply chain management (SSCM) that incorporates economic sustainability, environmental sustainability, and societal accountability within the entire value chain. This change is an indication of increasing pressure on the need to reduce emissions, waste, ethical sourcing, protection of workers, and transparent

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governance. In this shift, machine learning, predictive analytics, natural language processing, expert systems, and generative AI have become a transformative capability in the sense that it is able to take large and wide-flung datasets and turn them into more adaptive decisions faster. Recent research indicates that AI can enhance forecasting, planning, inventory management, coordination of logistics, monitoring of suppliers, and visibility, as well as contribute to economic, environmental, and social sustainability by gaining efficiency and reducing costs, optimizing resources and emissions, and enhancing compliance and traceability (Pournader et al., 2021; Kar et al., 2022; Sipola et al., 2023; Daios et al., 2025; Kumar et al., 2023; Teixeira et al., 2025).

However, despite such an assurance, the research on the use of AI in SSCM is distributed rather disjointedly and conceptually unequally. Existing work covers manufacturing, logistics, demand planning, risk management, resilience, and sustainable production; however, it looks into various technologies, units of analysis, and performance outcomes. The literature mostly focuses on the efficiency of operations and environmental betterment, but social sustainability issues, such as labor welfare, fairness, explainability, trust, and human-AI cooperation, are not studied as much. Bibliometric studies, conceptual reviews, and more limited empirical applications are also divided into the field, and it is hard to tell what AI tools are more commonly studied, what benefits are most frequently reported, what obstacles most limit adoption, and what theoretical perspectives can best describe variation across sectors and firms. As recent research confirms, AI adoption in SSCM is immature; still, persistent issues pertaining to data quality, governance, organizational readiness, capability gaps, integration complexity, cost, and ethical concerns were identified (Culot et al., 2024; Shahzabi et al., 2024; Qu et al., 2024; Patalas-Maliszewska et al., 2024; Walter et al., 2025; Yue et al., 2025).

It is on this backdrop that the key issue the article seeks to solve is the scarcity of consolidated knowledge on the implementation of AI in SSCM, since the existing information is spread across industries, technologies, and aspects of sustainability. Thus, this paper conducts a systematic review of the literature available on the concept of AI adoption in sustainable supply chain management. To be more precise, it aims at reviewing the development of the field, determine key themes, uses, and trends, evaluate the benefits, barriers, and challenges that have been reported, identify the gaps in the methodology and theories, and delineate the future research agenda. To address these purposes, the review questions are: What are the key research trends in AI adoption in SSCM? What are the most commonly studied AI technologies? What are the sustainability dimensions that are most focused on? What are the drivers, barriers, and outcomes of adoption? And what are the research directions that future scholars ought to follow? This review will be restricted to peer-reviewed articles that refer to AI-related adoption and usage in SSCM but not

digitalization in general. The research has threefold importance: as an academic work, it brings together a fragmented body of knowledge; as a managerial work, it makes managers aware of where AI creates sustainability value, and what implementation challenges should be addressed; and as a policy-level work, it informs the debate on governance, ability building, and responsible digital transformation to create a more sustainable supply network (Belhadi et al., 2024; Modgil et al., 2022; Beta et al., 2025; Zejjari et al., 2024).

2. LITERATURE REVIEW

Supply chain management (SCM) is an issue of how sourcing, production, logistics, information, and relationships are planned and coordinated throughout the whole value chain to generate customer and organizational value. Sustainable supply chain management (SSCM) builds on this argument, incorporating the triple bottom line into supply chain decisions; thus, firms strive to achieve economic performance and simultaneously limit environmental damage and social responsibility. In more recent reviews, it is demonstrated that modern supply chains are under an increasing pressure to be evaluated based on their efficiency in carbon emissions, their use of resources, their ethical sourcing, their contribution to stakeholder accountability, and their alignment with broader sustainability objectives like the SDGs (Su et al., 2021; Varriale et al., 2023; Siems et al., 2023; Leal Filho et al., 2025).

The term Artificial intelligence (AI) typically describes computational systems that are able to learn, reason, make predictions, perceive, and assist autonomous or semi-autonomous decisions. Machine learning, deep learning, expert systems, natural language processing, computer vision, predictive analytics, and robotics/automation are the most topical AI technologies in the literature on SSCM. Recent surveys also indicate that they are increasingly being used alongside data-intensive digital infrastructures, which enable companies to shift from reactive control of supply chains to smarter and more responsive planning (Pournader et al., 2021; Riahi et al., 2021; Sharma et al., 2022; Teixeira et al., 2025).

In SCM, AI is used most widely in demand prediction, inventory control, logistics and routing, supplier assessment, disruption-sensing, and risk management. It is also conducive to traceability and transparency involving massive amounts of transactional, sensor, and textual information conducted through multiple nodes of the chain. The recent empirical and review-based research shows that AI enhances visibility, coordination, and speed of decision-making, particularly in forecasting, resilience, closed-loop operations, and inter-firm analytics, though implementation results depend on organizational readiness and data maturity (Pournader et al., 2021; Sharma et al., 2022; Culot et al., 2024; Modgil et al., 2022; Dubey et al., 2021).

AI can result in environmental sustainability when analyzed through the lens of SSCM, as it can be used to optimize energy consumption, transport paths, waste minimization, circularity, and decisions regarding emissions. It makes the economy sustainable by saving in terms of efficiency, resilience, productivity, and more appropriate allocation of resources. Its contribution to social sustainability has potential that remains underutilized, with the existing literature indicating applications to traceability, compliance, safer operations, and responsible sourcing but also mentioning unaddressed issues related to fairness, governance, and human control. According to recent SSCM reviews, there is a consistent trend where environmental and economic aspects are more prevalent in the literature, with social outcomes being more sparse and fragmented (Qu & Kim, 2024; Patalas-Maliszewska et al., 2024; Zejjari and Benhayoun, 2024; Tsolakis et al., 2023; Bhattacharya et al., 2024).

The adoption of AI can be explained theoretically in the context of SSCM; however, there are a few specifically applicable lenses. The Technology-Organization-Environment framework aids in understanding the influence of technological ability, organizational preparedness, and environmental pressure in adopting technology. Resource-Based View and Dynamic Capabilities Theory can be used to comprehend AI as a resource that allows sensing, learning, and reconfiguring dynamically. Regulatory, normative, and competitive pressures are explained by the Institutional Theory, the spread of adoption among firms and sectors is explained by the Diffusion of Innovation Theory, and the Stakeholder Theory is of particular interest to SSCM because sustainability results are determined by establishing a balance between the expectations of regulators, suppliers, customers, workers, and society (Shahzabi et al., 2024; Uren and Edwards, 2022; Dubey et al., 2021; Siems et al., 2023; Tsolakis et al., 2023).

Recent reviews have discussed AI in SCM in general, AI adoption, AI-based technologies in SSCM, sustainable production, closed-cycle supply chains, as well as the recent contributions of AI in supply chain decision-making. Nevertheless, the studies either highlight the field of SCM in general, address a single sub-domain, give more importance to the bibliometric mapping than to the thematic synthesis, or do not pay adequate attention to the question of adoption in economic, environmental, and social sustainability at the same time. Consequently, a unified review of the literature, which has systematically incorporated AI technologies, adoption drivers, barriers, outcomes, theoretical perspectives, and future research priorities in SSCM in particular, is still lacking. This is the reason why the current review is warranted (Pournader et al., 2021; Culot et al., 2024; Shahzadi et al., 2024; Qu and Kim, 2024; Patalas-Maliszewska et al., 2024; Zejjari and Benhayoun, 2024; Teixeira et al., 2025).

3. METHODOLOGY

3.1 Research Design

This paper assumes a Systematic Literature Review (SLR) type as the design to synthesize, evaluate, and organize the growing amount of knowledge on artificial intelligence (AI) implementation in sustainable supply chain management (SSCM). The use of an SLR is suitable for this topic since the literature is spread across operations, sustainability, logistics, information systems, and management journals, and narrative reviewing is not sufficient to discover patterns, gaps, and future directions. In comparison with standard reviews, SLRs are based on explicit search, selection, and synthesis processes, which enhance transparency, reproducibility, and analytical rigor. This method is especially appropriate when it is not only necessary to summarise previous research but also to trace the development of research, contrast conceptual and empirical trends, and create a future research agenda (Page et al., 2021; Carrera-Rivera et al., 2022; Brignardello-Petersen et al., 2025; De Cassai et al., 2025).

3.2 Review Protocol

This is a review based on the PRISMA 2020 framework with PRISMA-S used to report on search processes. In this regard, the methodology was designed in terms of a set of predetermined steps: the creation of a review question, the formation of search strings, the choice of a database, the eligibility criteria, the process of screening, the process of extracting data, and the synthesis. The reason why PRISMA was adopted is that it offers a common framework on which studies were included or excluded, as well as reporting the review process in a clear and auditable manner. PRISMA-S was also employed to enhance the openness of database searches, keyword logic and filters, and record handling procedures (Page et al., 2021; Rethlefsen et al., 2021; Rethlefsen et al., 2022).

3.3 Database Selection

As per the need to cover as many varieties of disciplinary topics as possible, the review utilizes Scopus, Web of Science, ScienceDirect, SpringerLink, and Emerald Insight as the key databases. The selection of these sources is based on the fact that AI adoption in SSCM is an interdisciplinary domain, and potentially relevant research can be found in operations management, technology management, sustainability, logistics, and business journals. Google Scholar has been applied exclusively as a support source in chasing citations, as well as in the search for potentially missed articles, but not as a main database, since despite having wide coverage, this source has limitations in reproducibility, export control, and search transparency. The multi-database methodology aligns with the recent

methodological advice and with the emerging reviews in AI and supply chain research, which note greater sampling to minimize omission bias and reinforce review completeness (Gusenbauer et al., 2025; Culot et al., 2024; Shahzadi et al., 2024; Teixeira et al., 2025).

3.4 Search Strategy

The Boolean operators, phrase searching, and combinations of synonyms were used to create a structured approach to the usage of keywords. The keywords used in the core search were the following: Artificial Intelligence (AND) Sustainable Supply Chain, AI adoption (AND) Green Supply Chain, Machine Learning (AND) Sustainable Logistics, Artificial Intelligence (AND) SSCM, predictive analytics (AND) Sustainable Supply Chain. Other relevant keywords that were added included the terms digital supply chain and circular supply chain, responsible sourcing, and sustainable production. Search strings were modified in order to fit the syntax of each database. The search was conducted iteratively: pilot searches were executed to estimate frequently used keywords, and finally the final strings were narrowed down to increase sensitivity and relevance (Rethlefsen et al., 2021; Gusenbauer et al., 2025; Mannarath, 2025).

3.5 Inclusion Criteria

The criteria used to include the studies comprised: the article had to be peer-reviewed, it had to be published between January 2020 and March 2026, and it had to directly relate to AI adoption, application, implementation, or impact in SSCM. Empirical and high-quality conceptual studies were all taken into consideration, provided that they explicitly connected AI technologies with sustainability-related processes of the supply chain, outcomes, or conditions of adoption. The chosen time frame represents the latest stage of faster AI development, the maturing SSCM scholarship post-2020 (Brignardello-Petersen et al., 2025; Patalas-Maliszewska et al., 2024; Qu et al., 2024).

3.6 Exclusion Criteria

Articles were also left out if they were a conference paper, book chapter, dissertation, editorial, notes, non-English articles, or duplicates. Articles that were based either on AI in technical or engineering language without a supply chain setting or dealt with supply chain management but omitted a sustainability aspect were also excluded. Similarly, articles on general digitalization, Industry 4.0, blockchain, or analytics were not included unless an analytical construct of AI and relevance of SSCM were direct. With the help of these criteria, conceptual focus and analytical consistency were kept (Page et al., 2021; De Cassai et al., 2025).

3.7 Selection and Screening Process

The assessment of the study underwent four PRISMA steps, namely identification, screening, eligibility, and final inclusion. The initial step was to retrieve records in all databases and export them, which were then merged, and then duplicates were eliminated. Second, the titles and abstracts were filtered through the eligibility criteria. Third, the conceptual fit, methodological adequacy, and explicit applicability of the possible relevant articles were evaluated. Lastly, the studies that met all the requirements were retained to be synthesized. The PRISMA flow chart is employed to capture records of each step and report the number of records excluded openly (Page et al., 2021; Rethlefsen et al., 2022).

3.8 Data Extraction

To avoid inconsistency in data capture of study characteristics, a data extraction sheet was designed in a structured manner. The variables were extracted according to the following criteria: author(s) and year, country or region, industry context, AI technology applied, supply chain function of interest, sustainability dimension (economic, environmental, or social), research method, theoretical lens, and key inferences. Additional coding categories included reported drivers of adoption, barriers/challenges, and organizational/sustainability outcomes. This framework facilitates descriptive mapping and thematic comparison between the studies (Culot et al., 2024; Shahzadi et al., 2024; Teixeira et al., 2025).

3.9 Data Analysis Technique

A combination of descriptive analysis, thematic analysis, and content analysis was used to analyze the final dataset. The years of publication, countries, sectors, methods, and AI technologies were summarized using descriptive analysis. Thematic and content analysis were subsequently applied to determine patterns of recurrence in terms of adoption drivers, barriers to implementation, the impact of sustainability, and research gaps. Moreover, even less bibliometric trend analysis has been added, which could be followed to see an increase in publications and new topical accents, but bibliometric mapping was not used as a replacement for interpretive synthesis. Such a balanced method has been aligned with the modern recommendations to consider connecting bibliometric measures with further conceptual elaboration to yield a more significant review and a better research agenda in the future (Donthu et al., 2021; Mukherjee et al., 2022; Popenoe et al., 2021; Hulland, 2024).

4. RESULTS

The coded corpus shows a clear acceleration of interest in AI and sustainable supply chain research after 2023. Of the 18 core studies, 12 were published in 2024–

2025, indicating that the field is still expanding rapidly. Review-based work dominated the corpus, while direct empirical studies remained comparatively limited. This pattern suggests that the field is still consolidating concepts, technologies, and application areas rather than reaching strong empirical maturity. Recent review papers also show that the literature is concentrating around AI-enabled resilience, demand planning, sustainable production, traceability, and broader SSCM transformation.

Table 1 *Publication and methodological profile of the coded corpus (n = 18)*

Category	Frequency	Percentage
Publication year		
2021	3	16.7
2022	2	11.1
2023	1	5.6
2024	7	38.9
2025	5	27.8
Article type		
Systematic/structured reviews	11	61.1
Bibliometric/survey papers	3	16.7
Empirical/design studies	4	22.2

Table 2 *Study-level coding matrix of the review corpus*

Study	Year	Article type	Main focus	Sustainability lens
Pournader et al.	2021	Systematic review	AI applications in SCM	Economic/operational
Riahi et al.	2021	Bibliometric review	AI literature mapping in supply chains	Economic/operational
Dubey et al.	2021	Empirical	AI-powered analytics and alliance management	Economic/resilience
Modgil et al.	2022	Empirical	AI for supply chain resilience	Economic/resilience
Kar et al.	2022	Systematic review	AI and sustainability broadly	Economic/environmental/social

Sharma et al.	2022	Review	AI role in SCM territory mapping	Economic/operational
Sipola et al.	2023	Empirical qualitative	AI adoption in sustainable business	Economic/environmental/social
Culot et al.	2024	Systematic review	Empirical AI studies in SCM	Economic/operational
Qu and Kim	2024	Review	AI-integrated technologies in SSCM	Economic/environmental/social
Zejjari and Benhayoun	2024	Bibliometric review	AI for sustainable supply chains	Economic/environmental/social
Patalas-Maliszewska et al.	2024	Systematic review	AI for sustainable production and supply chains	Economic/environmental
Shahzadi et al.	2024	Systematic review	AI adoption in SCM	Economic/organizational
Bhattacharya et al.	2024	Systematic review	AI in closed-loop supply chains	Environmental/economic
de Mattos et al.	2024	Structured review	AI capabilities in demand planning	Economic/operational
Teixeira et al.	2025	Systematic review	AI contributions to intelligent SCM	Economic/environmental
Daios et al.	2025	Survey/review	AI applications across SCM processes	Economic/operational
Walter et al.	2025	Systematic review	AI in demand planning for supply chains	Economic/operational
Necula and Rieder	2025	Design/model study	Generative and adaptive AI for sustainable SC design	Economic/environmental

The thematic coding also demonstrates that the literature remains skewed towards generic SCM and operations performance, and sustainability-oriented literature constitutes a larger but smaller group. Specifically, environmental and economic outcomes were much more prevalent than social sustainability outcomes. Research papers that directly tackled the subjects of ethical sourcing, labor relations, equity, or human-centered AI were relatively less common. This verifies the disproportion that has already been implied by recent SSCM reviews, which focus more on environmental optimization and efficiency than social sustainability.

Table 3 *AI technologies most frequently reported in the coded corpus*

AI technology	Number of studies mentioning or emphasizing it	Percentage
Machine learning	15	83.3
Predictive analytics	12	66.7
Natural language processing	8	44.4
Deep learning	8	44.4
Expert systems/decision support	7	38.9
Robotics/automation	6	33.3
Computer vision	4	22.2
Generative AI	3	16.7

The technological trend that is the most evident is the pre-eminence of machine learning and predictive analytics, then NLP and deep learning. The problem structure of the existing supply chain research is represented in this distribution, in which forecasting, classification, anomaly detection, disruption sensing, and decision support are the focus. Generative AI can only be found in the latest section of the corpus, which implies that the unification is a new rather than an established theme in SSCM literature.

Table 4 *Main supply chain application areas identified in the corpus*

Application area	Frequency	Percentage
Demand forecasting/planning	11	61.1
Risk management/resilience	9	50.0
Logistics/routing/transport optimization	8	44.4
Inventory and production optimization	7	38.9
Supplier selection/sourcing	6	33.3
Traceability/transparency	6	33.3
Closed-loop/circular/reverse logistics	5	27.8
Sustainable design/strategic network planning	4	22.2

According to the application results, the highest level of AI application is in the field of forecasting and demand planning, then resilience/risk management and logistics optimization. These are the fields in which big data, cyclic decision processes, and quantifiable performance benefits make AI more readily justifiable. In comparison, circularity, sustainable design, and socially oriented use cases exist in the form of relatively newer versions. This trend is supported by recent research

on demand planning, sustainable production, closed-loop production, and sustainable supply chain design.

Table 5 Sustainability dimension coverage in the corpus

Sustainability dimension	Frequency*	Percentage
Economic sustainability	16	88.9
Environmental sustainability	13	72.2
Social sustainability	7	38.9
Triple-bottom-line integration	7	38.9

**Multiple coding allowed; totals exceed 18 because one study may cover more than one dimension.*

The sustainability coding has justified that economic sustainability is the prevailing code of sustainability, then the environmental sustainability. The least attention was paid to social sustainability, including even the papers that were stated to be based on SSCM. Practically, the literature is now more robust in terms of cost efficiency, forecasting quality, resilience, minimizing waste, and decisions on emissions than on labor welfare, algorithm fairness, stakeholder justice, and human-AI cooperation.

Table 6 Most common drivers and barriers of AI adoption in SSCM

Factor	Frequency	Percentage
Drivers		
Efficiency and productivity improvement	15	83.3
Better forecasting/decision quality	13	72.2
Resilience and risk mitigation	10	55.6
Sustainability/compliance pressure	9	50.0
Visibility and traceability needs	8	44.4
Competitive advantage/innovation pressure	8	44.4
Barriers		
Data quality and availability problems	14	77.8
Skills and capability gaps	13	72.2
Integration complexity	12	66.7
High cost/infrastructure burden	11	61.1
Governance, privacy, and ethics concerns	9	50.0
Resistance to change/trust deficit	8	44.4
Limited explainability	5	27.8

The findings point to the fact that companies are attracted to AI, as it offers more effective decision-making, greater resilience, and quantifiable efficiency, yet its implementation is limited due to data preparedness, organizational capacity, and integration issues. These obstacles are not technological only, though, but also managerial and institutional. This explains why the literature is moving towards the adoption of AI in SSCM as a capability-building and governance challenge, but not as an issue of mere technology implementation.

5. DISCUSSION

This review indicates that the application of AI in sustainable supply chain management (SSCM) is currently a rapidly expanding area, yet the area is uneven in its conceptual focus, empirical maturity, and sustainability coverage. The highest number of studies was found in 2024-2025, which means that AI-SSCM scholarship is at an expansion stage and not a research field that is fully stable. This is one of the reasons as to why review-based articles prevail in the literature, as compared to empirical and theory-testing studies. That is, the discipline is yet to delimit its boundaries, important technologies, and uses and proceed to causal explanation (Culot et al., 2024; Shahzabi et al., 2024; Teixeira et al., 2025).

One of the main trends is the prevalence of machine learning and predictive analytics, particularly in the area of demand forecasting, resilience, logistics optimization, and inventory planning. The use of these applications is not incredible since they apply structured data, recurrent decision-making, and quantifiable operational performance. In terms of sustainability, AI has been utilized in the most efficient way in areas where environmental and economic benefits interact, including route optimization, minimizing waste, energy efficiency, and resource planning. The review, however, also indicates that the least developed dimension is social sustainability. Social challenges, including labor well-being, fairness, explainability, and bias due to algorithms and the collaboration of humans and AI, are addressed much less than efficiency and emissions-related advantages. This supports previous suggestions that the studies on SSCM tend to prioritize environmental and economic performance and focus on social sustainability as a secondary outcome (Qu & Kim, 2024; Patalas-Maliszewska et al., 2024; Zejjari and Benhayoun, 2024).

The results also indicate that the adoption of AI in SSCM cannot be perceived as a technical process. Despite the desire to improve the quality of decisions, resilience, visibility, and competitive advantage, the key obstacles are the issues of data quality, the lack of skills, the integration complexity, the high cost of its implementation, and the governance issues. This confirms the utility of such frameworks as TOE, RBV, and Dynamic Capabilities Theory that underline that the adoption is conditional upon technological readiness, organizational capabilities, and

environmental pressures, instead of technology availability (Dubey et al., 2021; Uren and Edwards, 2022).

Altogether, this review makes contributions by demonstrating that AI can obviously be used to enhance SSCM, although its value is now concentrated in the economically and environmentally quantifiable spheres. This discussion thus indicates an essential future requirement: further empirical, theory-based, and context-specific studies which focus on SMEs, the developing economies, sector-related issues, and, above all, the undervalued social aspect of sustainability.

6. CONCLUSION

This literature review study has analyzed the emerging literature on the adoption of artificial intelligence in sustainable supply chain management and demonstrated that artificial intelligence is emerging as a significant driver of supply chain transformation. The review shows that AI technologies, especially machine learning, predictive analytics, natural language processing, and automation, are increasingly utilized to enhance forecasting, logistics, inventory management, risk management, and supply network visibility. These applications demonstrate great potential to enable sustainability through the enhancement of efficiency and resilience, waste reduction, and emissions reduction, as well as the enhancement of transparency of supply chain operations.

Simultaneously, the review shows that the literature on the subject remains unequal. The majority of research is concentrated on the economic and environmental performance, whereas the social aspect of sustainability has been taken rather poorly developed. Similarly, there are more review-based and concept-building studies in the field, but limited empirical studies that examine the drivers of adoption, the readiness of the organization, and the sustainability results over the long term in different industries and contexts. The evidence also confirms that even though the adoption of AI has significant benefits, all of it is limited by the inability to overcome challenges of poor data quality, insufficient technical capacity, the difficulty of integration, cost pressure, and administrative issues, including ethics, trust, and explainability.

Altogether, the present review yields its contribution by bringing together the disjointed knowledge and explaining the primary technologies, themes, applications, and barriers that exist in adopting AI in SSCM. It also points to the necessity of forthcoming studies that are more theoretically informed, context-specific, and based on empirical evidence, particularly in SMEs, emerging markets, and the socially responsible use of AI in supply chains. To sum up, AI may have a transformative effect of making supply chains more sustainable, although its value in the long term

relies on the ability of the firms to match the technological innovation with environmental responsibility, economic feasibility, and social responsibility.

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Impact of Digital Ambidexterity on Circular Supply Chain through Sustainable Operational Excellence and Supply Chain Resilience

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ABSTRACT

In today's competitive era, manufacturing firms face pressure to align their supply chain with circularity and sustainability imperatives. Despite the emergent interest in circular supply chain management (CSCM), the mechanisms through which digital capabilities support this transition remain unexplored. This study examines the role of digital ambidexterity to foster sustainability initiatives through supply chain resilience (SCR). Based on the dynamic capabilities view (DCV) and the natural resource-based view (NRBV) theory, a framework was developed. Survey questionnaire data from 159 Pakistani manufacturing firms were gathered and analyzed through a structural equation model. The findings affirmed that digital ambidexterity capabilities significantly promote sustainable operations and SCR. However, the association between SCR and CSCM is insignificant. Theoretically, the study contributes by integrating DCV and NRBV to elucidate circularity and sustainability initiatives as a capability orchestrator. Practically, this study offers strategic insights for firms and policymakers to balance digital capabilities, resilience, circularity, and sustainability outcomes.

Keywords: Digital Ambidexterity, Sustainable Operational Excellence, Circular Economy, Supply Chain Management

1. INTRODUCTION

In today's global competitive era, every firm wants its supply chain to be more sustainable and eco-friendly. Recently, the world has been grappling with a mounting sustainability crisis marked by resource depletion, waste proliferation, and other climate issues (Kaur et al., 2026). According to Statista (2025), more than two billion metric tons of solid trash are created worldwide each year, with a projected four billion tons by 2050. Climate change poses a hazard to future generations since the world's population is anticipated to exceed 10 billion by the end of the century. These concerns have fueled calls for a fundamental overhaul in supply chain management. In response, circular supply chain management (CSCM) incorporates

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circular economy ideas into supply chain management (Le et al., 2025). Farooque et al. (2021) define CSCM as the application of circular thinking to the management of the supply chain and its surrounding industrial and natural ecosystems. It methodically repairs technical materials and regenerates biological materials to achieve a zero-waste goal through system-wide innovation in business models and supply chain operations. CSCM provides a fresh viewpoint on sustainable development and has received scholarly attention, indicating widespread awareness (Polimetla et al., 2025). However, the transition to CSCM creates additional concerns and complications for organizations attempting to combine economic performance and environmental imperatives (Cano et al., 2025; Garcia-Buendia et al., 2024; Le et al., 2025).

At organization levels, manufacturing firms face dual challenges to excel at operational performance while implementing circular economy initiatives. For instance, Sasso et al. (2024) and Nadeem et al. (2025) argued that the integration of CE in lean management (C-Lean) serves as a proactive response strategy to mitigate environmental challenges. Xu et al. (2025) affirmed that manufacturing firm dynamic capabilities and CE practices mutually promote eco-friendly initiatives in digitalization. However, embedding the CE principle into established operations is not a simple process. Traditional operational excellence focuses on quality control, efficiency, and cost reduction. Whereas CE focuses on remanufacturing, reuse, reducing, and broader environmental goals. Likewise, conventional SC focuses on cost and quality, while CSCM emphasizes waste reduction and resource circulation (Cano et al., 2025). Consequently, there is a misalignment between circular principles and other conventional processes and operations. Furthermore, Cotta et al. (2022) argued that supply chain managers face tensions when implementing distinct sets of SC practices. Nevertheless, when managed adroitly, CE can unlock complementary benefits. For instance, Sasso et al. (2024) and Alanezi & Franchetti (2025) argued that the synergy between operational (lean) and CE offers substantial benefits for operational efficiency, environmental performance, and competitive advantage. Alanezi & Franchetti (2025) argued that the integration of CE into operations enables manufacturers to meet cost, quality, and environmental targets concurrently. However, the paradoxical concepts require new capabilities and approaches to navigate the apparent contradictions (Mishra et al. 2022; Albertsen et al. 2023). This organizational challenge underscores the need for ambidexterity, which requires organizations to exploit their existing strengths while exploring CE solutions in tandem (Sahoo et al., 2024; Martinez-Falco et al., 2024; Acquier et al., 2024).

A promising avenue to achieve this balance lies in harnessing digital transformation. Chen et al. (2024) argued that digitalization enables firms with new infrastructure and capabilities to achieve sustainable performance. From this perspective, digital ambidexterity helps firms achieve longevity if they concurrently

exploit existing digital technologies and also explore new ones (Jing et al., 2023). Fundamentally, digital ambidexterity consists of digital exploitation and exploration capabilities (Chen et al., 2024; Jing et al., 2023; Wetering, 2022). Moreover, Zahoor et al. (2025) contended that AI capabilities and ambidexterity are the underlying mechanisms to achieve CE practices in public organizations. Likewise, Sahoo et al. (2024) claimed that Industry 4.0 strategies and organizational ambidexterity strengthen firm circularity practices in emerging economies. This highlights that digital ambidexterity helps organizations to streamline their processes to promote CE practices and overcome the trade-off between productivity and sustainability. However, the process by which digital exploits and explores capabilities translates into dual outcomes (operational and CE) remains unexplored, especially in SCM literature. Prior literature studied the role of digital ambidexterity to promote sustainable performance (Chen et al., 2024), transformation performance (Jing et al., 2023), and business value (Wetering, 2022). Moreover, past studies explore the role of AI capabilities and organizational ambidexterity to promote CE practices (Zahoor et al., 2025; Sahoo et al., 2024; Acquier et al., 2024). Against these knowledge gaps, the present study proposes a holistic framework that establishes the association with digital ambidexterity and circular SCM through operational excellence and resilience. As Faggioni et al. (2024) argued, a resilient SC is essential in CE, as the recent global crises have underscored that resilience is essential for long-term viability. Moreover, Le et al. (2025) argued that SC experts warn that integrating circular models without encouraging resilience could leave firms vulnerable to disruption and resource shocks. Thus, the purpose of this research is to examine the role of digital ambidexterity (exploit & explore) to promote circular SCM through operational excellence and resilience. Moreover, this study investigates the mediating role of supply chain resilience and the moderating role of digital leadership on the proposed relationships.

2. THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

2.1 Dynamic capability view (DCV)

In this study, the dynamic capability view (DCV) explains the logical relationship between digital ambidexterity and other constructs (Teece et al., 1997). The DCV posits that organizations have three sets of primary competencies: sensing, seizing, and transforming (Kessler, 2013). The sensing concept highlights the managerial vision, insights, and analytical process to recognize future opportunities (Teece, 2007). Whereas seizing capability highlights the business framework to capture value and satisfy customer needs (Teece, 2007). Finally, transforming capability emphasizes that firms realign their resources with new opportunities (Teece, 2007). Moreover, Kessler (2013) argued that the change process is the focal

point of DCV. It is determined that the firm's plans are matched to customer needs and technological advancement (Kessler, 2013). From strategic aspects, O'Reilly and Tushman (2008) contended that the firm's survivability required operational capabilities and competencies in established markets as well as the ability to recombine and reconfigure assets to adapt to emerging technologies and markets. This affirmed that DCV is the heart of a firm's ability to be ambidextrous; to compete concurrently in mature and emerging markets to exploit and explore (Abbas et al., 2025). Moreover, Li et al. (2025) argued that firms can develop and apply DCV in different organizational contexts.

In this study, the DCV is applied in the digitalization context (Li et al., 2025; Sahoo et al., 2024; Zahoor et al., 2025). This study conceptualizes digital ambidexterity as a firm's dynamic capabilities to respond to the ever-evolving technological environment. Acquier et al. (2024) argued that ambidexterity only becomes a DC if the firm's exploit and explore capabilities are strategically integrated. Wetering (2022) claimed that digital ambidexterity is a dual digitalization approach to enhance firm operational processes. Furthermore, Chen et al. (2024) claimed that the driving forces for sustainable performance are the firm's digital capabilities, and it must develop them to adjust to the changing market needs.

2.2 Natural resource-based view (NRBV) theory

In this paper, the NRBV theory illustrates the logical connections between operational excellence, the circular economy, and supply chain management. The NRBV theory is an extension of the RBV theory. The RBV hypothesis emphasizes that important resources and competencies are scarce, precious, and cannot be replicated to achieve a competitive advantage (Barney, 1991). Hart (1995) expands on the RBV hypothesis, arguing that a firm's competitive advantage is determined by its link to the natural environment. According to Hart (1995), the heart of NRBV consists of three interrelated strategies: pollution avoidance, product stewardship, and sustainable development (Johl et al., 2024). According to Graham et al. (2023), these interrelated sustainability-oriented strategies aim to achieve long-term growth inside firms and the larger business ecosystem. Furthermore, Coppola et al. (2023) argued that there is no fixed hierarchy for NRBV tactics, which may be executed in any sequence. Pollution prevention, according to NRBV philosophy, focuses on reducing waste during the manufacturing process rather than at the end of the pipe. Product stewardship is the mitigation of environmental consequences throughout the product's life cycle (McDougall et al., 2019). Finally, sustainable development emphasizes economic, social, and environmental elements at the micro and macro levels (Johl et al., 2024; McDougall et al., 2019).

A strong foundation for explaining the company's support for environmental policies is provided by the combination of DCV and NRBV (Coppola et al., 2023).

Previous research confirmed that DCV is an essential initial step in spreading and maintaining the businesses' CE. Similarly, Achyar (2025) said that DCV adds to and expands upon the NRBV to provide a more comprehensive knowledge of how businesses implement sustainable development plans. According to Borazon et al. (2021), integrating DCV and NRBV provides a thorough insight into how a company moves from static to dynamic capabilities. Haylemariam et al. (2025) contended that DCV and NRBV are interconnected and offer a robust framework to understand how firms can leverage digital technologies to promote CE initiatives. Zhang et al. (2024) argued that the integration of NRBV and DCV is a research paradigm of “resource-capability-performance”. The integration of DCV and NRBV is well supported by past studies. However, past literature reviews emphasize the green dynamic capabilities to promote CE and sustainability initiatives (Zhang et al., 2024; Makhoulfi et al., 2023; Borazon et al., 2021; Achyar, 2025; Tanchangya et al., 2025). There is a lack of a framework that highlights how digital ambidexterity as a DCV promotes the CE and sustainable initiatives (NRBV) in supply chain management.

2.3 Hypotheses development

2.4 Relationship between digital ambidexterity capabilities, sustainable operational excellence and SCR

In the digitalization context, the notion of firm ambidexterity has been operationalized through the dynamic capability view (Haylemariam et al., 2025). DCV postulates that firms continuously sense, seize, and reconfirm their resources in the evolving technologies (Borazon et al., 2021). In the digital transformation, organizations have undergone massive capabilities shifts for a resilient future. This highlights that organizations need to exploit existing capabilities as well as explore new avenues. From this perspective, firm digital exploration capabilities (DEIC) have gained dynamic value to deal with the complexity. In OPEX, digital exploration helps firms to sense waste patterns, inefficiencies, and emissions hotspots in their operations (Naik et al., 2022). Then, firms seize opportunities through new digital tools (predictive analysis or digital twins) to optimize process control (Machado et al., 2025). Finally, firms reconfigure capabilities by integrating real-time sustainability key indicators into operational dashboards (Shuvabrata et al., 2020). Whereas in CE implementation, DEIC sense capabilities through product-service systems or reverse logistics models (Johl et al., 2024; Acquier et al., 2024). This also includes customer preferences or new platforms for remanufacturing (Li et al., 2025; Chaudhuri et al., 2022). Then, seizing capabilities focuses on adopting digital platforms for reverse logistics or new CE frameworks like pay-per-use or refurbishment networks (Johl et al., 2024; Acquier et al., 2024). Lastly, the firm reconfirming capabilities includes modifying SC to close loops or CE models (Yu et al., 2025; Borazon et al., 2021; Falco et al., 2024). Prior literature supports that firm

exploration capabilities support the firm's sustainable and CE outcomes. For instance, Chen et al. (2024) argued that DEIC supports sustainable as well as long-term business success. Likewise, Haylemariam et al. (2025) contended that AI capabilities and exploratory innovation are mutually responsible for corporate environmental performance. Sahoo et al. (2024) affirmed that Industry 4.0 and explorative capabilities jointly affect the firm's CE performance. Kayikci et al. (2021) argued that firm blockchain technology capabilities promote operational excellence in perishable food SC during outbreaks. Based on the theoretical and literature support, the following hypotheses have been proposed.

H1: *Digital ambidexterity capabilities have a positive impact on sustainable operational excellence.*

The notion of digital ambidexterity also emphasizes that firms need to exploit existing digital resources to gain sustainable performance (Haylemariam et al. 2025). DCV posited that the exploitation capabilities help firms to continuously adapt and optimize their operations for greater efficiency and reliability. In OPEX, the exploitation capabilities help firms to refine current digital tools like ERP to monitor energy usage and waste levels. It helps managers to sense inefficiencies against environmental standards. These inefficiencies can be fixed through AI-enabled scheduling and real-time quality monitoring, which fall under the firm seizing opportunity (Machado et al., 2025). Finally, firm reconfigure capabilities through upgrading existing equipment to digitally compatible models. Whereas organizations sense CE implementation by exploiting existing digital networks and data analysis platforms to track materials and identify CE intervention points (Acquier et al., 2024). Then, existing capabilities support CE implementation through automation and integrating secondary resource flows into production. Finally, firms reconfirm CE initiatives through creating supplier protocols for recycled materials or integrating circular logistics into enterprise systems. Prior literature supports that firm digital exploitation capabilities (DERC) support the firm's sustainable and CE outcomes. Sahoo et al. (2024) affirmed that Industry 4.0 and exploitative capabilities jointly affect the firm's CE performance. Katou et al. (2023) contended that organizational exploiter attributes significantly promote CE and sustainability outcomes. Falco et al. (2024) argued that ambidexterity and CE played a vital role to achieve sustainable in SCM. Haylemariam et al. (2025) contended that AI and exploitative capabilities are mutually responsible for corporate environmental performance. Based on the theoretical support by DCV and literature arguments, the following hypotheses have been proposed.

H2: *Digital ambidexterity capabilities have a positive impact on SCR.*

2.5 Relationship between sustainable operational excellence and supply chain resilience

The Natural resource-based view (NRBV) theory provides the theoretical base to explain the association between sustainable operational excellence and supply chain resilience. NRBV theory extends the resource-based view (RBV) perspective and is based on pollution prevention, product stewardship, and sustainable development aspects (Hart, 1995; McDougall et al., 2019). Kaur et al. (2026) contended that these three resources are the critical strategic capabilities. The concept of pollution prevention is the foundational capability to enhance sustainable performance while improving internal efficiency (Hart, 1995). From the pollution prevention concept, sustainable OPEX refers to streamlining processes, minimizing resources and energy, and eradicating inefficiencies (Naik et al., 2022). Consequently, it minimizes environmental harm and makes operations simple, fast, and more adaptable (Carvalho et al., 2019). Whereas product stewardship extends the firm's responsibility towards environmental responsibility across the entire value chain (McDougall et al., 2019).

Empirical evidence supports the association between sustainable OPEX, CE, and SC resilience. Islam et al. (2025) argued that CE is a vital factor to promote SC resilience from an Industry 4.0 perspective. Guoli et al. (2025) contended that CE is a dynamic resource capability to promote SC resilience in Chinese SMEs. Pellegrino et al. (2025) claimed that adoption of CE practices fosters SC resilience, which can lead to firm overall performance.

H3: *Sustainable operational excellence has a positive and significant effect on Circular Supply Chain Management.*

2.6 Relationship between supply chain resilience and circular supply chain management

The concepts of CE and resilience have been integrated into SCM and conceptualized as SC resilience (SCR) and CSCM. Le et al. (2025) argued that SCR and CSCM are the temporal dynamic capabilities to support broader SC performance. From an NRBV perspective, CSCM is a proactive environmental strategy, like reuse and remanufacturing practices, and perfectly aligns with product stewardship to reduce life-cycle impact. From a DCV perspective, the organization develops adaptive capabilities to sustain these environmental initiatives. Therefore, implementing CSCM entails a radical shift in how materials are reproduced and recovered, which necessitates strong organizational capabilities to manage this change (Cotta et al. 2022). Garcia-Buendia et al. (2024) argued that SCR practices help firms to better accommodate and tackle unforeseen circumstances. Moreover,

dynamic and flexible capabilities have emerged as critical attributes in CSCM (Garcia-Buendia et al. 2024). Past literature highlights that the association between SCR and CSCM can generate both synergies and tensions. Le et al. (2025) affirmed that SCR strategies can support circularity by fostering a flexible distribution network. Cotta et al. (2022) claimed that SC managers perceived the SCR and CSCM relationship as conflictive, synergistic, and orthogonal. Gani et al. (2023) concluded that resilience capabilities help organizations to avoid losses and promote SC sustainable performance. Based on the theoretical and literature support, the following hypothesis has been proposed.

H4: *Supply chain resilience has a positive and significant effect on circular supply chain management.*



Figure 1. *Research Framework*

3. RESEARCH METHODOLOGY

In order to accomplish its goals, this study employs the research onion approach recommended by Saunders et al. (2019). A research onion contains six layers, according to Saunders et al. (2019). Because the data gathering was planned and organized, the first layer was founded on the positivist research philosophy. Due to the mono-quantitative method utilized in the second and third levels, this study employed a deductive approach. According to Saunders et al. (2019), positivist philosophy and the deductive method are connected to the quantitative research design. The fourth and fifth levels employed a cross-sectional survey approach. The last layer explains the process of data collection and analysis. For this purpose, the entrepreneurial firm in the manufacturing domain operating in Pakistan was the target population. The minimum sample size was 105 observations calculated through G*power software. The respondents of this research were supply chain and quality managers, and only one questionnaire per organization was included for data analysis.

Pre-testing and pilot testing were done before actual data collection. The survey questionnaire was finally released to the potential respondents in both physical and online forms. A total of 460 potential supply chain and quality managers

were given the questionnaire. Following two reminders, 159 questionnaires were analyzed further. The final response rate is 34.56%. This research has used the PLS-SEM analysis tool with SmartPLS software. PLS-SEM is a statistical package that is the second generation and can be used with non-normality assumptions at small sample sizes (Hair et al., 2019).

3.1 Measures

All the study items were adapted from past studies. The digital ambidexterity capabilities construct has been adapted from Chen et al. (2024) and Jing et al. (2023). Sustainable operational excellence (SOE) has been measured through a six-item scale adapted from Prashar and Chaudhuri (2024) and Fernando et al. (2024). Furthermore, a five-item scale of supply chain resilience was adapted from Cheng & Shan (2025) and Al-Naimi et al. (2021). Finally, circular supply chain management was measured through five items adapted from Farooque et al. (2022) and Alghababsheh (2024). All items were measured on a seven-point Likert scale.

4. ANALYSIS AND RESULTS

4.1 Multivariate assumptions and Common method bias

To perform the PLS-SEM, the multivariate assumptions, such as multicollinearity, normality, and outliers, must be satisfied (Hair et al., 2019). For multicollinearity, the inner variance inflation factor (VIF) was used with a threshold value of less than 5 (Hair et al., 2019). To perform the normality, skewness, and kurtosis statistical analysis, a threshold value of ± 2 (George & Mallery, 2024) was used. Finally, the outlier analysis, Mahalanobis D2 ($D2/df$), was applied with a threshold value ≥ 2.5 for small samples and ≤ 4 for large samples (Hair et al., 2019). After performing multivariate assumptions, common method bias analysis was performed. Procedural and statistical precautions were proposed to alleviate the problem of CMB by Podsakoff et al. (2003). Statistically, the single-factor test by Harmon was conducted. The results indicate that the maximum variance of one factor was 31, which is not equal to the 50% threshold (Podsakoff et al., 2003).

4.2 Structural equation modeling

4.2.1 Reliability and validity

Reliability and convergent validity tests were performed in the measurement analysis of PLS-SEM. When evaluating the construct's reliability, composite reliability (CR) is superior to Cronbach's alpha, according to Hair et al. (2019). According to Hair et al. (2019), the CR cutoff value is ≥ 0.70 . Table 1 shows that every research variable's reliability analysis value is higher than the cutoff. It shows

that variables may be effectively employed in further analysis. Additionally, the average variance extracted (AVE) was used to compute the convergent validity. The cutoff value of ≥ 0.50 is pretty acceptable, according to Hair et al. (2019). Table 1 shows that every variable in the research has an AVE value that is higher than the cutoff.

Table 1 *Reliability and Validity*

Constructs	Items	Loading	CR	AVE
Digital Ambidexterity capabilities	DAD1	0.696	0.847	0.584
Digital Ambidexterity capabilities	DAD2	0.709	0.847	0.584
Digital Ambidexterity capabilities	DAD3	0.701	0.847	0.584
Digital Ambidexterity capabilities	DAD4	0.739	0.847	0.584
Digital Ambidexterity capabilities	DAD5	0.774	0.847	0.584
Digital Ambidexterity capabilities	DAD6	0.724	0.847	0.584
Sustainable operational excellence (SOE)	SOE1	0.813	0.932	0.696
Sustainable operational excellence (SOE)	SOE2	0.785	0.932	0.696
Sustainable operational excellence (SOE)	SOE3	0.858	0.932	0.696
Sustainable operational excellence (SOE)	SOE4	0.843	0.932	0.696
Sustainable operational excellence (SOE)	SOE5	0.858	0.932	0.696
Sustainable operational excellence (SOE)	SOE6	0.847	0.932	0.696
Supply chain resilience (SCR)	SCR1	0.780	0.897	0.635
Supply chain resilience (SCR)	SCR2	0.767	0.897	0.635
Supply chain resilience (SCR)	SCR3	0.794	0.897	0.635
Supply chain resilience (SCR)	SCR4	0.803	0.897	0.635
Supply chain resilience (SCR)	SCR5	0.840	0.897	0.635
Circular supply chain management (CSCM)	CSCM1	0.732	0.900	0.644
Circular supply chain management (CSCM)	CSCM2	0.854	0.900	0.644

Circular supply chain management (CSCM)	CSCM3	0.809	0.900	0.644
Circular supply chain management (CSCM)	CSCM4	0.806	0.900	0.644
Circular supply chain management (CSCM)	CSCM5	0.806	0.900	0.644

4.2.2 Discernment validity

The assessment included many indicators, including cross-loading, Fornell-Larcker, and the Heterotrait-Monomethod Ratio of Correlation (HTMT), to assess the discriminant validity. According to Hair et al. (2019), HTMT is a more accurate indicator of discriminant validity. HTMT's upper break-even threshold is limited to 0.90. All of the study's variables had values below 0.90, as Table 3 shows.

Table 2 *Discernment validity (HTMT)*

Variable	DAD	SOE	SOR	CSCM
DAD				
SOE	0.474			
SOR	0.464	0.445		
CSCM	0.237	0.162	0.22	

4.2.3 Hypotheses analysis

Analyzing the structural model as suggested by Hair et al. (2019) is the second stage in the PLS-SEM. Furthermore, Hair et al. (2019) recommended using the bootstrapping approach to test the hypotheses with a resample size of 5000 resamples, as shown in Table 3.

Table 3 *Hypotheses analysis*

Relationship	Original sample (O)	Sample mean (M)	S.D	T statistics	P values
H1: DAD -> SOE	0.421	0.433	0.061	6.854	0.000
H2: DAD -> SCR	0.406	0.419	0.058	7.031	0.000
H3: SOE -> CSCM	0.076	0.081	0.097	0.785	0.216

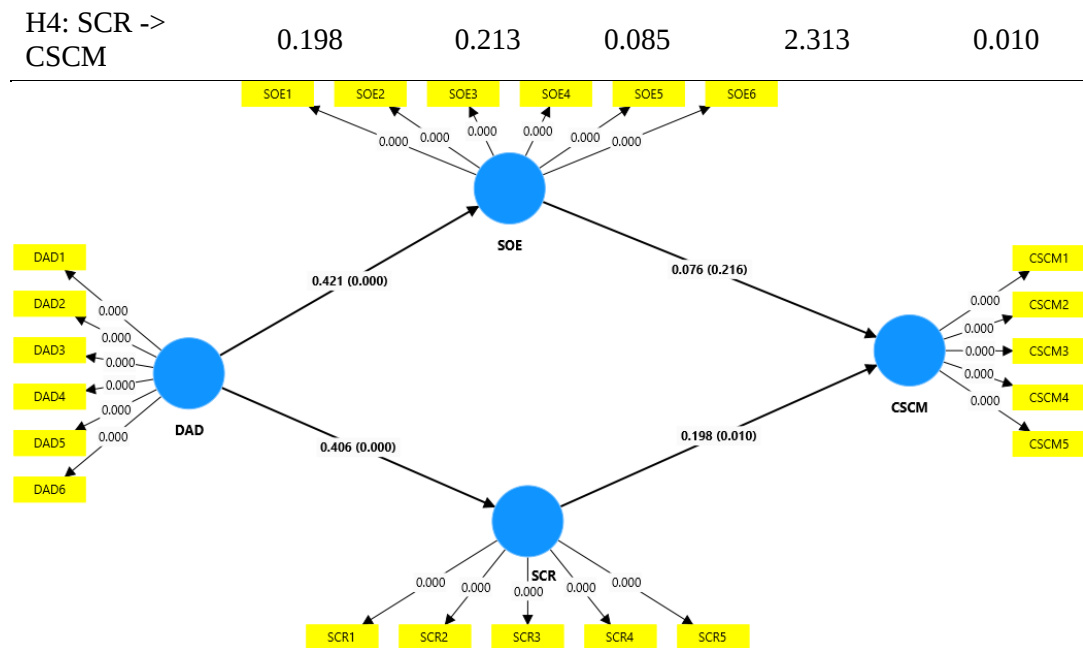


Figure 2. PLS-SEM Output

5. DISCUSSION AND CONCLUSION

5.1 Research contributions

The study findings offer multifold theoretical contributions. First, the study offers a novel integration of DCV and NRBV. Although past studies integrate DCV and NRBV, but there focuses on green dynamic capabilities and underscores the digital aspects. Whereas this study positions digital ambidexterity as firm-level digital dynamic capabilities that promote ecological value creation (NRBV), offering a “resource-capabilities-performance” corridor. Second, the study positions digital ambidexterity in the context of SCM and circular economy. Prior studies predominantly explored innovation and digital-enabled performance. This study offers a novel context and positions DA as a dynamic enabler of sustainable operations in SCM. Moreover, this provides a fresh theoretical insight into how firms balance exploration and exploitation of digital initiatives to promote circularity and sustainability goals. Third, the study reconceptualises SCR as a strategic capability that mediates the transition towards CSCM. Previously, SCR has been framed as an outcome of risk management or agility. Grounded in DCV and NRBV, the study demonstrates that SCR enables firms to absorb variability and stabilize SC during the transition from linear to a circular framework. Moreover, the dual-mediating role of SCR highlights it as a proactive and integrative capability critical to long-term sustainability and circularity. Finally, this study reframes digital leadership as a capability orchestrator between digital ambidexterity and sustainability outcomes.

Past studies framed DL as a technology or innovation driver. This research highlights a nuanced role in shaping how firms leverage digital exploit and explore capabilities for CE and sustainable operational excellence. This extends DL from a top-down variable to a multi-level capability enabler that interacts with firm-level resources in a complex, sustainability-driven SCM context.

The study findings have multifold practical implications. First, the outcomes underline the role of dynamic capabilities like digital exploration and exploitation to promote sustainability and circularity goals. The executives and managers may view digital capabilities as a set of dynamic resources for sustainability-led transformation. Consequently, it strengthens the strategic role of digital transformation as well as resource-led sustainability imperatives. Second, the outcome emphasizes that managers should embed CE principles into the core operational systems rather than compliance-driven activities. Such reframing is essential for ecological outcomes as well as to achieve resilience and competitiveness in a volatile and resource-constrained environment. Third, the findings highlight that leaders in digital transformation should position themselves as an organizational integrator to foster digital exploration and exploit capabilities concurrently towards sustainable goals.

5.2 Limitations and future research directions

Despite its contributions and practical implications, this study has several limitations that suggest prolific avenues for future research. From a theoretical standpoint, future studies could examine other enablers like AI-driven capabilities, mediators like digital innovation orientation, and moderators like cultural orientation. Furthermore, alternative theoretical lenses like resource orchestration theory may also enrich understanding. In terms of knowledge domains, future research could explore resilience and circular economy in the new context of Industry 5.0, such as digital twin-enabled sustainability, green innovation, and AI-driven ecosystems. Methodologically, the cross-sectional design limits causal inference. Future research should employ longitudinal or mixed-methods approaches to capture the evolution of resilience and CE over time. Comparative studies across developed and emerging economies, or across industries beyond manufacturing, would enhance generalizability. Finally, expanding the sample to other GCC countries or diverse global contexts could yield comparative insights into how digital ambidexterity, resilience, and SCM interact in different institutional environments.

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