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Digital Technology in SMEs Sustainability Practies: A Systematic Literature Review

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ABSTRACT

The popularity of sustainability topics has increased, not only ini large companies, but also in small medium enterprises (SMEs). This study aims to analyze trends in publications related to digital technology implementation on SMEs sustainability practice. This research employs bibliometric analysis with a quantitative approach to identify the most used theory, variables, most influential journals and articles in this domain. The articles was extracted from the Scopus database. After applying a set of criteria, 62 articles were selected for this analysis. This systematic review demonstrates that research on digital technology in sustainable practices of SMEs is continuously evolving. This study reveals that the European continent leads in prominent publications on this subject. The Resource-Based View Theory is frequently employed to develop conceptual frameworks within this research area. Potential avenues for future research have been identified to provide recommendations for further studies. It highlights the need for adopting new theories, embracing qualitative methods and conducting cross-generational studies. This study enhances the utilization of technology in sustainable practices of SMEs, this paper highlights the need to adopt novel theories and recommends embracing experimental and longitudinal research methodologies, to uncover deeper insights into the implementation of digital technology in SMEs sustainable practices.

ABSTRAK

Popularitas topik keberlanjutan telah meningkat, tidak hanya di perusahaan besar, tetapi juga di usaha kecil dan menengah (UKM). Studi ini bertujuan untuk menganalisis tren dalam publikasi yang terkait dengan implementasi teknologi digital pada praktik keberlanjutan UKM. Penelitian ini menggunakan analisis bibliometrik dengan pendekatan kuantitatif untuk mengidentifikasi teori yang paling banyak digunakan, variabel, jurnal dan artikel yang paling berpengaruh dalam domain ini. Artikel-artikel tersebut diekstraksi dari basis data Scopus. Setelah menerapkan serangkaian kriteria, 62 artikel dipilih untuk analisis ini. Tinjauan sistematis ini menunjukkan bahwa penelitian tentang teknologi digital dalam praktik berkelanjutan UKM terus berkembang. Studi ini mengungkapkan bahwa benua Eropa memimpin dalam publikasi terkemuka tentang subjek ini. The Resource-Based View Theory sering digunakan untuk mengembangkan kerangka kerja konseptual dalam area penelitian ini. Potensi penelitian masa depan telah diidentifikasi untuk memberikan rekomendasi untuk studi lebih lanjut. Ini menyoroti perlunya mengadopsi teori-teori baru, merangkul metode kualitatif dan melakukan studi lintas generasi. Penelitian ini meningkatkan pemanfaatan teknologi dalam praktik berkelanjutan UKM, makalah ini menyoroti perlunya mengadopsi teori-teori baru dan merekomendasikan untuk merangkul metodologi penelitian eksperimental dan longitudinal, untuk mengungkap wawasan yang lebih dalam tentang penerapan teknologi digital dalam praktik berkelanjutan UKM.

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1. INTRODUCTION

Small and Medium Enterprises (SMEs) play a pivotal role in the economic growth and resilience of a nation. SMEs significantly contribute to job creation, increased public income, and the reduction of economic disparities (Indrawati et al., 2023). SMEs often serve as the backbone of economies, especially in developing countries, by absorbing a substantial workforce, including those from the informal sector. Furthermore, SMEs support local economies (Forcadell et al., 2021) and strengthen domestic supply chains (Wang & Esperança, 2023). In times of crisis, such as pandemics or recessions, SMEs tend to be more adaptive and contribute to maintaining grassroots economic stability, making them a crucial element for national economic sustainability. Therefore, SME development is a necessary condition for driving higher economic growth in Indonesia.

SMEs play a vital role in the economies of many countries. With the increasing accessibility of global markets, SMEs now have significant opportunities to penetrate international markets. The "SMEs Go Global" concept aims to assist small business actors in expanding their reach, enhancing competitiveness, and adopting global standards. This includes measures such as improving product quality, utilizing digital technology for marketing and sales (Quaye & Mensah, 2019), and leveraging e-commerce and global platforms as distribution channels.

Sustainability practices are becoming an important factor for SMEs seeking to penetrate foreign markets, as international consumers and business partners increasingly prioritize sustainability aspects when selecting products or services. By implementing sustainability, such as using environmentally friendly raw materials, energy efficiency, and responsible waste management, SMEs can meet global standards while enhancing their product appeal. Additionally, these practices help SMEs build a positive reputation in the global market, create added value, and open opportunities for collaboration with strategic partners who are also committed to sustainability. This approach not only expands market reach but also ensures long-term business continuity amidst growing environmental awareness.

The popularity of sustainability topics has increased in the last decade (Jain & Tripathi, 2023) and several literature reviews have been conducted, such as AlQudah et al. (2024); Aroul et al. (2022); Jain & Tripathi (2023); Mukhtar et al. (2024); Singhania & Chadha (2023). Indeed, some existing literature examines sustainability practices not only in large corporations but also in SMEs. However, previous studies have not examined these two prominent factors—digital technology and sustainability in MSMEs—within a single body of literature. With technological advancements, many companies, both large and small, are leveraging technology to enhance energy and resource efficiency, reduce environmental impact, and promote sustainable development (De Silva et al., 2024). Business owners can control supply chain management, reduce waste and energy consumption, thereby building a sustainable ecosystem in business operations. Furthermore, through technology implementation, companies can enhance employee productivity and well-being, meeting employee needs and performance more efficiently (Khasanah et al., 2023; Xi et al., 2024).

This study employs a bibliometric approach to systematically map existing sustainability research and integrates it with a literature review of articles featured in reputable academic journals. To the best of the authors' understanding, prior reviews have not specifically focused on sustainability within SMEs, particularly those sourced exclusively from high-impact or well-indexed journals. Emphasizing the criterion of "high-quality" is essential, given the growing recognition of rigorous academic standards and the concurrent proliferation of predatory publishing outlets (Jain & Tripathi, 2023). In bridging this gap, the present research undertakes a systematic review of credible and peer-reviewed studies on SME sustainability and visualizes their patterns through bibliometric mapping. Bibliometric techniques provide an extensive means of examining and evaluating large bodies of literature (Donthu et al., 2021), allowing researchers to detect thematic connections and structural relationships across numerous datasets with the aid of analytical software tools.

Data for this research were retrieved from the Scopus database to perform the bibliometric analysis. Following a systematic screening process, 62 relevant publications were identified and selected from Scopus. Thereafter, a comprehensive systematic literature review was undertaken, focusing exclusively on articles published in reputable and high-impact journals to ensure analytical depth and reliability. The present study was guided by the following research questions:

RQ1: In what ways has the body of literature on digital technology and sustainability practices in SMEs evolved within theoretical frameworks?

RQ2: What are the contextual dimensions of existing research, including the geographical and journal-wise distribution of the studies?

RQ3: Which characteristics—comprising independent, dependent, moderating, and mediating variables—have been explored over the last decade in the intersection of digital technology and SME sustainability practices?

RQ4: What research methodologies have been predominantly adopted in this field?

RQ5: What critical gaps remain, and what directions should future studies pursue to advance research on sustainability in SMEs?

This study contributes to theory by mapping an emerging interdisciplinary research area—digital technology and sustainability in SMEs—which has not been widely integrated before. By doing so, it offers a theoretical consolidation of two rapidly evolving fields and sets the groundwork for a more coherent body of knowledge. Moreover, by showing which digital technologies are most discussed in sustainable SME practices, the study helps SME practitioners and policymakers prioritize technologies that are empirically supported in the literature (e.g., IoT, digital platforms, cloud computing). It provides an evidence-based direction for investment and policy support.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Digital Technology

Digitalization is currently being widely adopted across various sectors, including the business domain. The digital transformation in business is driven by fundamental changes in how companies approach, collect, store, evaluate, and utilize increasingly complex sets of corporate information. A culture that encourages digital innovation cultivates an atmosphere open to adopting emerging technologies and novel ideas, with the objective of driving business expansion and ensuring long-term sustainability (Valero-Gil et al., 2024). Within the realms of business and management, digital tools—such as artificial intelligence, big data analytics, blockchain systems, and virtual reality applications—are increasingly utilized to strengthen organizational performance, streamline productivity, and improve the quality of strategic decision-making (Isensee et al., 2024; Denicolai et al., 2021). The integration of these technologies demands their alignment across diverse business functions, encompassing areas such as data-driven analysis, process automation, and organizational communication.

Digital technologies empower organizations to gather and interpret extensive datasets in real time, thereby supporting more precise decision-making and enhancing the efficiency of operational workflows. Moreover, the integration of digital tools within business and management practices enables firms to obtain critical insights and a more profound comprehension of customer behavior patterns and evolving market dynamics (Khasanah et al., 2023; Xi et al., 2024). Such insights underpin data-driven managerial decisions, facilitate the formulation of targeted marketing initiatives, and promote the customization of products and services to align more effectively with consumer preferences.

Therefore, digitalization should not only be viewed as a new opportunity but also as a transformative mechanism for reshaping business processes, including the implementation of sustainable practices

Sustainability Practice in SMEs

The concept of sustainability encompasses practices that ensure the long-term health and viability of both natural and social environments while simultaneously pursuing economic growth. This concept is an extension of the Triple Bottom Line (TBL) framework introduced by Elkington J (1997). According to Elkington J (1997), sustainable business practices must address and integrate environmental, social, and financial demands. These three dimensions are interdependent and must be implemented concurrently. As such, corporate sustainability requires firms to manage the TBL—a process through which companies navigate financial, social, and environmental risks, responsibilities, and opportunities (Rajan et al., 2024).

The three pillars of sustainability constitute the fundamental framework guiding Micro, Small, and Medium Enterprises (MSMEs) in the implementation of sustainable practices. The economic aspect highlights an organization's capacity to sustain its financial viability over the long term. Achieving economic sustainability entails adopting strategic initiatives aimed at improving operational efficiency, optimizing profitability, and preserving market stability (Rajan et al., 2024). This component plays a vital role in securing a firm's competitive edge and in strengthening overall shareholder value (Reyes-Rodríguez et al., 2023).

Complementing the economic perspective, the social dimension of sustainability focuses on the business's impact on human capital, including employees, customers, and the broader community. It involves fostering corporate social responsibility, ensuring ethical labor practices, and contributing positively to community well-being. This dimension aims to create sustainable and mutually beneficial relationships between businesses and their social stakeholders, cultivating a symbiotic interaction where enterprises contribute to societal progress while benefiting from a stable, healthy, and supportive social environment (Rodríguez- Espíndola et al., 2022a).

Meanwhile, the environmental dimension is one of the most critical aspects of sustainability. It

encompasses practices such as waste management, the use of environmentally friendly materials and energy sources, and the contribution of enterprises to envirsonmental improvement. This dimension is essential to ensure that business operations do not harm the environment and that ecological integrity is preserved (Newman et al., 2020; Rajan et al., 2024).

3. RESEARCH METHOD

Although the concept of digital technology emerged earlier, the integration of digital technology in ESG sustainable practices gained significant attention in both academic and industry research in the early 2000s. Exclusion criteria were also developed to eliminate research that was not directly relevant to the research problem or that did not meet certain quality standards. Table 1 presents a detailed description of the article selection criteria, and Appendix 1 shows the list of analyzed articles.

Table 1 Inclusion Criteria for Article Selection

Criteria	Description
Keyword	"ESG" OR "SUSTAINABILITY" OR "CSR" AND "SMES" AND "TECHNOLOGY" OR "DIGITAL"
Journal Category	Akuntansi, Manajemen, Dan Bisnis
Document Type	Artikel
Language	Inggris
Accessibility	All Access

This research explores the progressive landscape of sustainability studies through a bibliometric lens. Bibliometric analysis represents a structured and comprehensive approach designed to investigate and interpret extensive datasets (Donthu et al., 2021). The technique is widely applied to generate a quantitative overview of a specific academic field (Losse & Geissdoerfer, 2021). In addition, a content analysis of peer-reviewed and high-quality journal publications was performed to achieve a deeper conceptual understanding of the topic. Accordingly, the Scopus database was exclusively utilized as the primary source for data collection. Figure 1 illustrates the methodological framework adopted in this study. The initial stage of the process involved defining the boundaries of the review. To this end, the researchers established a series of inclusion criteria to systematically identify and select the most relevant studies.

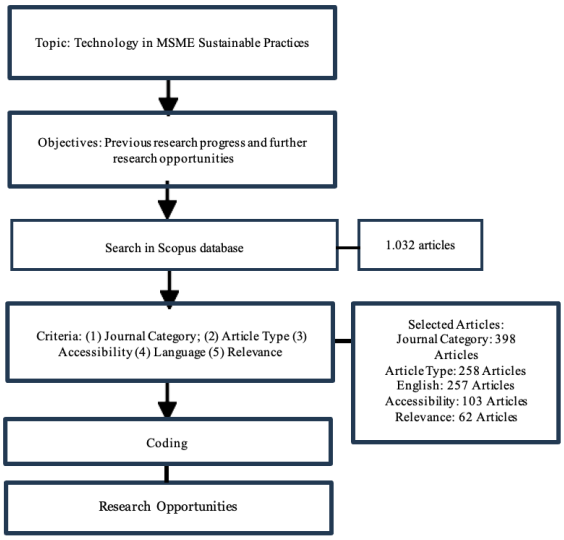

Figure 1 PRISMA Flow Diagram

First, this study used search terms reflecting the topic under investigation, namely "esg" OR "sustainability" OR "csr" AND "smes" AND "technology" OR "digital" in Scopus Database to provide comprehensive results related to the topic of digital technology in improving SMEs sustainability with high quality journal. Scopus only indexes journals that have gone through a rigorous evaluation process based on international quality standards. The publication period criterion was not applied due to the limited number of relevant studies, as digital technology only began developing in the early 2000s and sustainability has only recently become a prominent research focus. Second, articles were selected based on journals in the accounting, management, and business categories. This approach facilitates the identification of studies that are more directly aligned with accounting-related research. Third, only empirical articles were selected, in accordance with the research questions. Non-empirical articles typically do not present empirical data and therefore do not meet the criteria required for a systematic review. Fourth, publications had to be in English. Lastly, an accessibility criterion was applied, meaning that articles in this study were available for download.

Articles that have passed the inclusion and exclusion screening criteria were subsequently subjected to the coding process and data analysis. To ensure the reliability of the coding process and data analysis, a structured and transparent procedure was employed throughout the review. The initial coding framework was developed based on the research questions and refined iteratively during the screening and full-text review stages. Categories such as

theoretical frameworks, research methods, key variables, geographical focus, and sustainability dimensions were systematically coded. To minimize subjectivity and enhance consistency, the coding process was either cross- validated by multiple researchers or piloted on a subset of articles to ensure a shared understanding of coding criteria. ANALYSIS AND DISCUSSION

Bibliometric Profile of Research on SMEs' Sustainable Practices

As illustrated in Figure 3, the distribution of articles by publication year demonstrates a significant trend in research regarding the role of technology in SME sustainability practices. The inception of research on the role of technology in SME sustainability practices occurred in 2014. This aligns with the technological development trend that began to evolve in the 2000s. Since 2018, there has been a notable increase in the number of studies on this topic. The year 2024 marks the year with the highest number of articles, with 18 publications, representing 29% of the total selected articles. Years 2023 and 2022 follow with 17 and 8 articles, comprising 27% and 13% of the total articles, respectively. The significant upward trend in publications during this period reinforces our conviction regarding the importance of conducting a systematic literature review on the topic of digital technology and SME sustainability. The continuous development across time highlights the need to map existing research and identify gaps to provide deeper contributions to the field.

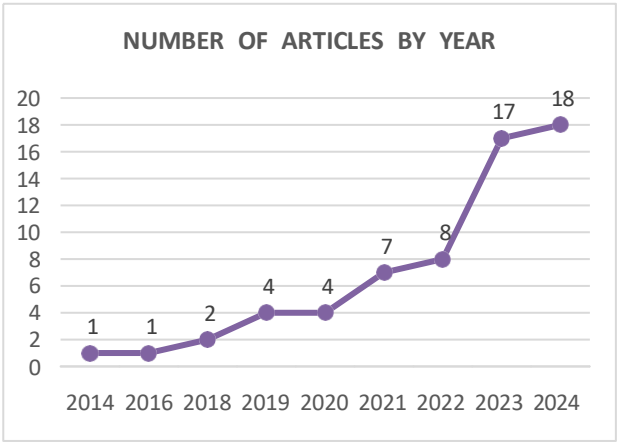

Figure 3 Distribution of Articles by Year. Author's own work

Figure 4 illustrates the journal-wise distribution of publications, highlighting the ten most active journals identified in this review. These top ten outlets were selected from a total of forty journals based on publication frequency, indicating that they host the largest concentration of studies addressing digital technology and sustainability within SMEs. All of the listed journals are indexed in Scopus under Q1, Q2, or Q3 categories. Among them, Cogent Business & Management accounts for the highest contribution, publishing seven of the sixty-two reviewed articles (approximately 11%). This predominance may be explained by the journal's emphasis on contemporary and emerging topics in business and management research, including those relevant to small and medium-sized enterprises.

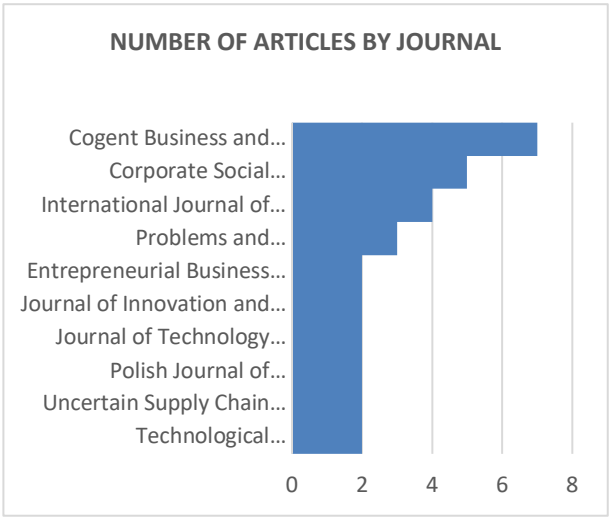

Figure 4 Top 10 Journal. Author's own work

The frequency distribution of articles by journal quality is shown in Figure 5. It is observed that 25 out of the 62 reviewed articles were published in Q1 indexed journals (40%), followed by 20 articles in Q2 indexed journals (32%). Q3 and Q4 indexed journals accounted for 15 (25%) and 2 (3%) articles, respectively. The distribution shows that the majority of articles were published in high-quality journals, with 72% appearing in Q1 and Q2 outlets. This indicates strong academic interest and credibility in the topic of digital technology and SME sustainability. The smaller proportion in Q3 and Q4 suggests emerging contributions and opportunities for further development in reputable journal.

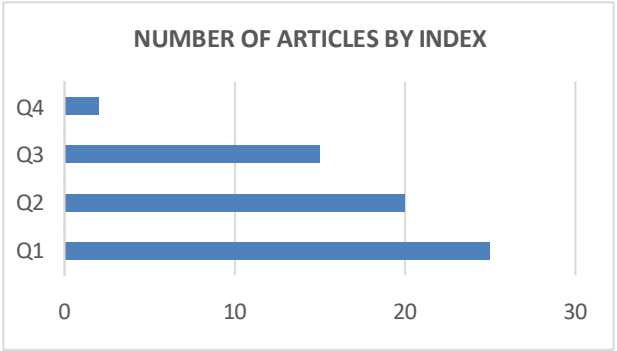

Figure 5 Most Publications Index Chart. Author's own work

Table 2 Most Cited Articles. Author's own work

No	Title	Total Citation
1	Sustainability strategy as a moderator in the relationship between digital business strategy and financial performance (Ukko et al., 2019)	734
2	The role of circular economy principles and sustainable-oriented innovation to enhance social, economic and environmental performance: Evidence from Mexican SMEs (Rodríguez-Espíndola et al., 2022)	691
3	Management accounting practices of SMEs: The impact of organizational DNA, business potential and operational technology (Azudin & Mansor, 2018)	414
4	The intervention of organizational sustainability in the effect of organizational culture on open innovation performance: A case of thai and chinese SMEs (Srisathan et al., 2020)	351
5	Smes must go online—e-commerce as an escape hatch for resilience and survivability (Costa & Castro, 2021)	348
6	Digital sustainability communication in tourism (Tiago et al., 2021)	344
7	The impact of social media marketing for Indonesian SMEs sustainability: Lesson from Covid-19 pandemic (Patma et al., 2021)	327
8	Disentangling the impact of ICT adoption on SMEs performance: the mediating roles of corporate social responsibility and innovation (León-Gómez et al., 2022)	123
9	Opportunities And Threats of Digital Transformation of Business Models in SMEs (Straková et al., 2022)	96
10	Social media and corporate communication antecedents of SME sustainability performance: A conceptual framework for SMEs of Arab world (Basri & Siam, 2019)	91

This study gathered citation data from three databases: Google Scholar, Scopus, and ResearchGate. Table 2 displays the Top 10 articles with the highest citation counts. Ukko et al. (2019) is the most cited article, with 734 citations. It is followed by Rodríguez-Espíndola et al. (2022) and Azudin & Mansor (2018) with 691 and 414 citations, respectively.

Country-Based Analysis of Published Articles

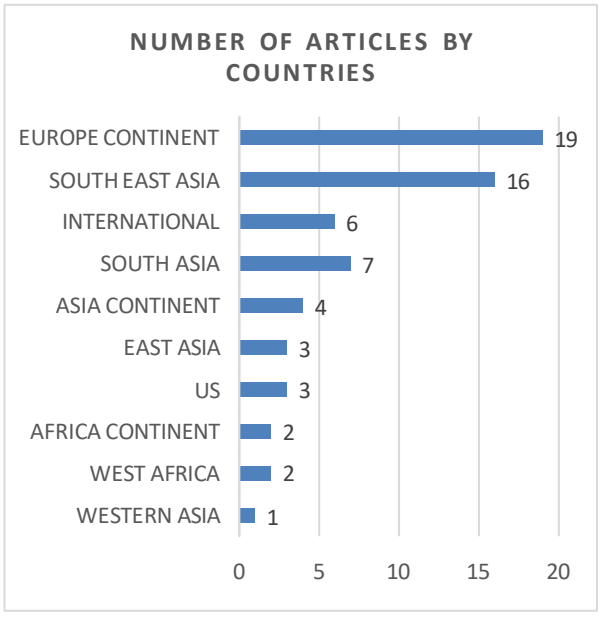

Figure 6 Distribution of Articles Based on Country Settings. Author's own work

This study categorizes the country settings of the reviewed articles into several categories, as depicted in Figure 6, in the following manner. First, articles using settings of one or more countries originating from the same region were classified and labeled using the region's name. Subsequently,

articles featuring samples from multiple countries across various regions and continents were labeled "International." European countries are the most frequently used settings for research on this topic, totaling 19 articles (31%). This indicates that SMEs in European countries have been leveraging digital technology to optimize sustainable practices. Following this, research in ASEAN countries amounted to 16 articles (26%). ASEAN (South East Asia), dominated by developing countries, heavily relies on the existence of SMEs to sustain its economy. It is high time for SMEs and governments to give significant attention to the implementation of sustainable practices by utilizing technological advancements.

Theories and Conceptual Models Used

Table 3 Theories Developed in Digital Technology and Sustainability Research in MSMEs. Author's own work

Theories	No. of Articles	%	References
Resourches Based View Theory	11	31%	(Adam et al., 2024; Alam et al., 2022; Asim, Li, & ur Rehman Makhdoom, 2019; Budiarto et al., 2022, 2023; Reyes-Rodríguez et al., 2023; Rodríguez-Espíndola et al., 2022; Sukri et al., 2023; Suriani et al., 2024; Trueba-Castañeda et al., 2024; Yang et al., 2022)
Stakeholder Theory	4	12%	(Corazza, 2018; M. I. Hossain et al., 2022; León-Gómez et al., 2022; Sundström et al., 2020)
Belief-Action-Outcome theory	2	6%	(Isensee et al., 2023a, 2024)
Natural-Resource-Based View of the firm (NRBV)	2	6%	(M. I. Hossain et al., 2022; Pichagonakesit et al., 2023)
Others	17	45%	(Azudin & Mansor, 2018; Bachtiar et al., 2023; Bruce et al., 2023; Cheffi et al., 2021; Endrődi-Kovács et al., 2024; M. I. Hossain et al., 2022; Laila et al., 2023; Le, 2022; Megawati et al., 2024; Patma et al., 2021; Rajan et al., 2024; Saci & Mansour, 2023; Sarkum & Syamsuri, 2021; Saura et al., 2023; Srisathan et al., 2020; Twum-Darko & Sibanyoni, 2014; Wibowo et al., 2024)

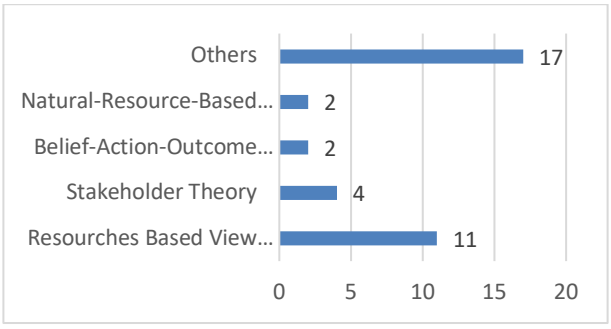

Figure 6 Theories Developed in Selected Articles. Author's own work

This study classifies the geographical contexts of the reviewed publications into several regional categories, as illustrated in Figure 6. Initially, articles that examined one or more countries within the same geographic region were grouped and labeled according to that region's designation. In contrast, studies incorporating samples from multiple regions or continents were categorized as "International." The findings reveal that European

nations represent the most frequently examined context in this research domain, accounting for 19 articles (31%). This suggests that SMEs in Europe have actively utilized digital technologies to enhance sustainable business practices. The ASEAN region follows with 16 publications (26%). Comprising primarily developing economies, ASEAN countries rely heavily on the contributions of SMEs to support their economic stability. Therefore, both SMEs and policymakers in these nations must prioritize the adoption of sustainable practices facilitated by technological innovation.

Determining Variables of SME Sustainability

Table 4 Most Used Dependent Variables. Author's own work

Variable Category	Variables	References
Sustainability Practice/ Performance	sustainable business development indicator, Business Sustainability;sustainability of tourism SMEs, sustainability practices, Business sustainability, Sustainability, Sustainability Focus, SMEs Sustainability, corporate, economic sustainability of halal SMEs social responsibility, environmental performace, Sustainable Business Performance, MAPs practiced, sustainable strategy, Sustainable Green Practice, Sustainable Manufacturing Practice, Intention to Participate in Waqf, agency usage	(Adam et al., 2024; Amoah et al., 2023; Antara et al., 2024; Asim, Li, & ur Rehman Makhdoom, 2019; Asim, Li, Makhdoom, et al., 2019; Azudin & Mansor, 2018; Bangun et al., 2024; Bruce et al., 2023; Budiarto et al., 2023; Endrődi-Kovács et al., 2024; Hoa & Tuyen, 2021; M. I. Hossain et al., 2022; Jagoda et al., 2016; Laila et al., 2023; Lima et al., 2024; Megawati et al., 2024; Msomi & Kandolo, 2023; Patma et al., 2021; Pichagonakesit et al., 2023; Rajan et al., 2024; Rodríguez-Espíndola et al., 2022; Straková et al., 2022; Trueba-Castañeda et al., 2024; Utaminingsih et al., 2020; Valero-Gil et al., 2024; Wibowo et al., 2024; Yang et al., 2022)
Innovation	Eco-innovation, Green Innovation, innovation, open innovation performance	(Alam et al., 2022; Le & Govindan, 2024; León-Gómez et al., 2022; Martínez-Martínez et al., 2023; Srisathan et al., 2020)
Financial performance	business performance, profitability, market performance, financial performance, market performance, firm resilence	(Asad et al., 2023; Awad & Martín-Rojas, 2024; Endrődi-Kovács et al., 2024; Kim, 2021; Spigarelli et al., 2024; Sukri et al., 2023; Türkeş, 2024; Ukko et al., 2019; Valdez-Juárez et al., 2024; Wijaya et al., 2023)
Technology Implemen	Actual System Use, Digitalization strategy, Digital	(Abdullah & Ampauleng, 2024; Patma

tation	Marketing, Integrative Logic in BS	et al., 2021; Tworek et al., 2019; Valero-Gil et al., 2024)

77% of the selected articles employed empirical testing by identifying dependent variables. Among these articles, 45% utilized dependent variables related to sustainability practices/sustainability performance. The remaining articles employed dependent variables related to innovation, financial performance, and technology. Innovation variables developed in previous studies are associated with environmentally friendly innovations, such as eco- innovation and green innovation (Alam et al., 2022; Le & Govindan, 2024; León-Gómez et al., 2022; Martínez-Martínez et al., 2023; Srisathan et al., 2020). Meanwhile, financial performance variables are often juxtaposed with sustainability performance. Sustainability performance, as a non- financial performance element, is frequently compared or associated with financial performance. Both are major objectives that often become the primary focus of companies and are interconnected (Ukko et al., 2019; Valdez-Juárez et al., 2024). Lastly, variables related to technology accommodate the research objective of developing sustainability strategies through the implementation of digital technology (Abdullah & Ampauleng, 2024; Patma et al., 2021; Tworek et al., 2019; Valero-Gil et al., 2024).

Table 5 Most Used Independent Variables. Author's own work

Variable Category	Variables	References
Technology Related Variables	Readiness for Digital Transformation (RDT), digital marketing, Digital Transformation, ICT adoption, Green Technological Innovation, Digitalization, Digital technologies, Entrepreneurial technology opportunism, technological factor, green technologies, operational technology, Value chains, Social Media Usage; Social Media Integration, Technology Adoption, Technology Infrastructure, IT Capability, The perceived usefulness (PEU), Smart technologies IT	(Asad et al., 2023; Asim, Li, & ur Rehman Makhdoom, 2019; Awad & Martín-Rojas, 2024; Azudin & Mansor, 2018; Bruce et al., 2023; Budiarto et al., 2023; Endrődi-Kovács et al., 2024; Hoa & Tuyen, 2021; M. I. Hossain et al., 2022; Le & Govindan, 2024; León-Gómez et al., 2022; Lima et al., 2024; Patma et al., 2021; Pichagonakesit et al., 2023; Rajan et al., 2024; Saary et al., 2022; Straková et al., 2022; Tworek et al., 2019; Utaminingsih et al., 2020; Valdez-Juárez et al., 2024; Wijaya et al., 2023)
Firm level related variables	firm size, existence of a business plan, succession plan, degree of localization, and gender of the business owner, eco-innovation capabilities, cost efficiency and operational excellence of SMEs, SMEs' diversification , corporate entrepreneurship, organizational and environmental factor, Institutional environment, Open Innovation; Competitive Advantage, organizational DNA, business potential, Operational Ability, knowledge transfer effectiveness, organizational	(Awad & Martín-Rojas, 2024; Azudin & Mansor, 2018; Budiarto et al., 2022; M. I. Hossain et al., 2022; Jagoda et al., 2016; Kim, 2021; Srisathan et al., 2020; Sukri et al., 2023; Suriani et al., 2024; Ukko et al., 2019; Utaminingsih et al., 2020; Wibowo et al., 2024; Wijaya et al., 2023)

	culture, SMEs' Entrepreneurial abilities			network orientation and innovation orientation, STP Strategy	
Manajerial characteristics	Entrepreneurs' skills; Marketing capabilities; Source of funds; Use of technology; Motivation; Family member, Sustainable Leadership; Green Entrepreneurial Orientation, Top Management Advocacy, Response to climate change, Managerial ability, green knowledge, CSR initiative, financial awareness, Financial literacy; Technology literacy, Religiosity; Knowledge; Attitude	(Adam et al., 2024; Alam et al., 2022; Antara et al., 2024; Asim, Li, & ur Rehman Makhdoom, 2019; Cheffi et al., 2021; Hamdana et al., 2022; Laila et al., 2023; Martínez-Martínez et al., 2023; Msomi & Kandolo, 2023; Ukko et al., 2019)	Stakeholder related variables	Circular Economy Public; Digital Economy Policy; Social Security Policy, Buyers Influence; Suppliers Influence; Governmental Influence; Green Investment Influence, Customer; Government Support	(M. I. Hossain et al., 2022; Megawati et al., 2024; Rodríguez-Espíndola et al., 2022)
			Country level related variables	GDP, Exports	(Endrődi-Kovács et al., 2024; Valero-Gil et al., 2024)
Strategy and Orientation	Sustainable Supply Chain Strategy, Smart Supply Chain Strategy, E-Market Orientation; Sustainability Orientation; Technology Orientation, intellectual Capital, business strategy, entrepreneurial orientation, green entrepreneurial orientation, customers orientation, competitor orientation, technology orientation,	(Abdullah & Ampauleng, 2024; Asad et al., 2023; Bangun et al., 2024; Budiarto et al., 2023; Ramakrishna Thota et al., 2023; Türkeş, 2024; Utaminingsih et al., 2020; Yang et al., 2022)			

Based on the list of independent variables in Table 5, 37.5% of the articles employing empirical testing utilized independent variables related to technology or digital aspects. The selection of technology-related variables was diverse, ranging from digital technology (Trueba-Castañeda et al., 2024; Valero-Gil et al., 2024) to the use of simple technologies such as social media (Bruce et al., 2023). The remaining articles utilized variables related to firm characteristics (23%), manager and business owner characteristics (18%), firm strategies and objectives (14.5%), stakeholder engagement (5%), and country-level variables (2%).

Table 6 The Most Used Mediating And Moderating Variables. Author's own work

Variables Category	Variables	References
Mediating Variables		
Innovation	Incremental eco-innovation knowledge, Eco-innovation capabilities, Technological Innovation; Non technological Innovation, Green Business Innovation,	(Antara et al., 2024; Martínez-Martínez et al., 2023; Sukri et al., 2023; Valdez-Juárez et al., 2024)

	Green Digital Innovation	
Technology	Integration of CSR into Management Control Technology, Technology Opportunism, Social Media Adoption, Manufacturing Technology, technology adoption, social media marketing, System Approach, Technology; CE principles; SOI, Social Media Martketing	(Abdullah & Ampauleng, 2024; Asim, Li, & ur Rehman Makhdoom, 2019; Bruce et al., 2023; Cheffi et al., 2021; Patma et al., 2021; Pichagonakesit et al., 2023; Rodríguez-Espíndola et al., 2022; Tworek et al., 2019)
Managerial Related Variables	Involvement of Management Accountants in CSR, green business behavior	(Cheffi et al., 2021)
Stakeholder Related Variables	customer orientation of tourism SMEs	(Lima et al., 2024)
Firm Performance	CSR, Business sustainability, SME Performance, Competitive Advantage, Absorptive Capacity	(Awad & Martín-Rojas, 2024; Bangun et al., 2024; Bruce et al., 2023; Budiarto et al., 2023; León-Gómez et al., 2022; Rajan et al., 2024; Srisathan et al., 2020; Suriani et al., 2024; Trueba-Castañeda et al., 2024; Wijaya et al., 2023; Yang et al., 2022)
Moderating Variables		
Managerial related variables	Managerial Environmental Concern	(Le & Govindan, 2024)
Technology related variables	Knowledge Transfer and Integration; Green Technology Dynamism, Green Technology Adoption	(Asad et al., 2023; M. I. Hossain et al., 2022)
Firm Performance	Innovation Capabilities, Supply chain practices, Sustainability strategy	(Hamdana et al., 2022; Megawati et al., 2024; Valdez-Juárez et al., 2024)
Country level	Comparing between countries	(Saary et al., 2022)

Table 6 presents a list of articles that utilized mediating or moderating variables to explain the relationship between dependent and independent variables. 27 articles, or 43% of the selected articles, employed mediating variables. Innovation (Antara et al., 2024; Martínez-Martínez et al., 2023; Sukri et al., 2023; Valdez-Juárez et al., 2024), technology (Abdullah & Ampauleng, 2024; Asim, Li, & ur Rehman Makhdoom, 2019; Bruce et al., 2023; Cheffi et al., 2021; Patma et al., 2021; Pichagonakesit et al., 2023; Rodríguez-Espíndola et al., 2022; Tworek et al., 2019), managerial-related (Cheffi et al., 2021), stakeholder-related (Lima et al., 2024) ad firm performance (Awad & Martín-Rojas, 2024; Bangun et al., 2024; Bruce et al., 2023; Budiarto et al., 2023; León-Gómez et al., 2022; Rajan et al., 2024; Srisathan et al., 2020; Suriani et al., 2024; Trueba- Castañeda et al., 2024; Wijaya et al., 2023; Yang et al., 2022) were identified as mediating variables in several studies within the domain of sustainability and technology. Conversely, 9 articles, or 14.5% of the selected articles, utilized moderating variables. Managerial-related variables (Le & Govindan, 2024), technology (Asad et al., 2023; M. I. Hossain et al., 2022), firm performance (Hamdana et al., 2022; Megawati et al., 2024; Valdez-Juárez et al., 2024) and country level (Saary et al., 2022) were investigated in previous research as moderating variables.

Table 7 The Most Widely Developed Research Method. Author's own work

Method	**Reference**
Quantitative	(Abdullah & Ampauleng, 2024; Adam et al., 2024; Alam et al., 2022; Amoah et al., 2023; Antara et al., 2024; Asim, Li, Makhdoom, et al., 2019; Awad & Martín-Rojas, 2024; Azudin & Mansor, 2018; Bachtiar et al., 2023; Bangun et al., 2024; Bruce et al., 2023; Budiarto et al., 2022, 2023; Cheffi et

	al., 2021; Corazza, 2018; Endrődi-Kovács et al., 2024; Hamdana et al., 2022; Hoa & Tuyen, 2021; M. B. Hossain et al., 2022; M. I. Hossain et al., 2022; Jagoda et al., 2016; Kim, 2021; Laila et al., 2023; Le & Govindan, 2024; León-Gómez et al., 2022; Lima et al., 2024; Martínez-Martínez et al., 2023; Megawati et al., 2024; Msomi & Kandolo, 2023; Patma et al., 2021; Pichagonakesit et al., 2023; Rajan et al., 2024; Ramakrishna et al., 2023; Saary et al., 2022; Saci & Mansour, 2023; Saura et al., 2023; Spigarelli et al., 2024; Srisathan et al., 2020; Straková et al., 2022; Trueba-Castañeda et al., 2024; Türkeş, 2024; Tworek et al., 2019; Ukko et al., 2019; Utaminingsih et al., 2020; Valdez-Juárez et al., 2024; Valero-Gil et al., 2024; Wijaya et al., 2023; Yang et al., 2022)
Qualitative	(Bachtiar et al., 2023; Isensee et al., 2023b, 2024; Izadi Z.D et al., 2020; Ogrean & Herciu, 2021; Pellegrini et al., 2023; Reyes-Rodríguez et al., 2023; Sukri et al., 2023; Sundström et al., 2020; Tiago et al., 2021; Twum-Darko & Sibanyoni, 2014)
Mix Method	(Suriani et al., 2024; Wibowo et al., 2024)

Quantitative methods dominate the research approaches employed in studies related to sustainability and technology. 48 articles, or 78% of the selected articles, utilized quantitative methods, with data collection through survey questionnaires (Abdullah & Ampauleng, 2024; Adam et al., 2024; Amoah et al., 2023; Antara et al., 2024; Asim, Li, Makhdoom, et al., 2019; Awad & Martín-Rojas, 2024; Azudin & Mansor, 2018; Bachtiar et al., 2023; Bangun et al., 2024; Bruce et al., 2023; Budiarto et al., 2022, 2023; Cheffi et al., 2021; Corazza, 2018; Hamdana et al., 2022; Hoa & Tuyen, 2021; M. B. Hossain et al., 2022; M. I. Hossain et al., 2022; Jagoda et al., 2016; Kim, 2021; Laila et al., 2023; Le & Govindan, 2024; León-Gómez et al., 2022; Lima et al., 2024; Martínez-Martínez et al., 2023; Megawati et al., 2024; Msomi & Kandolo, 2023; Patma et al., 2021; Pichagonakesit et al., 2023; Rajan et al., 2024; Ramakrishna et al., 2023; Saary et al., 2022; Saci & Mansour, 2023; Saura et al., 2023; Spigarelli et al., 2024; Srisathan et al., 2020; Straková et al., 2022; Trueba-Castañeda et al., 2024; Türkeş, 2024; Tworek et al., 2019; Ukko et al., 2019; Utaminingsih et al., 2020; Valdez-Juárez et al., 2024; Valero-Gil et al., 2024; Wijaya et al., 2023; Yang et al., 2022) or data extraction from databases(Alam et al., 2022; Endrődi-Kovács et al., 2024). In contrast, only 12 articles, or 19% of the selected articles, conducted qualitative research, with one of them employing an experimental approach. Qualitative data were gathered through interviews or website content analysis. The remaining 2 articles, or 3% of the reviewed articles, utilized a mixed-methods approach (Suriani et al., 2024; Wibowo et al., 2024).

Thematic Mapping Through Co-Word Analysis

Figure 2 presents the outcome of the co-word analysis conducted using the authors' selected keywords from the 62 reviewed publications. The prominence of each keyword is represented by the relative size of the circles in the visualization, with larger circles indicating higher frequency of occurrence. Consistent with the central focus of this review, the terms sustainability and SMEs emerge as the most dominant keywords, illustrated by the two largest circles positioned at the core of Figure 2.

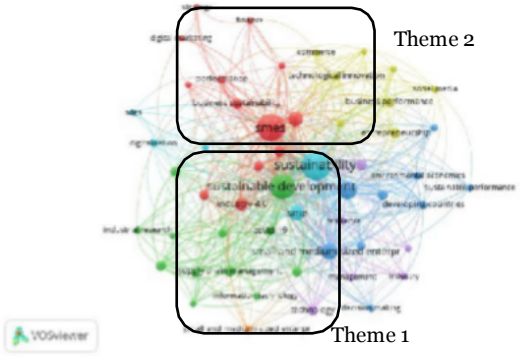

Figure 2 Co-word Analysis

1. **The use of digital technology in the sustainability practices of SMEs**

The use of digital technology in the sustainability practices of SMEs has become a central focus in numerous studies that highlight its role in enhancing business efficiency and competitiveness. Patma et al. (2021) demonstrated that the strategic use of social media by Indonesian SMEs during the COVID- 19 pandemic not only supported business continuity but also promoted more inclusive and sustainable business practices. Similarly, Bruce et al. (2023) emphasized that social media integration enhances transparent communication with customers and stakeholders, thereby strengthening SMEs' social performance. Valero-Gil et al. (2024) further underscored the importance of digital transformation in achieving long- term competitive advantages, noting that data utilization and digital systems significantly improve sustainability- oriented decision-making processes.

Moreover, Tworek et al. (2019) explored a systemic approach to digital technology adoption, highlighting how the integration of technology

across the entire value chain optimizes operational efficiency and reduces environmental footprints. The implementation of tools such as management information systems, e-commerce platforms, and digital marketing enables SMEs to expand market reach while adopting sustainable principles such as energy reduction and improved waste management. Collectively, these studies assert that digital technology serves not merely as a business enabler but as a critical driver in SMEs' sustainability strategies across environmental, social, and economic dimensions. Therefore, digital adoption in the SME sector holds significant potential in accelerating the transition toward a more inclusive and green economy.

2. The Impact of Innovation on the Performance and Sustainability of SMEs

Innovation plays a crucial role in enhancing the performance and sustainability of SMEs, as demonstrated by several studies included in the reviewed literature. Alam et al. (2022) emphasized that eco-innovation allows SMEs to address climate change challenges by incorporating environmentally friendly technologies that improve operational performance and environmental outcomes simultaneously. Le and Govindan (2024) also highlighted that innovation, especially when aligned with managerial and digital capabilities, enhances organizational agility, enabling SMEs to respond more effectively to market dynamics and regulatory demands for sustainability. In this context, innovation becomes not only a technical solution but a strategic approach to long-term value creation and competitive advantage.

Further evidence from Martínez-Martínez et al. (2023) and Srisathan et al. (2020) confirms that innovation capabilities—such as open innovation and incremental eco-innovation—act as mediating factors that link technology adoption to improved business outcomes. These studies show that SMEs engaging in innovation practices tend to experience higher levels of financial performance, social responsibility, and environmental compliance. Antara et al. (2024) also found that innovation initiatives embedded in leadership strategies positively influence SMEs' efforts to achieve sustainable business models. Taken together, these findings suggest that innovation is a central mechanism through which SMEs can balance economic goals with environmental and social imperatives, making it a key driver of sustainable development in the SME sector.

Further Research Opportunities

Previous research has not utilized a unified theoretical framework in this research area, and no comparative studies have been conducted to predict the role of technology in sustainability practices using two distinct theories. Therefore, we suggest developing a hybrid model that incorporates components from various theories to provide a more comprehensive understanding of the determinants of technology's role in business unit sustainability. Furthermore, we recommend comparative studies to predict the implementation of technology in SME sustainability practices using two different theories. For example, comparing the predictive power of institutional theory and organizational theory in the context of differing internal and external organizational factors to investigate the most influential determinants of sustainability practices in SMEs. 42% of the reviewed articles were not based on any theoretical framework, indicating a reliance solely on empirical findings. Consequently, future research should more frequently apply theory to sustainability practices in SMEs and also explore novel theories to explain the motivations of management and business owners to adopt technology in sustainable practices. For instance, future research could investigate the theory of planned behavior (TPB), which has not been specifically used to explain the utilization of digital technology for SME sustainability. This theory has been applied in various fields to understand how managerial characteristics and behaviors control the commitment to participate in sustainable activities (Galeone et al., 2024; Hassan et al., 2023). Future research can leverage this theory to investigate how managerial behavior motivates sustainability practices in SMEs.

Another avenue for sustainability research could explore the differences in sustainability practices between SMEs with male versus female managers. A gender perspective has been utilized to explain the differing motivations that drive companies to optimally engage in sustainable activities in large corporations (Bouzari et al., 2021; Dicuonzo et al., 2024). For example, do female managers place greater emphasis on sustainability practices and are they more capable of leveraging emerging technologies to optimize sustainability practices in SMEs? Understanding the unique motivations and barriers for each gender can aid in developing green practice tactics. We must continue to investigate innovative studies and research questions related to these theories to advance our knowledge of how digital technology impacts sustainability practices in SMEs. In addition to incorporating gender as a novel perspective in future research, intergenerational

studies are also warranted. Previous research predominantly relied on questionnaire data collected from managers or business owners. However, these studies did not categorize managers and owners by generation. Notably, the rapid advancement of digital technology around 2018 suggests that managers or business owners from different generations may exhibit varying approaches toward the integration of technology in sustainable practices within SMEs. Studies focusing on Generation Z or Generation Alpha present compelling avenues for further exploration.

From a methodological standpoint, there is a need for the application of experimental designs in future research to gain a deeper understanding of technology utilization in sustainable practices. Only two studies have employed experiments to demonstrate the key dynamics of SMEs (value creation, profitability, risk, leverage, and equity multiplier, among others) and sustainability indicators (Corazza, 2018; Saci & Mansour, 2023). Therefore, future research can implement modern data collection techniques in experimental studies to investigate SME sustainability performance.

5. CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

It is the closing of the article which reflects the essence and reasoning of the research by the writer. It is also logically based on the evidence taken from, and presented by the writer in paragraphs. Implication, limitations, and suggestions are also presented in paragraphs without numbering. It is the closing of the article which reflects the essence and reasoning of the research by the writer. It is also logically based on the evidence taken from, and presented by the writer in paragraphs. Implication, limitations, and suggestions are also presented in paragraphs without numbering.

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