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Review

FinTech in sustainable banking: An integrated systematic literature review and future research agenda with a TCCM framework

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Abstract: Academic interest in understanding the role of financial technology (FinTech) in sustainable development has grown exponentially in recent years. Many studies have highlighted the context, yet no reviews have explored the integration of FinTech and sustainability through the lens of the banking aspect. Therefore, this study sheds light on the literature trends associated with FinTech and sustainable banking using an integrated bibliometric and systematic literature review (SLR). The bibliometric analysis explored publication trends, keyword analysis, top publisher, and author analysis. With the SLR approach, we pondered the theory-context-characteristics-methods (TCCM) framework with 44 articles published from 2002 to 2023. The findings presented a substantial nexus between FinTech and sustainable banking, showing an incremental interest among global scholars. We also provided a comprehensive finding regarding the dominant theories (i.e., technology acceptance model and autoregressive distributed lag model), specific contexts (i.e., industries and countries),

characteristics (i.e., independent, dependent, moderating, and mediating variables), and methods (i.e., research approaches and tools). This review is the first to identify the less explored tie between FinTech and sustainable banking. The findings may help policymakers, banking service providers, and academicians understand the necessity of FinTech in sustainable banking. The future research agenda of this review will also facilitate future researchers to explore the research domain to find new insights.

Keywords: sustainable development; FinTech; sustainable banking; systematic literature review; TCCM framework

JEL Code: M20, Q5, Q55

Abbreviations: SDGs: Sustainable development goals; SLR: Systematic literature review; FinTech: Financial technology; AI: Artificial intelligence; IoTs: Internet of things; ML: Machine learning; SPAR-4-SLR: Scientific procedures and rationales for the systematic literature reviews; IS: Information system; TAM: Technology acceptance model; TTAT: Technology threat avoidance theory; PDT: Psychological distance theory; NT: Needs theory; SIT: Service innovation theory; ST: Society theory; PT: Protection theory; ARDL: Autoregressive distributed lag; UTAUT: Unified theory of acceptance and use of technology

1. Introduction

FinTech and sustainability have grown in heightened importance due to digital transformation and emphasis on achieving sustainable development goals (SDGs) across the countries (Parmentola et al., 2022). In response to ensuring compliance with the SDGs, FinTech and sustainability have received sharp attention from scholars investigating the implications of digitization (Danladi et al., 2023). In addition, the Intergovernmental Panel on Climate Change has focused on accelerating the growth of sustainable and the FinTech industry over the past ten years (Brahmi et al., 2023). Understanding the emergence and importance, many past studies have explored FinTech and sustainability in various aspects, such as the impact of blockchain in banks (Ji & Tia, 2022), green banking adoption (Tara et al., 2019), FinTech adoption for sustainable performance (Yan et al., 2022), and green banking discloser (Bose et al., 2018). However, most empirical studies have focused on individual aspects (FinTech or sustainability) or both (Guang-Wen & Siddik, 2023; Nenavath, 2022) in scattered or isolation. Thus, the extant literature on the collective view of FinTech and sustainability remains fragmented and less explored. Hence, scholars, e.g., Ellili (2022), have underscored conducting review studies to collectively and sophisticatedly present FinTech and sustainability from an industry aspect. This evidence underpins the current review to shed light on how FinTech adoption promotes sustainability in the banking industry.

A more holistic and comprehensive understanding of the role of FinTech in sustainable banking would be crucial for three reasons. First, studies have illustrated that FinTech is highly relevant and practical for financial organizations to accelerate sustainable banking performance. For example, extant literature has presented that the adoption of FinTech increases banks' environmental performance (Guang-Wen & Siddik, 2023), service continuance (Ashrafi et al., 2022), endorsing

financial inclusion to accomplish carbon neutrality (Brahmi et al., 2023), and achieving SDGs (Danladi et al., 2023). Thus, creating and managing a sustainable policy combining FinTech across the banking industry should be a top priority for practitioners. Second, in the banking industry, blockchain, cryptocurrencies, artificial intelligence (AI), Internet of things (IoTs), machine learning (ML), cloud computing, virtual/augmented reality, and e-commerce significantly affect daily banking operations (Truby et al., 2020). Yet little is known about the antecedents of adopting these technologies, amplifying sustainable banking from a synthesis view. Hence, a collective overview of key constructs and their associations will serve as roadmaps for future research (Ellili, 2022). Finally, indeed, many recent reviews have identified how FinTech is foregrounding in sustainable financial contexts (Cumming et al., 2023; Ellili, 2022; Aracil et al., 2021; Ashta & Herrmann, 2021). Yet, to date, there has been no attempt at consolidating the theories, contexts, and methods used in past research on FinTech in sustainable banking to guide scholars to explore the research field.

So far, this review is the first to attempt to fill these research gaps using the theory-context-characteristics-methods (TCCM) review framework (Paul et al., 2021) in the context of FinTech and sustainable banking. The TCCM framework was selected for two primary reasons. First, the review framework offers a collective delineation of the breadth of a research domain (Hassan et al., 2022). In this case, it details us to critically assess the theoretical foundations, methodological approaches, and diverse settings of FinTech in sustainable banking research. Furthermore, the framework examines the distinctive characteristics or crucial factors and their interconnections (Hassan et al., 2022), thereby facilitating a more thorough examination of the fundamental aspect of FinTech in sustainable banking, including its predictors and outcomes.

Therefore, we aim to achieve the following objectives:

a) Highlight the association between FinTech and sustainable banking (RO 1);
b) explore the publication trends, top contributing publishers, popular keywords, and top cited authors (RO 2);
c) identify the frequently used theories and models in the context of FinTech adoption in sustainable banking (RO 3);
d) discover the contexts (e.g., organizations and countries) (RO 4);
e) shed on the most influential traits or factors involved in FinTech adoption in sustainable banking (RO 5);
f) find the most popular research methods (RO 6);
g) provide future research directions in this context (RO 7).

We combine bibliometric analysis and systematic literature review (SLR) to map out the present breadth of FinTech in sustainable banking. To our knowledge, inadequate extant reviews have considered both approaches to synthesize research findings from FinTech and sustainability aspects. In sum, this study contributes to the existing literature in three ways: First, it provides a holistic overview of the current knowledge of FinTech and sustainable banking research, showing their interconnection, current research trends, top contributing publishers, popular keywords, and top cited authors; second, it entails contemporary and classic theories, contributing organizations and countries, major antecedents, and popular research methods; third, it identifies research gaps and provides directions for future inquiry.

The subsequent sections of this work are structured in the following manner. The section under methodology provides a comprehensive overview of the technique used and the pertinent data utilized in the study. Afterward, the association between FinTech and sustainable banking is illustrated. Next,

the general section comprises publication trends, top publishers, popular keywords, and top-cited authors. Then, the TCCM framework is illustrated, following the future research agenda. The subsequent sections are implications and conclusions with limitations, summarizing the study.

2. Methodology

We consider the bibliometric approach following Khan et al. (2022) and the SLR outlined by Paul et al. (2021). Initially, we performed trend and evolution analyses and keyword co-occurrence mapping analysis, following top contributing authors, organizations, and countries. In doing so, the VOSviewer software was used. Next, we outlined the theoretical framework, contextual factors, distinctive features, and methodologies of the FinTech and sustainable banking domains based on the TCCM framework.

2.1. Data

Following the methodology used by Paul et al. (2021), we used the scientific procedures and rationales for the systematic literature reviews (SPAR-4-SLR) protocol. Figure 1 illustrates the search approach and the several phases involved in data extraction. Under the SPAR-4-SLR methodology, the three steps of assembly, organization, and evaluation were carried out.

2.2. Assembling

The assembly step has two sub-stages: identification and acquisition (Paul et al., 2021). The objective of the identification was to locate scholarly literature on the correlation between FinTech and sustainability. In doing so, we chose the Scopus database. The Scopus database was preferred over other databases (e.g., Web of Science (WoB)) for mostly three reasons: It 1) covers 60% more than WoB (Zhao & Strotmann, 2015); 2) comprises journals with higher rankings than other databases (Kumar et al., 2023); and 3) is the leading and highest cited database of peer-reviewed journals worldwide (Singh et al., 2023). The search syntax encompasses the terms “FinTech”, “Financial Technology”, and “Sustainable Banking.” The search query was executed in the Scopus database on June 11, 2023, resulting in 219 documents.

Further refining procedures were used throughout the acquisition sub-stage, including the search duration, topic domain, source selection, and document categorization. The search duration spanned from 2002 until June 11, 2023. The topic areas included in this study comprise the fields of “social sciences,” “business, management, and accounting”, “economics, econometrics, and finance”, and “decision sciences”. The sources used in this study mainly consisted of scholarly publications (journal articles, n = 97).

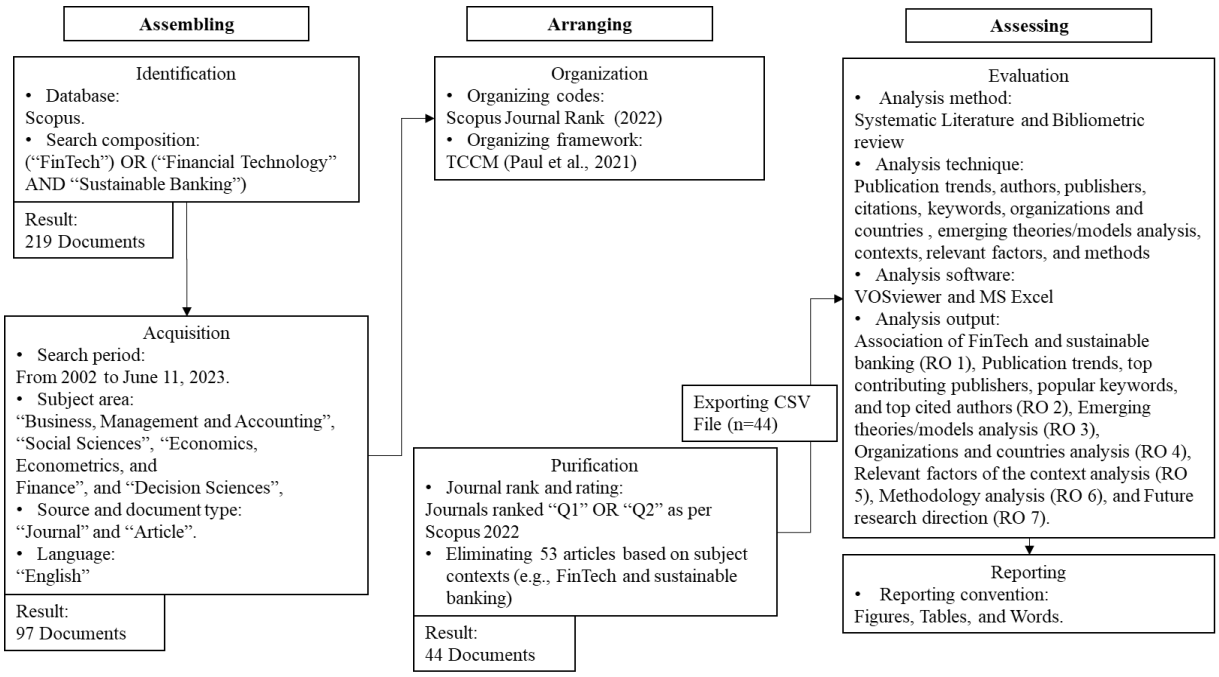
2.3. Arranging

This step includes two distinct sub-stages: organization and purification (Paul et al., 2021). This research utilizes the Scopus journal rating (2022) as organizing codes, following the TCCM as the organizing framework. After completing the purification sub-stage, the articles underwent filtration based on the Scopus quartiles 1 and 2 to only include journals with high rankings. After eliminating 53 articles based on the subject context, the search retrieved 44 documents. According to Paul et al.

(2021), 40 articles are enough to conduct a review in a given research field; this indicates the number of articles used in this review is above that benchmark. The data were converted to CSV format in Excel and uploaded to VOSviewer for bibliometric analysis.

2.4. Assessing

The assessing step involves assessment and reporting. In the assessment sub-stage, 44 articles were subjected to bibliometric analyses and scientific mapping. The VOSviewer tool, specifically the "keyword co-occurrence cartography" feature, was used to ascertain the primary subjects of the study domain, followed by the citation assessments of authors, organizations, and countries. Then, a comprehensive content analysis elucidates the theories, contexts, characteristics and methods. In the reporting sub-stage, we display its findings using figures, tables, and textual descriptions.



[i]**Figure 1**. Structure of the review using the SPAR-4-SLR protocol.

[i] **Note:**1st **Search Syntax:**

(TITLE-ABS-KEY (FinTech) OR TITLE-ABS-KEY (financial AND technology) AND TITLE-ABS KEY (sustainable AND banking))

2nd Search Syntax:

(TITLE-ABS-KEY (FinTech) OR TITLE-ABS-KEY (financial AND technology) AND TITLE-ABS-KEY (sustainable AND banking)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (LANGUAGE, "English"))

3. Association between FinTech and sustainable banking (RO 1)

The term "Financial Technology" or "FinTech" refers to the technology used to transmit various financial services (Khan et al., 2023), including m-banking, digital currency, leasing, invoicing, digital payments, crowdfunding, etc. Evidence suggests that FinTech presents a voluminous opportunity to increase financial transparency, customer friendliness, and cost-effectiveness; it enables businesses to operate more freely within the regulatory sandbox to develop new products (Boratyńska, 2019). Additionally, FinTech users can conduct commercial transactions at any time and location (Iman, 2018), enabling banks to become more innovative in providing services to clients and investors (Ashta & Herrmann, 2021; Iman, 2018). FinTech accelerates financial growth, diversity, social stability, credibility, and consequential sustainable development by creating the foundation for an innovative financial environment (Aracil et al., 2021). Consequently, between 2013 and 2018, there was a more than six-fold increase in global FinTech investment, going from $18.9 billion to $111.8 billion (Ashrafi et al., 2022).

However, individuals increasingly seek ecological or environmentally friendly products to lead a more sustainable life. This is due to the recent media exploration (Sun et al., 2021). According to a study conducted by Nielsen Media Research, 66% of customers globally are willing to allocate more financial resources towards purchasing sustainable goods (Mohr et al., 2022). Mohr et al. (2022) also noted that customers' inclination towards sustainability is particularly prominent among millennials (73%). Sun et al. (2021) identified that customers are likely to pay more for and purchase items from companies they believe to be sustainable.

The arguments mentioned above prove that the term "sustainable banking" or "green banking" has drawn more attention from financial industry practitioners. Dewi and Dewi (2017) conceptualized sustainable banking as a banking approach that focuses on integrating environmental management into the basic operations of a bank. In other words, Bose et al. (2018) noted that green banking implements and advocates environmentally sustainable technology within both the internal and external operations of financial institutions, aiming to mitigate carbon emissions and effectively manage the environment. The extant literature has proven that the banking sector plays a vital intermediation functional role, directing financial resources toward sustainable goals (Paiva et al., 2021). In line with the sustainable responsible investment theory, Gangi et al. (2021) affirmed that banks contribute to achieving the SDGs by allocating resources to green initiatives. Based on the service innovation theory, Zhao et al. (2019) found that service innovation strategies accelerate banks to achieve sustainable performance. Recent studies have also shown that FinTech has a wide-ranging impact on society, the economy, and the environment (Mądra-Sawicka, 2020; Mhlanga, 2023). Thus, it is expected that using FinTech, allocating funds for eco-friendly projects, and advancing renewable energy and environmental infrastructure may lead to environmentally sustainable growth worldwide (Rahman et al., 2022; Aracil et al., 2021; Ji & Tia, 2022).

4. General overview (RO 2)

4.1. Publication trends

Figure 2 illustrates that the initial publication progress was slow and volatile. However, since 2019, the number of publications in this field has progressively increased in 2020, showing an average

growth rate of 75% between 2019 and 2020. More specifically, a total of 14 articles were published from 2021 to 2023. We believe the exponential rise in publications illustrates a growing interest among researchers in exploring the linkage between FinTech and sustainability.

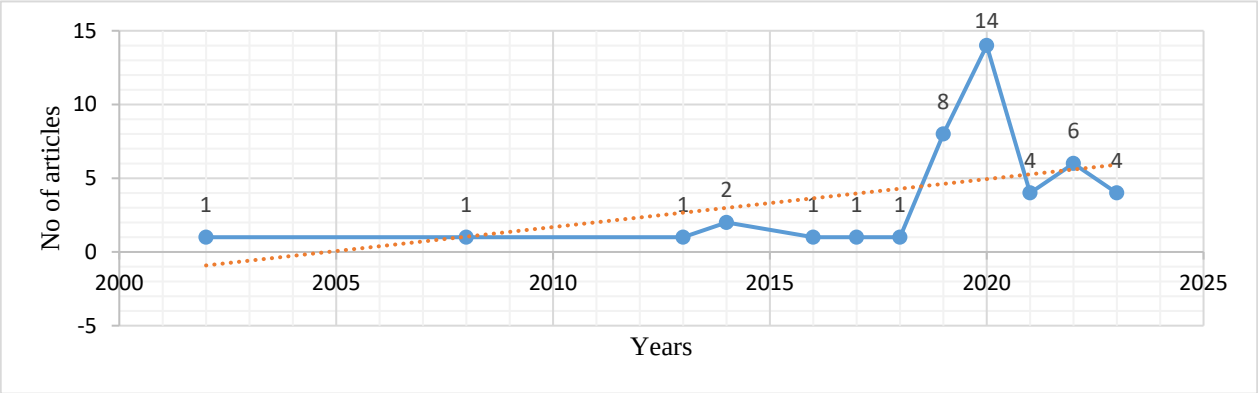


Figure 2. Publication trend (N=44).

4.2. Top publishers

Figure 3 presents the top five publishers in FinTech and sustainability. Among these publishers, Sustainability Switzerland published the most articles (18). On the other hand, Economic Analysis and Policy, Industrial Management and Data Systems, International Journal of Social Economics, and Sustainable Development journals each published two papers in the current research context. Surprisingly, research articles from the mainstream finance and economics-related journals were lacking in the top five journals. This indicates that there is scope for numerous extensive investigations in the context of finance and economics. Moreover, scholars conducting research in the field can target these top publishing journals. This may help to save time and effort.

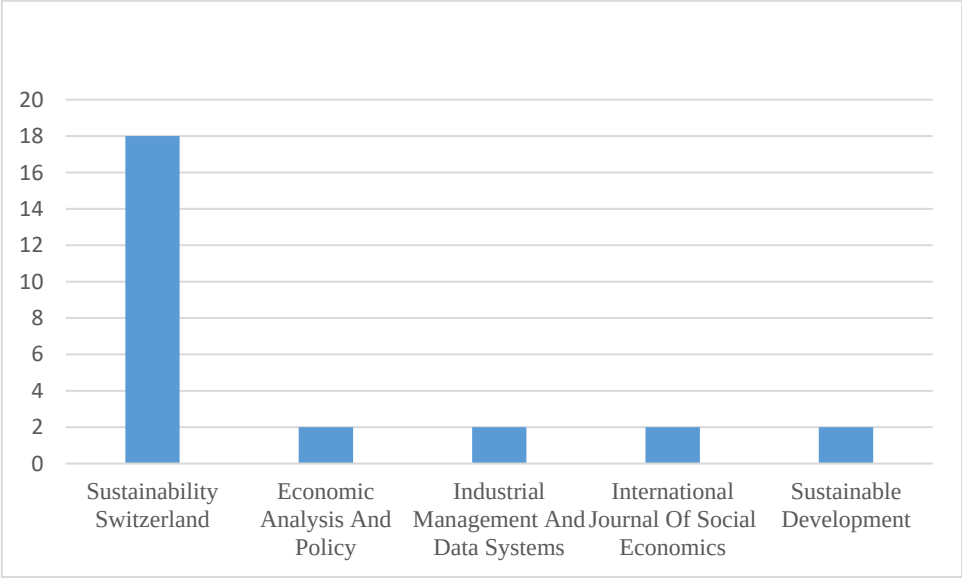


Figure 3. Top five publishers.

4.3. Popular keywords

We explored the keywords of FinTech and sustainable banking with the help of co-occurrence analysis. As per the recommendation of Khan et al. (2022), each keyword was filtered with a minimum threshold of two to ensure the meaningfulness of the results. This systematic process generated 15 keywords out of 277 words; later, we excluded the repeated keywords. Figure 4 represents the results, identifying three major clusters: sustainable development, banking, and innovation. Each cluster demonstrates individual association with many other keywords. Figure 4 and Table 1 exhibit three major clusters where sustainable development, banking, and innovation are marked blue, green, and red, respectively.

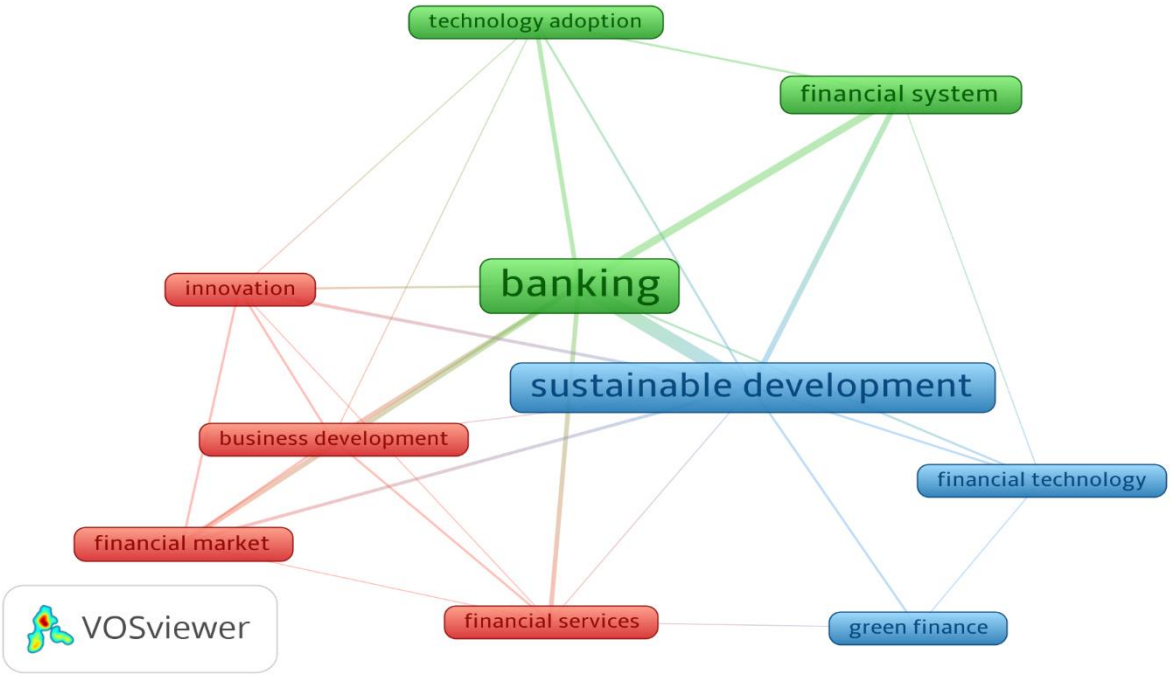


Figure 4. Keywords analysis.

Table 1. Cluster keywords distribution.

No	Cluster	Keywords
01	Sustainable development	Financial technology, Green finance
02	Banking	Technology adoption, Financial system
03	Innovation	Financial market, Financial services, Business development

However, sustainable development clusters have focused on financial technology and green finance, which indicate the role of FinTech in helping green financial activities (Gbongli et al., 2020), achieving sustainable development (Aduba, 2021), and fostering the growth of FinTech companies (Çera et al., 2020; Zuo et al., 2021). In the banking cluster, studies have explored the context of sustainability and technology adoption from banking aspects (Lekakos et al., 2014) and the influence of FinTech in enhancing economic, entrepreneurial, and financial innovations during the global pandemic (Banna et al., 2022; Hommel & Bican, 2020; Talom & Tengeh, 2019). Finally, in the

innovation cluster, studies have examined the impact of digital transformation and information technology on sustainable economic growth and financial development (Fenwick & Vermeulen, 2020; Tsindeliani et al., 2022). In addition, the contribution of FinTech to the assurance of financial market and service has been observed in this cluster (Banna et al., 2022; Zhang, 2023).

The terms "sustainable development", "banking", and "innovation" appeared frequently in papers from 2018 to 2023, demonstrating a direct connection between the advent of FinTech and the financial and banking sectors. FinTech has also helped to improve decision-making procedures and support sustainable development. For instance, Lai et al. (2023) investigated how to reduce corporate excess in China and found a significant link between FinTech and sustainability.

The keywords analysis by the current study provides valuable insights into the associations and linkage among the key concepts of FinTech and sustainable banking. The findings of this analysis present the knowledge structure of the research area. The insight may help future scholars to focus on which keywords or clusters (e.g., sustainable development, banking or innovation) they should retain as analyzing objects.

4.4. Top cited authors

The citation analysis of this review aims to identify the prominent authors who have made significant contributions to the publication of research on FinTech and sustainability (Cumming et al., 2023; Goodell et al., 2021; Kumari & Devi, 2022). According to the findings of our study, Tchamyou et al. (2019) have garnered the most substantial citations (280). The scholars with the most significant number of citations (Table 2) in the present study were Tchamyou et al. (2019), Yigitcanlar and Cugurullo (2020), and Hassan et al. (2020), who have been cited in the highest number of papers. In contrast, Zhao et al. (2019), Ortas et al. (2013), Sethi et al. (2020), and Gbongli et al. (2020) have contributed to the field of FinTech and sustainability research with more than 60 citations. With this analysis, future scholars can benefit from finding the most influential authors in FinTech and sustainable banking research. Moreover, the findings may aid them in going through their ideas to understand the contexts better and incorporate the insights into their future research.

Table 2. Most cited authors.

No	Authors	No of citations
01	Tchamyou et al. (2019)	280
02	Yigitcanlar and Cugurullo (2020)	85
03	Hassan et al. (2020)	68
04	Zhao et al. (2019)	67
05	Ortas et al. (2013)	66
06	Sethi et al. (2020)	62
07	Gbongli et al. (2020)	61

5. The Theory-Context-Characteristics-Methods (TCCM) review framework

5.1. Theories (RO 3)

While reviewing 44 articles, we identified 12 popular theories employed to explore the context of FinTech and sustainability. As shown in Table 3, the technology acceptance model (TAM) (Davis

et al., 1989) has been used in the most 3 studies. Mainly, TAM comprises two significant variables widely used in various information systems (IS) arena (Sagnier et al., 2020). Namely, these two variables are perceived usefulness (focusing on how a desired technology can improve performance) and perceived ease of use (indicating how users feel comfortable and confident while using technology with less mental and physical effort (Davis et al., 1989). In investigating the tie between FinTech and sustainability, Lekakos et al. (2014) utilized TAM to discover customers' reactions toward sustainable operation by banks. In another study, Naruetharadhol et al. (2021) used TAM to predict the influential factors of customers' mobile banking in sustainable intention, identifying a notable influence of perceived ease of use and perceived usefulness over sustainable intention. Similarly, Gbongli et al. (2020) integrated self-efficacy, technology anxiety, and personal innovativeness with TAM. They found that perceived ease of use significantly impacted customers' attitudes toward mobile-based money.

Table 3. Emerging theories in FinTech and sustainability context.

No	Theory/Model/Framework	Authors
01	Technology Threat Avoidance Theory	(Jibril et al., 2020)
02	Grounded Theory	(Guo et al., 2014)
03	Needs Theory	(Lekakos et al., 2014)
04	Technology Acceptance Theory	(Lekakos et al., 2014); (Naruetharadhol et al., 2021); (Gbongli et al., 2020)
05	Psychological Distance Theory	(Lekakos et al., 2014)
06	Service Innovation Theory	(Zhao et al., 2019)
07	Society Theory	(Abdul-Rahim et al., 2022)
08	Protection Theory	(Abdul-Rahim et al., 2022)
09	Technology-Organization-Environment based FinTech framework	(Taneja et al., 2023)
10	the ARDL model	(Ullah et al., 2023); (Sethi et al., 2020)
11	Unified Theory of Acceptance and Use of Technology	(Oseni et al., 2018)
12	Not specified	(Aduba, 2021; Alaabed et al., 2016; Banna et al., 2022; Çera et al., 2020; Chang et al., 2021; Coffie et al., 2020; Diep & Canh, 2022; Dong et al., 2018; Eisingerich & Bell, 2008; Fenwick & Vermeulen, 2020; Gozman & Willcocks, 2019; Gruin & Knaack, 2020; Hassan et al., 2020; Hommel & Bican, 2020; II & Demrig, 2002; Lai et al., 2023; Lee & Sohn, 2017; Mejia-Escobar et al., 2020; Nosratabadi et al., 2020; Ryu & Ko, 2020; Talom & Tengeh, 2019; Tara et al., 2019; Truby et al., 2020; Tsindeliani et al., 2022; Yan et al., 2022; Yang & Masron, 2022; Yigitcanlar & Cugurullo, 2020; Zhang, 2023; Zuo et al., 2021)

In unveiling the twist of FinTech and sustainable banking, several other emerging theories /models/frameworks are used in different studies in different contexts. For example, to examine the influence of online identity theft on consumers' willingness to e-banking, Jibril et al. (2020) employed technology threat avoidance theory (TTAT) in the context of Ghana. Dragging the TTAT, Jibril et al. (2020) identified how online identity theft impacts customers' inclination to engage in e-banking transactions. In the context of FinTech and sustainability, Zhao et al. (2019) used the service innovation theory (SIT) and noted that banks are moving towards operational innovation to achieve sustainable competitive advantage. In a similar context, Zuo et al. (2021) argued that such digital transformation

by banks has a significant effect on their sustainable efficiency enhancement. Given, the psychological distance theory (PDT), needs theory (NT) (Lekakos et al., 2014), the society theory (ST), the protection theory (PT) (Abdul-Rahim et al., 2022), the autoregressive distributed lag (ARDL) model (Sethi et al., 2020; Ullah et al., 2023), the unified theory of acceptance and use of technology (UTAUT) (Oseni et al., 2018), and so on have been used as theoretical foundations to explore the field of FinTech and sustainable banking research.

5.2. Context (RO 4)

5.2.1. Most contributing countries

Table 4 presents the top ten countries contributing to FinTech and sustainability research. The table also shows that China, the United Kingdom, and Australia recorded the highest number of publications with the most citations, whereas Australia headed the top position with 553 citations and 9 publications. Regarding the number of articles, China stands at the top position, with 15 publications cited 249 times. In contrast, the United Kingdom is in second place with 11 publications and a total citation of 288. Nearly 28.57% of all articles and 33.05% of all citations originate from the United Kingdom and China combined. This concentration of study suggests that a small number of European and Asian countries have produced the majority of the work in this field.

In addition, this review mapped out country groupings (see Figure 5) for FinTech and sustainability research. The analysis concentrated on co-authorship nations with a minimum of two publications. Out of the 44 countries, China leads in terms of papers, citations, and link strength, especially among the three major groups of nations. With a key focus on sustainable performance, China also participates in substantial international collaboration with other Asian nations, such as South Korea, Singapore, Taiwan, and the Philippines. Australia, Hong Kong, and Germany are the leading cooperating nations with the United Kingdom. The scientific partnerships between Malaysia and Middle Eastern nations, including Jordan, Saudi Arabia, and the United Arab Emirates, are highlighted in that cluster.

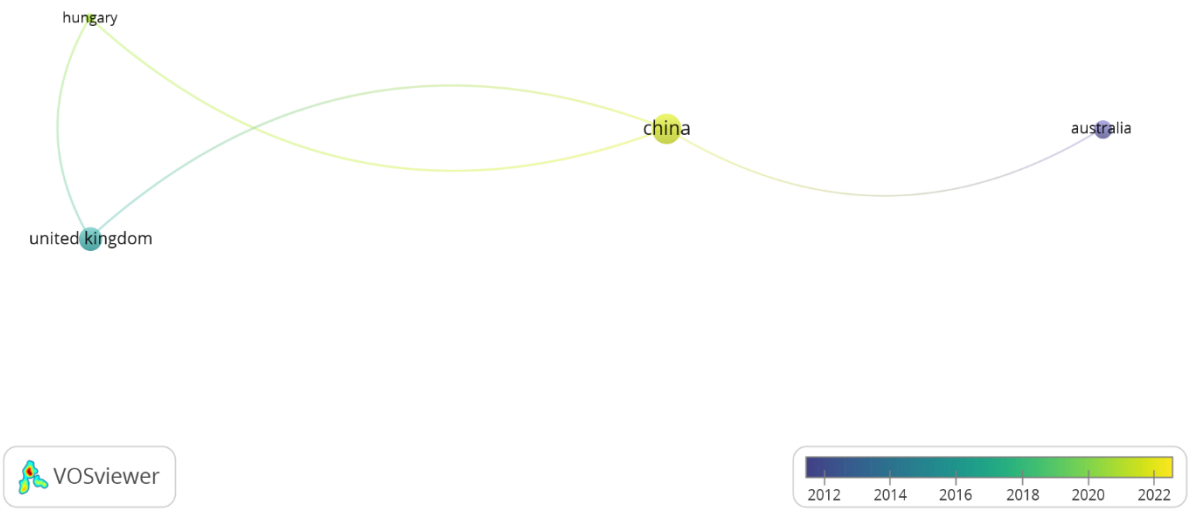


Figure 5. Co-authorship country networks.

Table 4. Most cited countries.

No	Country	Document	Citations
01	China	15	249
02	United Kingdom	11	288
03	Australia	9	553
04	Malaysia	7	86
05	United States	6	129
06	Hungary	4	102
07	India	4	114
08	Vietnam	4	36
09	Germany	3	60
10	Netherlands	3	43

5.2.2. Organization analysis

The review includes examining organizational citations, specifically the frequency of published publications, as shown in Table 5. The review identifies the top 10 organizations that made the most significant contributions. We found that the most cited organization is the Centre for Health Policy, University of Melbourne, with 280 citations, and the College of Science and Technology, Ningbo University has the lowest number of citations (68). According to the Table, European institutions are at the forefront of research in this sector, with five out of the top ten organizations being situated in Europe, namely in France, Australia, and the United Kingdom. The five institutions mentioned above together accounted for 48.33% of the total citations, while Asian organizations in Qatar, South Korea, and Dublin accounted for 31% of the total citations.

Table 5. Most cited organizations with no. of documents.

No	Name of the organization	No of document	Citation
01	Centre for Health Policy, University of Melbourne	1	280
02	Faculty of Applied Economics, University of Antwerp	1	280
03	Institute of Development Policy, University of Antwerp	1	280
04	School of Natural Science, Trinity College Dublin	1	85
05	School of Built Environment, Queensland University	1	85
06	Business School, York St John University	2	77
07	College of Business Administration, University of Bahrain	1	68
08	Department of Economics and Finance, University of New Orleans	1	68
09	Department of Finance and Accounting, Kingdom University	1	68
10	College of Science and Technology, Ningbo University	1	67

5.3. Characteristics (RO 5)

In this review section, we illustrate the key significant variables that predict FinTech adoption and sustainable banking operation. Table 6 represents the different variables in FinTech and sustainable banking.

5.3.1. Factors affecting FinTech adoption for sustainable banking

The factors affecting FinTech adoption for sustainable banking were extracted from 17 articles, and the rest were found to have unspecified variables (see Table 6). Based on the context of the study,

many authors used divergent variables. For example, Zuo et al. (2021) use financial technology and sustainability as major variables to measure the digital transformation of Chinese commercial banks and identify their effects on efficiency gains. In doing so, the authors used the DEAMalmquist index approach, which was complemented with a distance function and time to compare the dynamic changes in productivity. On the other hand, Diep and Canh (2022) explored interest rates, accessibility, and loan and approval process speeds that influence consumer happiness and loyalty while utilizing peer-to-peer services. They intended to determine if the peer-to-peer services, FinTech, and conventional banks should interact with sustainable development. It is expected that sustainable development will be based on green and digital finance (Zuo et al., 2021). To examine the relationship between green finance and FinTech, Zhang (2023) concluded a strong tie based on the data from three South Asian nations between 2000 and 2018.

In a similar vein, Chang et al. (2021) conducted a study to find the influence of environment, social, and governance on the cost efficiency of developed and emerging Asian banks. They claimed that the findings of their study might help investors and bank executives, the whole banking sector, and the global economy. Similarly, Aduba (2021) considered digital security infrastructure and users' socioeconomic status and found their strong effects on FinTech adoption for sustainable banking in the socio-environmental context. Similarly, globalization, economic growth, and increased energy consumption significantly influenced the adoption of FinTech for sustainable banking (Sethi et al., 2020).

Many scholars have identified multiple influential variables in the context of the psychological, functional, and emotional aspects of FinTech and sustainable banking. For instance, Çera et al. (2020) proposed a paradigm for assessing and managing customers' financial capabilities. Drawing on psychological aspects, the authors argued that customer engagement is increased and cognitive dissonance is lessened due to previous knowledge, attitude, and experience with digital banking. From a functional aspect, Gbongli et al. (2020) predicted customers' acceptance of mobile-based money and sustainability to show how perceived ease of use and attitudes are twisted. Moreover, Gbongli et al. (2020) investigated the tie between general trust and perceived risk affecting FinTech adoption for sustainable banking. In a similar context, Oseni et al. (2018) found trust and effort expectancy as influencing factors. In a different aspect, Abdul-Rahim et al. (2022) examined the moderating effect of fear of COVID-19 on benefit-risk perceptions of FinTech adoption for sustainability from the standpoint of bank customers' behavior. Naruetharadhol et al. (2021) found an influential impact of perceived benefits and FinTech Adoption to influence sustainable mobile banking services.

Besides, most previous studies in this field have used sustainability, adoption intention and performance as dependent variables and digitization and environmental sustainability as independent variables. For instance, Zuo et al. (2021) and Abdul-Rahim et al. (2022) measured the associations of digitization, benefits and FinTech with sustainability. Evidence suggests that green finance, globalization, environmental issues and technology are also used as independent variables and sustainability and performance as dependent variables. Few scholars have used mediating and moderating variables along with the dependent and independent variables. For example, Zuo et al. (2021) tested the effect of production, transaction and management channels on the relationship between digital transformation and sustainability. Also, perceived trust and perceived usefulness have been frequently applied as mediating variables. We found that four recent studies have used moderating variables. For example, Lekakos et al. (2014) and Ryu and Ko (2020) considered perceived benefits and perceived ease of use as moderating variables. Additionally, prior experience

and FinTech were also utilized as moderating variables by Çera et al. (2020) and Taneja et al. (2023) respectively.

Table 6. Recent studies with different variables.

No	Authors	Independent Variables	Dependent Variables	Mediating Variables	Moderating Variables	Significant Variables
01	Zuo et al. (2021)	Fintech and Digitalization Investment	Sustainable Productivity	Production Channel, Transaction Channel and Management Channel	Not specified	Digitalization Investment
02	Diep and Canh (2022)	Interest Rate, Accessibility, Convenience, Ease of Obtaining Loan, Safety and Approval Process Speed	Satisfaction	Not specified	Not specified	Interest Rate, Accessibility, Loan and Approval Process Speed
03	Zhang (2023)	Green Finance and Fintech	High-Quality Economic Development	Not specified	Not specified	Fintech and Green Finance
04	Chang et al. (2021)	Environmental Practices, Socially Responsible Practices, and Improved Governance	Cost Efficiency	Not specified	Not specified	Socially Responsible Activities and Improved Governance
05	Aduba (2021)	Digital Security Infrastructure and Users' Socioeconomic Status	Electronic Payment Adoption	Not specified	Not specified	Digital Security Infrastructure and Users' Socioeconomic Status
06	Nosratabadi et al. (2020)	Value Proposition, Core Competencies, Financial Aspects, Business Processes, Target Customers, Resources, Technology, Customer Interface, and Partner Network	Sustainability	Not specified	Not specified	Value Proposition, Core Competencies, Financial Aspects, Business Processes, Target Customers, Resources, Technology, and Customer Interface
07	Sethi et al. (2020)	Globalization, Financial Development, Urbanization, Economic Growth, and Increased Energy Consumption	Environmental Sustainability	Not specified	Not specified	Globalization, Economic Growth, and Increased Energy Consumption
08	Çera et al. (2020)	Financial Capability, Technology Usage, Prior Experience and Demography	Online Shopping	Not specified	Not specified	Financial Capability and Technology Usage And Prior Experience
09	Lekakos et al. (2014)	CSR Performance and Self-Efficacy	Attitudes and Behavioural Intention	Not specified	Perceived Ease of Use and Perceived Usefulness	Subjective Norms, Perceived Ease of Use, and Attitudes

Continued on next page

No	Authors	Independent Variables	Dependent Variables	Mediating Variables	Moderating Variables	Significant Variables
10	Jibril et al. (2020)	Perceived Online Identity Theft	Intention to Engage in E-Banking, Security and Privacy Concern	Fear Of Financial Loss and Fear of Reputational Damage	Not specified	Perceived Online Identity Theft, Fear of Financial Loss and Fear of Reputational Damage
11	Oseni et al. (2018)	Performance Expectancy, Effort Expectancy, Social Influence and Trust	Adaption Intention	Not specified	Not specified	Trust and Effort Expectancy
12	Abdul-Rahim et al. (2022)	Perceived Benefits and Perceived Risk	FinTech Adoption Intention and Sustainability	Not specified	Not specified	Perceived Benefits
13	Naruethar adhol et al. (2021)	Perception and Service Quality	Sustainable Intention	Perceive Usefulness and Perceive Ease of Use	Not specified	Service Quality and Perception
14	Ryu and Ko (2020)	System Quality, Information Quality and Service Quality	Fintech Continuance Intention	Trust and Perceived Risk	Perceived Benefit	System Quality, Information Quality, Service Quality Trust and Perceived Risk
15	Taneja et al. (2023)	Sustainable Technology Orientation, Efficiency, and Environmental Performance	Organizational Value Creation	Not specified	Not specified	Sustainable Technology Orientation, Efficiency, and Environmental Performance
16	Gbongli et al. (2020)	Multidimensional Trust and Multi-Facet Perceived Risk	Adoption Of Mobile Financial Services	General Trust and Aggregate Perceived Risk	Not specified	General Trust, Multidimensional Trust and Multi-Facet Perceived Risk
17	Yan et al. (2022)	FinTech Adaption	Sustainability Performance	Green Finance and Green Innovation	Not specified	Green Finance, Innovation, and Fintech Adoption

5.4. Methods (RO 6)

Table 7 and Figure 6 present that the most popular research method used to explore the association of FinTech and sustainability is the quantitative approach, accounting for 25%. Then, qualitative and survey approaches have been used in 14% and 11% of the reviewed studies. As per the chart, it is evident that the research methods, the mixed methods approach and the in-depth interview approach, have been less frequently used, accounting for only 4%.

However, we found that a substantial number of studies have not employed specific research tools because most of these studies were qualitative in nature. As shown in Table 7, 17 documents were accomplished on average without using any specific analyzing tools. With the threshold of one document with a minimum of one tool, we found 17 analyzing tools used in FinTech and sustainability research. More specifically, structural equation modeling is the second most used analyzing tool (found in 9 documents). Delphi-Analytic Hierarchy Process, artificial neural network and T-statistic have also been frequently used in FinTech and sustainability research.

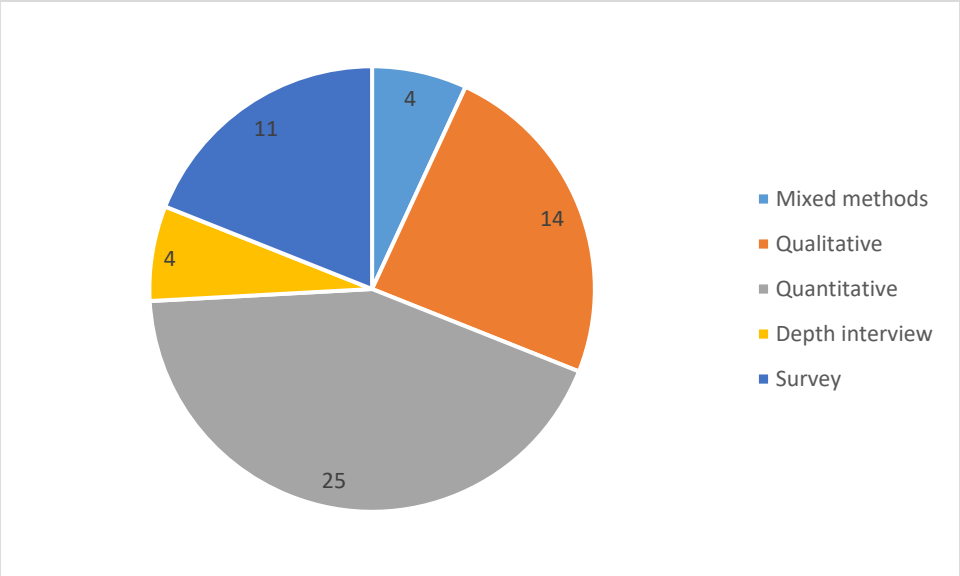


Figure 6. Popular research methods.

Table 7. Popular analyzing tools.

No	Name of the tools	Documents
01	Not specified	17
02	Structural equation modeling	9
03	Delphi-Analytic Hierarchy Process method	2
04	Structural Equation Modeling and Artificial Neural Network Approach	2
05	T-statistic	2
06	Cross-sectional dependence tests, panel unit root test, panel co-integration test	1
07	DEA Malmquist index method	1
08	Hybrid MCDM Model	1
09	Panel Regression model	1
10	Panel-Corrected Standard Errors, Two-Stage Panel Least Squares-Instrumental Variables, and Two-step System Generalized Method of Moments	1
11	Principal components analysis and logistic regression	1
12	Quasi-experimental	1
13	Semantic Feature Analysis	1
14	Statistical Package for the Social Science	1
15	Structural Equation Modeling and TOPSIS	1
16	The generalized structural equation modeling	1
17	Two-stepdynamic GMM	1

6. Future Research Directions (RO 7)

Following the TCCM framework proposed by Paul et al. (2021), we suggest future research directions regarding theory development, context, characteristics, and methodology. The following sections summarize the future research agenda in the context of FinTech and sustainable banking.

6.1. Theory

While conducting this rigorous review of 44 articles, we found that FinTech and sustainable banking research lack the employment of conceptual frameworks. Only 22.06% of the reviewed

articles have employed a conceptual framework. Past research suggests that a paucity of deploying conceptual frameworks in a given research field weakens the theoretical foundations (Yadav, 2010). We believe that theoretical frameworks act as the basements for guiding research. Thus, FinTech and sustainable banking scholars are suggested to use conceptual frameworks, especially for empirical research, to enrich the theoretical diversity of the given discipline. For example, Tripathi (2023), in his TCCM-based review framework, emphasized future researchers to use conceptual frameworks to explore and listen to the real-life experiences of stakeholders (e.g., customers, banks, investors, and so on) in sustainable finance settings. We also identified that most of the theories used by earlier researchers have been illustrated from banks' customer perspectives. Therefore, future scholars should also focus on the theoretical aspects from the organizations' point of view. In addition, the existing theories are also recommended for further examination to find what factors shape banking service providers' sustainable behavior.

However, we identified that most of the theories used in the reviewed articles are related to the information system and the socio-psychological fields, such as needs theory, society theory, SIT, TAM, UTAUT, and TTAT. Still, there is a scope for developing more sustainable finance-related theories like the resource theory of sustainable finance, the peer emulation theory of sustainable finance, the life span theory of sustainable finance, etc. We believe these theories might be more relevant and significant in addressing FinTech in sustainable banking. Therefore, we recommend future studies to illustrate the context more comprehensively.

6.2. Contexts

The findings of our review indicate that most of the reviewed papers were conducted in the banking and financial industries, specifically from business-to-consumer aspects. This indicates a research gap, suggesting further research opportunities from business-to-business perspectives. It is seen that the interactions between businesses and consumers vary when the interactions occur between businesses and other businesses (He & Zhang, 2022). In such a context, Puschmann et al. (2020) found that green FinTech has a prominent impact on the overall value chain of financial services covering business-to-business, business-to-consumer, and consumer-to-consumer.

In this review, out of 44 countries, most of the contributing countries in FinTech and sustainable banking were from high-income countries (e.g., China, Australia, and the UK) with industrial advancement. While conducting this review, we found a steadily growing contribution from the Asian countries, such as Bangladesh, Pakistan, Myanmar, Japan, and Thailand. This calls for more research from low-income or developing countries from the Middle East and Latin America. We contend that FinTech and sustainable banking can be new avenues of research in these countries. Because it is imperative to understand the behavioral diversity of individuals toward FinTech and sustainable banking, such evidence proves that cross-cultural studies address the nuances of culture, ethnicity, and nationality of a subject context (Muniz Jr & Schau, 2005).

6.3. Characteristics

Our findings show that the previous studies on FinTech and sustainable banking have highlighted the factors related to consumers' technology adoption or usage behavior. This indicates a notable research gap that could be filled by integrating or extending variables to address the behavior of bank

employees or even bank owners, going beyond solely exploring consumer behavior. Ultimately, bank employees (e.g., managers) and owners are the key stakeholders responsible for initiating and implementing strategic decisions (e.g., implementation of green banking policy).

The review's findings also discovered that various influential variables (e.g., perceived ease of use and perceived usefulness) affect the adoption of FinTech in sustainable banking. More specifically, functional value aspects have been widely studied in this discipline, such as perceived usefulness (Lekakos et al., 2014; Naruetharadhol et al., 2021), perceived ease of use (Lekakos et al., 2014), perceived benefits (Abdul-Rahim et al., 2022; Chang et al., 2021), accessibility, approval process speed (Diep & Canh, 2022), effort expectancy (Oseni et al., 2018), and environmental performance (Taneja et al., 2023). This presents a research gap predicting the adoption of FinTech in sustainable banking by integrating other contemporary variables (e.g., information accuracy, perceived informativeness, perceived innovativeness, etc.). In the context of emotional value perspectives, we found that several conceptual papers have integrated perceived trust (Gbongli et al., 2020; Ryu & Ko, 2020), although there is a research paucity to examine other emotional values, including perceived enjoyment, fun, entertainment, liking, etc. There is also a need to use monetary value of FinTech and sustainable banking, such as cost saving. Therefore, we suggest future studies to integrate and extend existing models/theories with these less explored variables to depict comprehensive insights into FinTech and sustainable banking.

6.4. Methods

Our findings offer a collective overview that shows an immense opportunity for future research to convert stakeholders' (e.g., bankers and customers) traditional understanding and outlooks toward sustainable banking through the transition of FinTech adoption. With the help of emerging and sophisticated research methods and tools, such as experimental research, researchers might be able to capture customers' real-time eye-tracking and behavior to gain deeper insights regarding their behavioral dynamics in the context of FinTech and sustainable banking. Based on the consumers' consumption patterns, Zhang (2023) affirmed that consumers' behaviors become dynamic while making product or service choices. Thus, analytical models (e.g., Pareto/ binomial models) can be employed to measure customer's lifetime value and purchasing behavior. Similarly, other new and technology-based methods like videography can also be used in the subject context. Furthermore, a mixed method approach (i.e., qualitative and quantitative) can be applied to the context where a sole method is challenging to predict a specific behavior.

7. Implications of the study

We aimed to investigate the published FinTech and sustainable banking articles using the TCCM framework. The findings of this review have laid a foundation for exploring the nexus between FinTech and sustainable banking as a research domain. While conducting this review, it is found that a substantial number of studies have the role of FinTech in sustainable banking in isolation. More specifically, scant studies have illustrated the advent of FinTech in sustainable development in banking or financial services (Gangi et al., 2021; Guang-Wen & Siddik, 2023; Lekakos et al., 2014), even though FinTech has opened a new research domain in sustainable development due to its emergence and importance in modern business arenas (Gbongli et al., 2020). In banking, this review is the first to

our knowledge to collectively and comprehensively explore the context of sustainable FinTech usage. Therefore, this review contributes to the existing literature on FinTech and sustainable banking from multiple dimensions. First, we identify a strong impact of FinTech on sustainable banking. Despite some existing reviews in green FinTech that have attempted to explore the context (Hyun, 2022), we present a holistic view drawing from past studies. Second, this study provides new and comprehensive insights into the existing literature on sustainable FinTech adoption in terms of current research trends, popular keywords, and most contributing publishers and authors. These findings will help to deepen the understanding of bibliographic information in the subject context (Ellili, 2022). Third, using the TCCM review framework, this review synthesizes the theory, context, characteristics, and methods available in the studied papers. Thus, this review provides a comprehensive understanding and underscores future research agenda, for instance, urging integrations of social and IS theories [e.g., TAM and PDT by Lekakos et al. (2014)].

From the practical implications, the findings of this research provide some valuable insights for the practitioners of banking sectors and developing countries (e.g., Vietnam, Pakistan, India, and Bangladesh) where the population (prospective customers, in other words) is increasing remarkably and operates many private and public banks. Policymakers and banking service providers may utilize the findings to comprehensively understand the importance of FinTech in sustainable banking and form and implement sustainable policies accordingly. Besides, the diagnosed influential factors that predict users' FinTech-based sustainable banking adoption can be employed by future researchers in rigorous conceptual studies across cultures and countries.

Overall, this review uncovers a holistic and comprehensive view of FinTech in sustainable banking from both theoretical and practical aspects, revealing the pathways for future researchers to investigate the context more sophisticatedly with emerging research methods and tools. We conclude that the findings of this review may help to enrich existing FinTech and sustainable banking literature, conglomerating the diversified aspects and attaining SDGs.

8. Conclusions and limitations

Our SLR examines previous articles on sustainable banking and FinTech to forecast the development of this field. In doing so, we attempt to recognize essential ideas and concepts about this specific area of inquiry and offers recommendations for the subsequent research based on the TCCM review framework. We identify the most contributing authors, companies, and nations by utilizing trends, bibliometrics, evolution, and content assessments. Mainly, we synthesize the emerging theories, contexts, characteristics, and methods in the context of FinTech and sustainable banking. We expect that the review's findings will help researchers and practitioners collectively understand the contexts. More specifically, scholars in this field may benefit from mapping out the most popular theories, contexts, variables, methods, and documents and determining potential future areas of study that they should concentrate on. Moreover, this will help deepen their understanding of the role of FinTech in developing sustainable banking.

Apart from the notable theoretical and managerial implications mentioned above, the review has several limitations. First, the titles, abstracts, and keywords in the search query included generic phrases related to FinTech and sustainable banking. Contemporary and relevant keywords, such as green investment, green bonds, green finance, sustainable behavior, etc., could be extended. Second, we consider only the articles published in the first and second quartiles. Hence, articles published in

the third and fourth quartile could be taken into account due to the topic's novelty. Third, we exclude publications published in databases like Web of Science, Google Scholar, and others and only selects papers from the Scopus database. Future research should consider other databases (e.g., Web of Science) to assess developments of FinTech in sustainable banking to draw a more comprehensive view.

Use of AI tools declaration

The authors declare that they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare no conflicts of interest.

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