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Role of Digital Transformation for Achieving Sustainability: Mediated Role of Stakeholders, Key Capabilities, and Technology

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Abstract: Sustainability through digital transformation is essential for contemporary businesses. Embracing sustainability, micro-, small-, and medium-sized enterprises (MSMEs) can gain a competitive advantage, attracting customers and investors who share these values. Moreover, incorporating sustainable practices empowers MSMEs to drive innovation, reduce costs, and enhance their reputation. This study aims to identify how owners or senior managers of MSMEs can initiate a sustainable digital transformation project. A systematic literature review was carried out, including 59 publications from 2019 to 2023. As a result, this research identifies the first steps owners of MSMEs can take to begin the transition by identifying critical organizational capabilities necessary for successful transformation, explores the technologies that can support MSMEs in their sustainability goals, and emphasizes the significance of stakeholders in achieving a successful digital transformation journey. Firstly, owners or senior managers should change the organizational culture to support decisions and strategies focus on sustainability. Secondly, the leading role of stakeholders is in the innovation process that allows businesses to be more competitive locally and globally. Finally, big data is the technology that can provide the most significant benefit to MSMEs because it will enable analyzing data of all kinds and contributes disruptively to decision-making.

Keywords: digital technology; ICT; management; MSMEs; organizational culture; stakeholder

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1. Introduction

In recent years, sustainability through digital transformation (DX) has emerged as a critical focus for micro-, small-, and medium-sized enterprises (MSMEs) [1]. This strategic combination of sustainability and technology adoption holds immense potential for driving positive environmental and social impact while ensuring the long-term viability of MSMEs [2,3].

DX enables MSMEs to integrate sustainable practices into their operations, fostering resource efficiency and minimizing their ecological footprint [4]. By leveraging technologies like data analytics, the Internet of Things (IoT), and cloud computing, MSMEs can optimize energy consumption, minimize waste, and make informed decisions that support sustainable manufacturing processes [5]. The adoption of these technologies not only benefits the environment but also enhances operational efficiency and cost-effectiveness for MSMEs [6].

Furthermore, DX empowers MSMEs to engage in sustainable supply chain management [7]. By utilizing Blockchain technology, companies can enhance transparency and

traceability across the supply chain, ensuring ethical sourcing, fair trade practices, and responsible production. This level of transparency builds trust among stakeholders and satisfies the growing consumer demand for sustainable products and services [8].

In addition to environmental considerations, DX enables MSMEs to prioritize social sustainability [9,10]. Through digital platforms and e-commerce, these enterprises can reach broader markets, connect with socially conscious consumers, and communicate their sustainability initiatives effectively [10,11]. Engaging in digital marketing and storytelling allows MSMEs to showcase their commitment to social responsibility, fair labor practices, and community engagement, creating a positive brand image and attracting loyal customers [12].

Integrating digital technologies also facilitates the development of innovative solutions to societal challenges [9,12]. MSMEs can leverage artificial intelligence and data analytics to identify social needs, create sustainable products or services, and contribute to the well-being of communities. For instance, by utilizing AI-driven predictive maintenance, MSMEs can optimize equipment usage, minimize downtime, and extend the lifespan of their assets, reducing the need for resource-intensive replacements [13].

However, owners and senior managers of MSMEs often need more information to initiate a sustainable DX. Existing resources and literature focus on more giant corporations or provide general guidelines that may not address MSMEs' unique challenges [14–16]. This lack of tailored information leaves them wanting to know where to begin and how to integrate sustainability and digitalization effectively [16,17].

The lack of specific guidance leaves owners and senior managers grappling with questions about technology adoption, aligning sustainability goals with business objectives, and managing financial constraints. They need help to assess their current digital capabilities, identify areas for improvement, and foster a culture of innovation within their organizations. This lack of clarity hinders their ability to simultaneously navigate the complexities of DX and sustainability. Furthermore, MSMEs may be unaware of the potential resources and support available through external partnerships and collaborations. Access to expertise and guidance is necessary for them to gain valuable insights that could inform their transformation journey.

Addressing the information gap and providing targeted resources and guidance for MSME owners and senior managers is crucial to empower them to navigate sustainable DX challenges. By filling this gap in the literature, MSMEs can overcome barriers, embrace sustainability, and effectively leverage digital technologies to drive their businesses forward. This research aims to bridge the gap by offering a descriptive analysis of sustainable DX and its implications for MSMEs, providing the necessary knowledge and tools for owners and senior managers to initiate and navigate this transformative journey confidently.

The research focuses on examining the essential capabilities required for MSMEs to initiate a sustainable DX, understanding the positive environmental impact of technologies employed in the process, and investigating the roles of various stakeholders in promoting sustainability through DX. By critically assessing these aspects, the research seeks to provide valuable insights into How can owners or senior managers of micro-, small-, and medium-sized enterprises initiate a sustainable digital transformation? The significance of answering the research question lies in the employment opportunities offered by MSMEs in Latin America and the world. By guiding sustainable DX, this research aims to empower owners and senior managers of MSMEs to navigate the complexities and challenges of integrating sustainability into their DX initiatives. The findings will contribute to the existing knowledge by shedding light on the critical capabilities, technological impacts, and stakeholder roles that drive sustainability through DX in MSMEs. Finally, the research aims to foster more informed decision-making, innovation, and value creation within MSMEs.

We have organized the paper as follows. Section 2 introduces the theoretical background. Section 3 details the methodology. Section 4 highlights the data analysis and results. Section 5 discusses the results and highlights research gaps. Finally, Section 6 presents concluding remarks.

2. Theoretical Background

2.1. Digital Capabilities

Digital capabilities are essential for enabling and driving DX within organizations. Digital capability can be seen as a dynamic capability that empowers companies to create new products and processes and adapt to market changes [18]. It involves leveraging technology affordances and establishing procedures that utilize human capital and knowledge assets to interact with specific digital technologies. These capabilities refer to digital systems that can autonomously generate new outcomes and structures without the system creator's need for external actors or deliberate planning [19]. The impact of digital orientation and capability on digital innovation is significant, and they also play a mediating role in the relationship between firm performance, digital direction, and digital ability [20].

To ensure the successful adoption of technological innovations, organizations require to identify the need for such advancements [21]. Adopting digital tools becomes crucial for enhancing the effectiveness of organizational functions and processes [11]. Digital capabilities enable organizations to leverage the information available from the environment and incorporate technology more efficiently in alignment with their value proposition [22].

However, many companies interested in DX need help building their IT organizations, developing necessary tools, and nurturing the required talent to manage digital information and establish online services and automated processes [23]. Often, these companies need to pay more attention to the fact that critical resources for DX may be readily available internally. While internal capability development takes time, seeking external digital capabilities can assist companies in overcoming innovation challenges and enhancing their competitiveness in the online domain.

Developing capabilities is a crucial aspect of DX, with the specific variety of capacities varying across sectors and individual company needs. Digital capabilities positively impact digital innovation, thereby driving DX. Research demonstrates the positive influence of digital orientation and capacity on digital innovation and their mediating effects on financial and non-financial performance [24]. Digital innovation, in turn, acts as a mediator between digital capabilities and business performance, leading to improved resilience and organizational performance [25]. Companies prioritizing sustainable practices also tend to achieve better performance outcomes [20,21].

2.2. Dynamic Capabilities

Dynamic capabilities theory aims to explain the competitive advantage, with firm performance as a critical component. Dynamic capabilities refer to a firm's ability to adapt and transform its ordinary capabilities or resource base, leading to changes in concert rather than explaining performance itself [24,26]. For that reason, dynamic capabilities have received significant attention in knowledge management. From a knowledge management perspective, firms must develop dynamic capabilities to effectively integrate and reconfigure internal and external knowledge in response to the ever-changing external environment. This adaptability and transformation is a potent source of competitive advantage for organizations [27].

Dynamic capabilities are a firm's capacity to generate new knowledge by integrating and reconfiguring its resources [25]. This process enables firms to acquire new resources and expertise necessary for growth and development. Dynamic capabilities are crucial in managing knowledge while adapting strategies to address environmental changes.

The impact of dynamic capabilities extends to various aspects of a firm's operations. They influence strategic performance by shaping resource allocation, operational routines, activities, knowledge development, transfer, and decision-making processes within a dynamic context. It is essential to note the close connection between dynamic capabilities and KM practices; as dynamic capabilities encompass a firm's ability to reconfigure its KM practices effectively [27].

Facilitating the recombination of a firm's resources and capabilities is one of the primary functions of dynamic capabilities. This recombination process enables the develop-

ment of new knowledge, which, in turn, drives innovation in the form of new products or services. Additionally, dynamic capabilities empower firms to continuously solve problems and seize opportunities through timely and market-oriented decision-making [24].

MSMEs aiming for sustainable digitalization depend on dynamic capabilities as an essential requirement. These capabilities empower firms to adapt to changing circumstances, transform their operations, and leverage their knowledge to drive innovation, address challenges, and make well-informed decisions that align with market demands and opportunities.

2.3. Digital Transformation

DX represents a new opportunity for MSMEs, as it entails fundamental changes in business processes, operational routines, and organizational capabilities [28]. Its implementation is a deliberate and continuous evolution that involves strategic and tactical aspects, including entering new markets or exiting existing ones [29].

The impact of DX goes beyond individual companies; it has the potential to transform the entire business world and society as a whole through the establishment of new internet-based technologies [30]. As a result, DX has the potential to revolutionize traditional industries and bring significant changes in how value is created and delivered to customers [31].

DX is an evolutionary process that leverages digital technologies and capabilities to create value changing the business models, operational activities, and customer experiences [32]. Organizations can experience profound shifts in their functioning and ability to provide value-added services to customers by integrating digital technologies and new business models [33]. Enterprises can adopt various technologies, including big data, mobile devices, and social media [34]. These technologies enable MSMEs to achieve significant business improvements, such as enhancing the customer experience, streamlining operations, and creating innovative business models [23].

DX is a strategic decision that top management makes to enhance organizational competitiveness, optimize resource utilization, and improve operational processes [33,35]. In today's globally competitive and economically challenging environment, effectively managing information, reducing operating costs, and analyzing real-time data have made DX increasingly significant [36,37]. As a result, organizations can achieve greater flexibility, cost savings, and improved decision-making capabilities.

DX differs from the traditional adoption of information and communication technologies (ICTs) as it impacts the business model and requires the support of at least one of the three methodologies of quality (Kaizen, Lean, or Six Sigma) [38–40]. Instead, the DX strategy concerns the adoption of ICTs in conjunction with a well-defined process, where the business model and quality management system (QMS) are the critical components for meeting customer expectations consistently [41–44].

A DX strategy is a crucial step for successful digital implementation at different points in an enterprise. The strategy should focus on changing the business philosophy [45–47]. Under this new paradigm, managers must understand their context, including situational opportunities and constraints that could impact economic growth, quality of working life, and production processes [41,48]. We can divide the context into internal and external components, with the former demanding special attention to costs and efforts for changing the business philosophy and the latter necessitating attention to economic, environmental, and political changes [43,44].

Adopting DX is crucial for MSMEs to stay competitive in today's digital landscape. It allows them to leverage technology to optimize their operations, reach new customers, and deliver products and services in innovative ways. Under this situation, MSMEs can unlock new opportunities for growth, efficiency, and customer satisfaction. However, top managers of MSMEs need to approach DX strategically, considering their unique organizational capabilities and resources. They should identify the specific digital technologies and business models that align with their goals and target markets. Additionally, MSMEs

should foster a culture of continuous learning and adaptation to ensure the sustainability of their DX efforts.

2.4. Micro-, Small-, and Medium-Sized Enterprises

According to the World Bank, MSMEs are classified based on their workforce size: micro enterprises employ 1–9 individuals, small enterprises employ 10–49 individuals, and medium enterprises employ 50–249 individuals [49]. However, the concept of MSMEs lacks a universally agreed-upon definition that can precisely outline its boundaries, primarily due to variations among countries, their economies, and the unique characteristics of their enterprises [50]. Nevertheless, a particular definition of MSMEs in each country considers the number of employees, turnover, and assets [51].

MSMEs are critical players in the broader entrepreneurial ecosystem. These companies are crucial in driving net job creation and fostering innovation and sustainability in the private sector. In emerging markets alone, there are approximately 365–445 million MSMEs, consisting of formal SMEs ranging from 25 to 30 million, formal micro enterprises ranging from 55 to 70 million, and a significant number of informal enterprises ranging from 285 to 345 million [49].

Globally, MSMEs have a representative contribution to production and employment, accounting for more than 90% of businesses. In low-income countries, MSMEs employ about 33% of formal sector workers, while in high-income countries, this figure rises to 62%. In countries with informal economies, the role of MSMEs in employment becomes even more prominent. For example, in India, a staggering 86% of the workforce is employed in the informal sector, which includes agriculture [52]. Although MSMEs are the most common type of business globally, their essential characteristics have yet to be widely understood. In general, MSMEs exhibit several common traits [53]:

1. operate as independent entities separate from large enterprises;
2. are typically established and managed by their owners, who face the associated risks;
3. have a relatively small number of employees;
4. have a limited range of products or services;
5. have a modest market share and a small customer base; and
6. help to access resources like funding, external advice, and government assistance.

Businesses of all sizes have been affected by the crisis. While large enterprises attract attention with their announcements of layoffs and substantial declines in sales and earnings, MSMEs also face challenges stemming from weakened demand, limited access to credit, and reduced orders from larger companies. As a result, small businesses across various sectors and organizational structures have experienced the impact [54].

Understanding how key capabilities contribute to the performance of MSMEs can provide valuable insights for enhancing their competitiveness [54,55]. Additionally, it is essential to identify the significance of human capital management for MSMEs and explore how the recruitment, development, and retention of skilled personnel affect their competitiveness, offering practical implications for fostering a capable workforce [56,57]. In this way, it is also relevant to examine how the participation of stakeholders can contribute to defining effective strategies for sustainability through DX [57].

2.5. Stakeholders

Stakeholders are those who have rights or interests in a system. For an organization, stakeholders are any group or individual who can affect or be affected by the achievement of the organization's purpose [58]. Different articles in the literature aim to explore the importance of stakeholders for companies and the importance of aligning corporate policies with their interests [1,59–64]. Stakeholders are crucial in shaping companies' success and long-term viability [60]. Therefore, understanding their interests and establishing effective relationships are essential for companies to operate socially responsible and economically viable [61]. According to Freeman and Reed, interested parties include individuals or groups that have a significant interest or connection to the organization, including citizens,

customers, employees, governments, intergovernmental organizations, non-governmental organizations, policymakers, and suppliers, whose support is vital to the long-term viability of the organization [59].

Regarding organizational structure, the nature of stakeholder relationships differs between the public and private sectors [65]. Private companies often view the relationship as a contractual arrangement involving private owners, employees, and other entities [66]. Therefore, the collaboration between government leaders, the dedicated employees of the department leading the initiative, the internal IT departments, and the IT service providers should be harmonious and synergistic. This collective effort would ensure comprehensive stakeholder involvement, allowing for the successful implementation of digitalization projects [67]. The government leadership would provide visionary guidance, while the department employees would bring valuable insights and commitment. Supported by the expertise of internal IT departments, the technical aspects would be well-coordinated, with IT service providers contributing their specialized skills. This ideal collaboration among stakeholders would create a robust foundation for the effective delivery of sustainable digitalization [64].

For any company size, stakeholders serve as a valuable asset in designing, implementing, and evaluating proposals, such as policies, products, services, and strategies [63]. Stakeholders actively collaborate to identify and evaluate organizational activity, enabling informed decision-making and effective resource allocation [62]. The management team must prioritize the well-being of key stakeholders, when making decisions or implementing strategies [66], and more so during times of crisis because they can accelerate organizational recovery [59,66,68].

The relevance of stakeholders for MSMEs In adopting environmentally sustainable practices is becoming increasingly important [1]. With the rise of environmental problems on a global scale and the growing ecological awareness among stakeholders, MSMEs are expected to prioritize the environmental behavior of these critical stakeholders [65]. Stakeholders can exert pressure or encourage MSMEs, going beyond what is legally required, to promote environmentally responsible practices [62]. Therefore, their influence can play a significant role in shaping the environmental initiatives undertaken by MSMEs. One way stakeholders express their expectations is through the demand for environmental reporting. Stakeholder pressure leads companies, including MSMEs, to engage in ecological reporting to demonstrate their commitment to environmental responsibility [1]. It indicates that stakeholders' concerns drive MSMEs' adoption of environmentally responsible practices.

2.6. Sustainability through Digital Transformation

Advances in digital technologies, such as process automation, 3D printing, the Internet of Things, and robotics, have transformed the process of international enterprises and contributed to their sustainability, survival, and development in the global market.

In recent years, sustainability has emerged as a critical aspect of DX, exerting a remarkable influence across diverse economic sectors, including agriculture [10]. In the agricultural domain, organizations recognize the importance of prioritizing effective waste management, sustainable production practices, and pollution control, acknowledging their great significance [69]. Consequently, this transformative shift holds profound implications for organizational capabilities, performance, and the strategic orientation of MSMEs in their pursuit of environmental sustainability [70]. These findings underscore the multifaceted nature of sustainability through DX in any economic context and its potential to drive positive change at various levels.

The paradigm of sustainable DX must generate internal and external benefits for the company [20]. It should promote greater environmental, economic, human, and social responsibility through business practices. Sustainable processes based on ICT can help companies develop solutions that make a real difference in their reduction, reuse, and recycling policies, thus protecting business margins and costs [71]. Furthermore, companies

can use ICT to innovate in business processes, deliver sustainability benefits to the entire company, and improve the quality of the working life of their employees [21].

2.7. Technology Absorptive Capacity

Achieving sustainable digital transformation in MSMEs relies on the crucial role of absorptive capacity. Absorptive capacity is the organization's ability to search, acquire, and exploit external technology, as evidenced by its characteristics. It refers to their ability to acquire and effectively utilize external technology [72]. Numerous studies highlight the importance of absorptive capacity in enhancing performance and driving innovation in MSMEs [73]. It serves as the foundation for technical learning within organizations, allowing them to identify and exploit knowledge from the external environment [74].

The influence of organizational culture on technology is particularly relevant to MSMEs [75]. Organizational culture shapes employee interactions and job execution, either facilitating or hindering organizational change and learning [72]. Additionally, MSMEs' interactions and connections with external organizations are vital for strengthening absorptive capacity and improving transfer performance [74].

For the long-term success of MSMEs, adopting sustainable DX is crucial, replacing outdated technologies, processes, and interactions with environmentally responsible alternatives. MSMEs can enhance technological capabilities and promote sustainable practices by incorporating external technologies and knowledge. Thus, fostering technological absorptive capacity is critical in enabling sustainable DX for MSMEs.

3. Methodology

The research method applied in this research is a systematic literature review (SLR) method [69,76]. Figure 1 shows the five phases of the methodology. The objectives of reviewing the literature are as follows:

- to identify the critical capabilities within the organization for achieving sustainability through DX;
- to determine the importance of stakeholders in achieving a successful DX; and
- to establish the technologies that MSMEs can employ in DX to achieve sustainability.

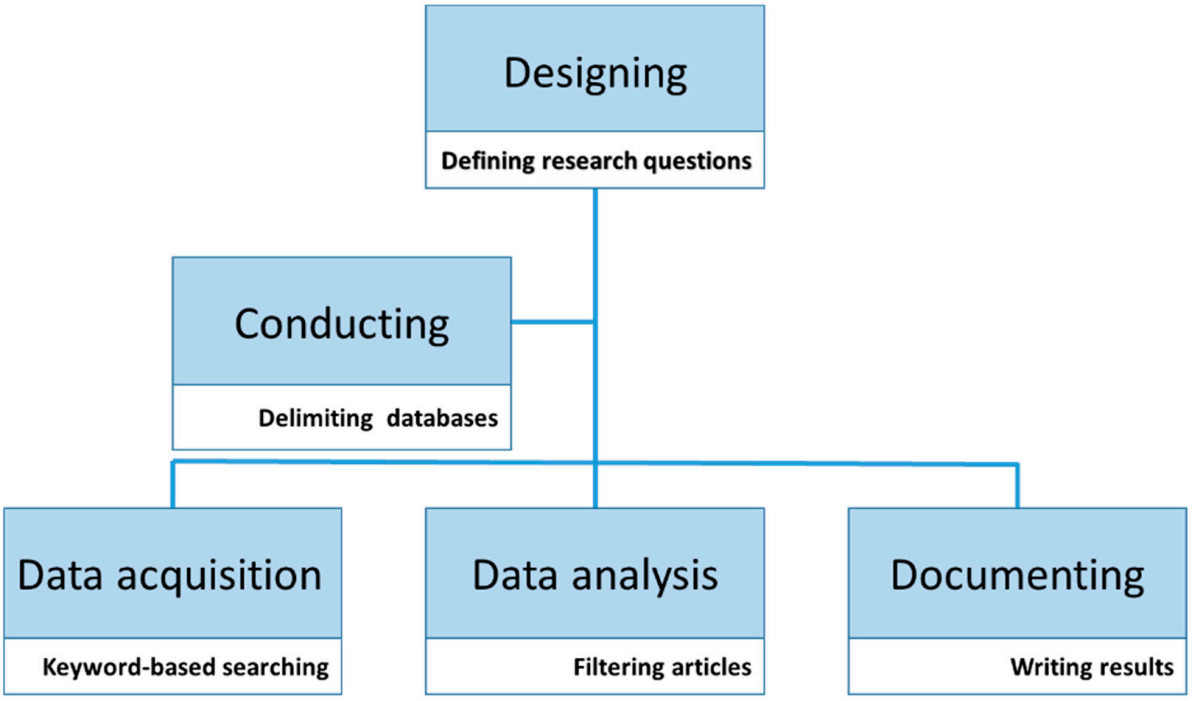

Figure 1. The methodology used in this research.

3.1. Designing

The following research questions are derived from the main objective and guide the research process, allowing for a systematic review of academic articles related to sustainability and DX.

- RQ1: What critical capabilities are required for MSMEs to achieve sustainability through DX?
- RQ2: What are the roles of stakeholders in promoting sustainability through DX in MSMEs?
- RQ3: Which are the leading technologies that positively impact sustainability through DX in MSMEs?

3.2. Conducting

We searched the publication using Clarivate's Web of Science Core Collection database, which is widely accepted by the academic community as an international database.

3.3. Data Acquisition

We focused on peer-reviewed academic journals published in the Web of Science Core Collection to ensure data collection from high-quality sources. Therefore, we decided to exclude conference papers, dissertations, and books. We used the following keywords—"sustainability" AND "digital transformation"—as a base to perform the database search. The search type was "by topic", which means that searches include title, abstract, author keywords, and keywords plus. After we applied all the eligibility criteria, we included the following keywords to refine the final result: "stakeholders", "key capabilities", "SME", and "MSME".

3.4. Data Analysis

After applying the first and second inclusion criteria, we initially found 511 academic articles. The inclusion criteria for publication years were then applied, reducing to 497 academic articles. We further refined our search by applying field inclusion criteria, which reduced the number of academic articles to 290. We then applied the exclusion criteria, leaving us with 241 academic articles. Table 1 summarizes the eligibility—inclusion or exclusion—criteria used in selecting academic articles.

Table 1. The eligibility inclusion or exclusion criteria adopted in this research.

Inclusion Criteria	Exclusion Criteria
Peer-reviewed publications	Adopt a vision of Industry 4.0 as a key element for digital transformation
Publications in English	Discuss just the benefit of one technology
Publication years: 2019–2023	Focus on mathematical models or algorithms
Field: environmental sciences, green sustainable science technology, environmental studies, management, business, and economics	Other field
Publications focus on analyzing sustainability through digital transformation	Propose a framework or strategy

After completing the first stage, we created a semantic map [77,78] to visualize the relationship among keywords and identify their association with sustainability DX. This map was generated from the 241 selected academic articles using their keywords. We utilized the VOSviewer software 1.6.19 to create the semantic map. Out of the 1405 identified keywords, we selected the top 50 based on a minimum occurrence of 8. We removed the keywords "0", "COVID-19", "China", and "systematic literature review" as they were not relevant to our research. Figure 2 presents the result of the semantic map, where the two most commonly used terms are "sustainability" and "digital transformation". However, the

terms "stakeholders", "key capabilities", "SME", and "MSME" do not appear as frequently in the literature and do not show strong associations with sustainability through DX.

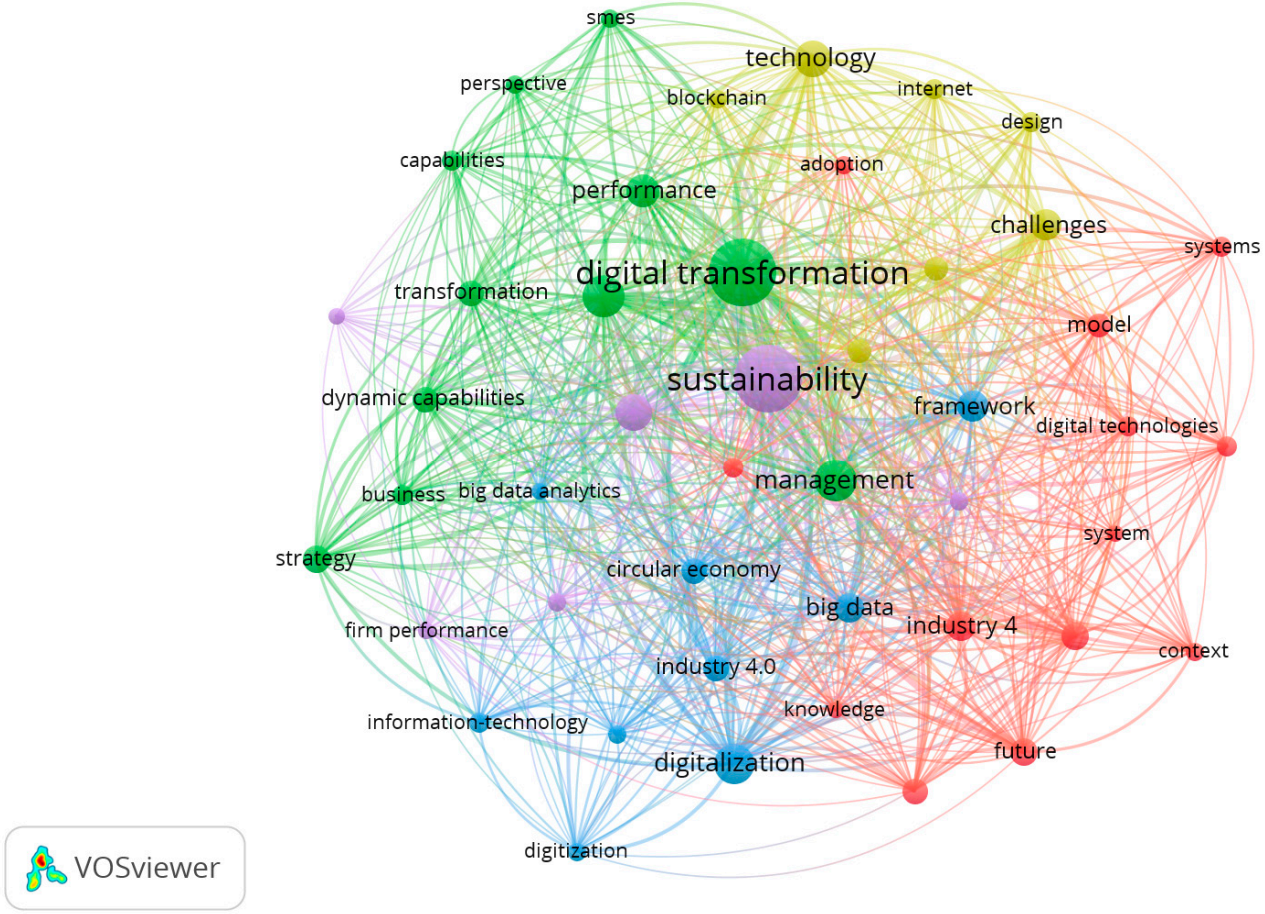

Figure 2. Keywords network based on co-occurrence.

We then added additional keywords, including "stakeholders", "key capabilities", "SME", and "MSME", to further refine our search results. Finally, we intersected possible combinations of three concepts to obtain a more precise outcome. Table 2 displays the total number of academic articles found in each search.

Table 2. Total number of publications found by year.

Keywords + Eligibility Criteria	2023	2022	2021	2020	2019	Total
Sustainability and Digital transformation	39	93	68	36	5	241
Sustainability and Digital transformation and Key capabilities	2	1	3	3	0	9
Sustainability and Digital transformation and SME	1	5	3	0	1	10
Sustainability and Digital transformation and MSME	2	0	0	0	0	2
Sustainability and Digital transformation and Stakeholder	6	20	10	9	0	45
Total number of publications per year	50	119	84	48	6	

Subsequently, we reviewed the abstracts and conclusions of each publication and excluded those unrelated to sustainability DX, resulting in a selection of 59 academic articles for further analysis. It is essential to mention that several academic articles not selected for a more rigorous analysis were used in the preliminary sections because they contain relevant information to contextualize the work.

4. Results

The following section describes the study's findings concerning the research questions posed. The first part of the discussion focuses on the state of the research field, emphasizing the quantity and scope of published literature. The subsequent subsections present evidence-based recommendations for the potential growth of MSMEs that want to implement sustainability through DX.

4.1. Characteristics of Academic Articles

Out of the 241 academic articles selected in the first stage (see Table 2), only 18.67% have reviewed the relevance of stakeholders in the process of sustainability through DX. Similarly, the percentages of academic articles related to (a) "sustainability", "digital transformation", and "key capabilities"; (b) "sustainability", "digital transformation", and "SME"; and (c) "sustainability", "digital transformation", and "MSME" are 3.73%, 4.15%, and 0.83%, respectively. From the total number of academic articles found in each search, we selected, after removing duplicates, 59 academic articles, as given in Table 3.

Table 3. The percentage of publications used for further analysis.

Keywords – Eligibility Criteria	Selected Publications after Removing Duplicates	Percentage Related to 241 Publications
Sustainability and Digital transformation	26	10.79%
Sustainability and Digital transformation and Key capabilities	4	1.66%
Sustainability and Digital transformation and SME	8	3.32%
Sustainability and Digital transformation and MSME	1	0.41%
Sustainability and Digital transformation and Stakeholder	20	8.30%
Total number of publications	59	24.48%

Consequently, the percentage of academic articles included in the analysis is 24.48%, out of 241. Figure 3 shows the total number of academic articles per year after the selection process.

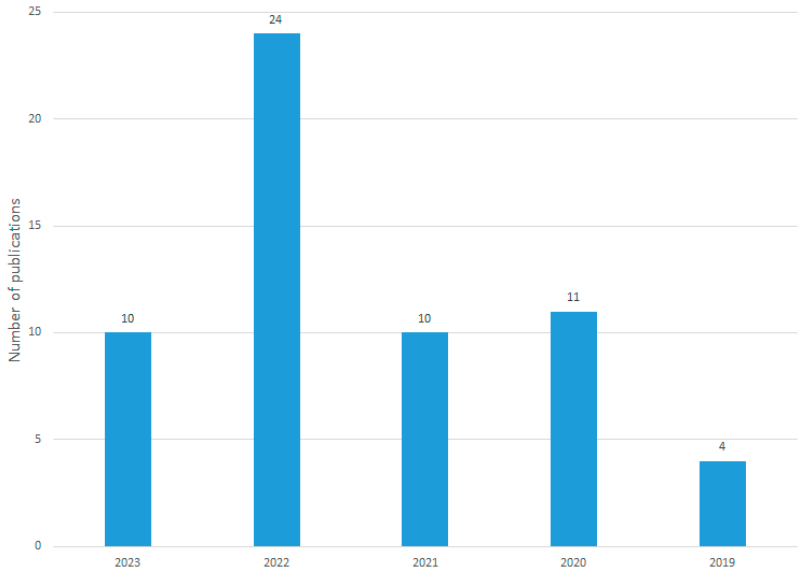

Figure 3. Distribution of publications by year.

Regarding geographic distribution, most research on sustainability DX has come from European countries, such as Italy, Spain, the United Kingdom, Croatia, Australia, and Germany, with percentages of 7.53%, 6.45%, 6.45%, 4.30%, 3.23%, and 3.23%, respectively. In contrast, research on the topic from Brazil, Chile, Colombia, and Mexico has accounted for 4.30%, 3.23%, 1.08%, and 1.08%, respectively (see Figure 4).

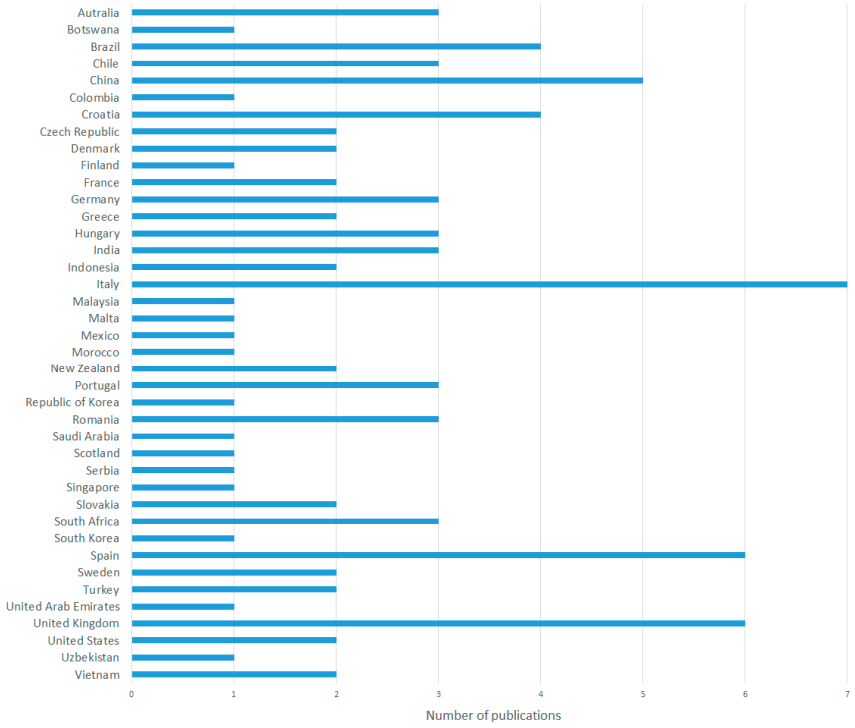

Figure 4. Distribution of publications by country.

Figure 5 shows the distribution of publications by journal. It is evident that the majority of the reviewed articles in this study are concentrated in the journal *Sustainability*. The *Journal of Business Research* ranks second in terms of article inclusion.

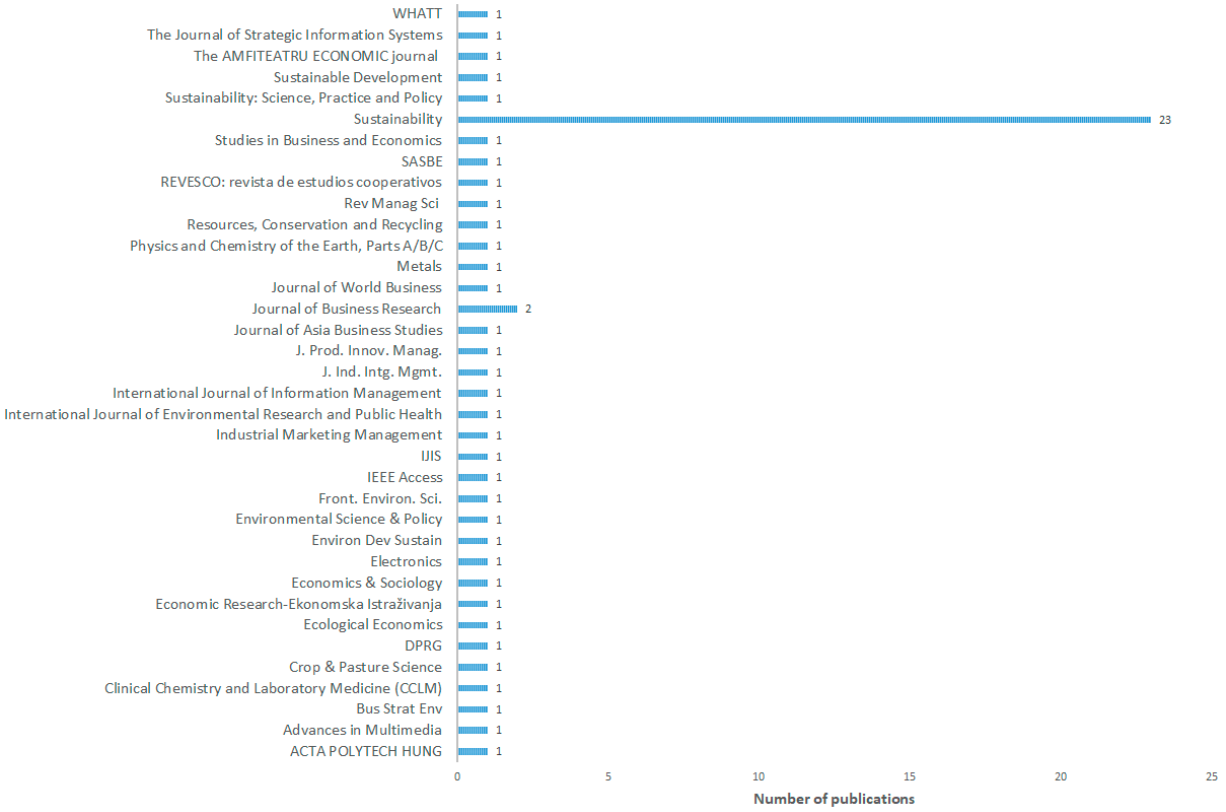

Figure 5. Distribution of publications by journals.

4.2. Critical Capabilities Required for MSMEs to Achieve Sustainability through DX

Sustainability through DX can provide new ways to manage resources, improve efficiency, and reduce negative environmental impacts for MSMEs [79]. According to the available academic articles, we can classify the critical capabilities required for MSMEs to achieve sustainability through DX into five major areas, as shown in Figure 6.

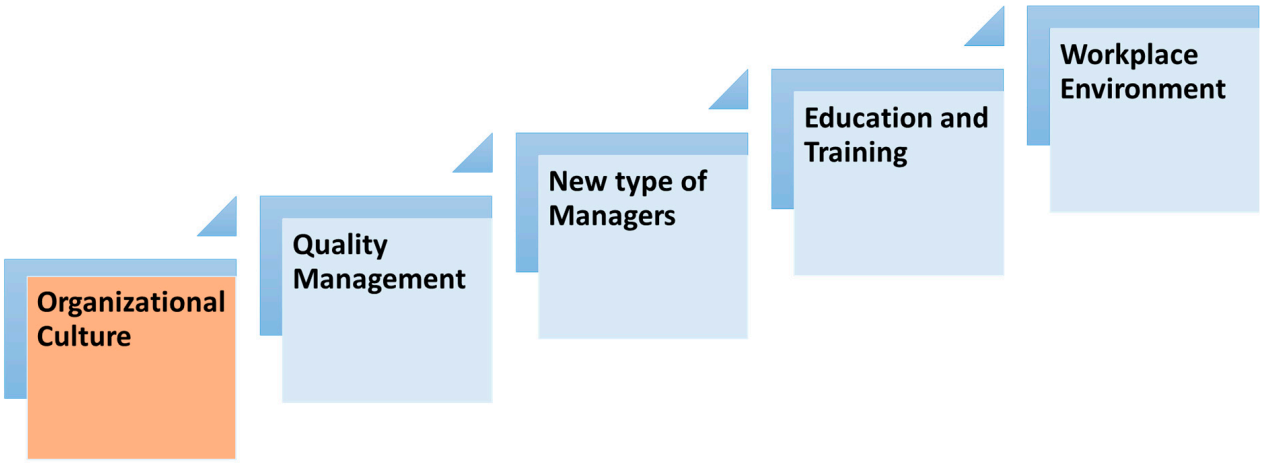

Figure 6. Major areas of change in MSMEs to initiate sustainability through DX.

4.2.1. Organizational Culture

The studies highlight the importance of including sustainability in the organizational culture, which directly influences sustainability through DX [80,81]. Therefore, MSMEs should adopt a vision that promotes sustainable DX to benefit the company, society, and the environment in their organizational culture. The research conducted in [82] assessed the correlation between digitization processes and corporate social responsibility, emphasizing a sustainable approach to determine their market advantages, revealing that sustainability achieved through DX holds significant value for stakeholders. Furthermore, the results emphasize the social responsibility aspect of digitization Ind its influence on market values for companies prioritizing advanced digital processes. Therefore, the implication of adopting sustainability through DX for customers in the organizational culture is the generation of valuable capabilities and competitive advantages, enabling the use of valuable and meaningful data as strategic assets to engage more customers [79].

4.2.2. Adopt a Quality Management Framework

Quality management is an essential component for the success of a sustainability DX in MSMEs [83]. Well-designed quality management helps MSMEs to meet customer expectations, improve processes, reduce waste, and increase customer satisfaction and reputation [84]. Quality management also helps MSMEs identify and address potential risks and opportunities, ensuring they remain competitive [85].

Previous research works have demonstrated that the implementation of a quality management system creates a positive impact on relationship quality and stakeholder loyalty [86]. Within a long-term relationship with interested parties, every detail about the quality of the service or product can influence the intentions of interested parties to collaborate with an organization [87]. Therefore, MSMEs must consider these details and deliver the highest level of quality to enhance stakeholders' satisfaction and loyalty based on increasing trust and satisfaction with the company [88].

Overall, quality management is crucial for MSMEs to achieve sustainable growth and success over time. Top managers can adopt critical points from different frameworks, such as ISO 9001, Kaizen, Lean, Six Sigma, and Total Quality Management (TQM) [79], to develop service quality [86].

4.2.3. New Type of Managers

Under this new reality, the traditional profile of managers requires a new perspective based on adaptable, agile, and innovative management models [89]. This new type of manager must have soft skills, such as analytical thinking, creativity, initiative, and originality [90]. Also, they must have technological skills associated with data science [91,92]. Moreover, managers must prioritize efficiency to reduce energy consumption, develop environmental management skills, and implement efficient maintenance practices [83].

Managers are responsible for promoting digitalization to improve companies' performance and sustainability [93,94]. Therefore, the position of top management is crucial in transforming existing corporate or business strategies into progressive and efficient business models. Business model transformation is a legitimate and necessary process driven by ongoing changes in both internal and external business environments. Additionally, the benefits of top management are essential in achieving sustainability through DX [95].

Managers are encouraged to embrace DX strategies, recognize the transformative nature of digital technologies, and optimize resource utilization for maximum benefits [96]. If the top managers can establish a shared vision among all the employees that promotes social responsibility, collaboration, and a learning culture, MSMEs could open new markets among consumers interested in the environment [97,98]. In this new scenario, managers can establish different processes to facilitate the connection of information and collaboration among stakeholders [99]. This approach focuses on customers' needs and enables effective communication among different departments, reducing resource waste and enhancing the social benefits of MSMEs [100].

4.2.4. Education and Training

In [80], the authors have examined the relationship between sustainability and DX practices in Romanian companies and identified two dimensions: (1) providing resources to acquire skills to leverage digital trends and (2) encouraging innovation with digital technologies. According to [91], education and training can enhance how employees use real-time information, which can help adopt DX processes, saving energy and resources. Therefore, the top management or owners of MSMEs need to invest in training courses for their employees to gain specialized knowledge in handling new technological tools and promote soft skills training to enhance communication and interpersonal abilities among employees [101].

Investing in human capital through formal education and training can help MSMEs overcome the current international crisis, contributing to the overall productivity and success of the organization [102]. This can be accomplished by establishing policies and a professional development plan to establish a regular education path for employees [103].

4.2.5. Workplace Environment

According to [104], it is evident that DX is altering the work structure in companies, including job roles and workplace requirements. It emphasizes the rise of flexible teams in various locations and the necessity to implement a digital workplace. However, organizations must consider implementing a training plan to prevent a skills gap between employees who have yet to undergo digitization and those who are digitally literate, thereby avoiding potential constraints. Furthermore, the new workspaces should encourage collaboration between employees of different profiles so that new ideas emerge, fostering collaborative innovation [105]. Consequently, the top management must offer workplaces that provide empowerment, encourage and facilitate creativity and personal initiative, and continuous improvement to consider and apply these changes [90].

The health and safety of employees must also be considered in new workspaces with the highest priority, thus promoting the social dimension through the establishment of medical facilities, supervision, accommodation, water supply, and bonuses [106].

4.3. Roles of Stakeholders in Promoting Sustainability through DX in MSMEs

MSMEs can identify their most loyal stakeholders by centralizing transaction records and customer data using technology, making the information accessible and manageable to specific stakeholders [107]. According to the available academic articles, we can categorize the stakeholders' participation in promoting sustainability through DX in MSMEs into four key roles, as shown in Figure 7.

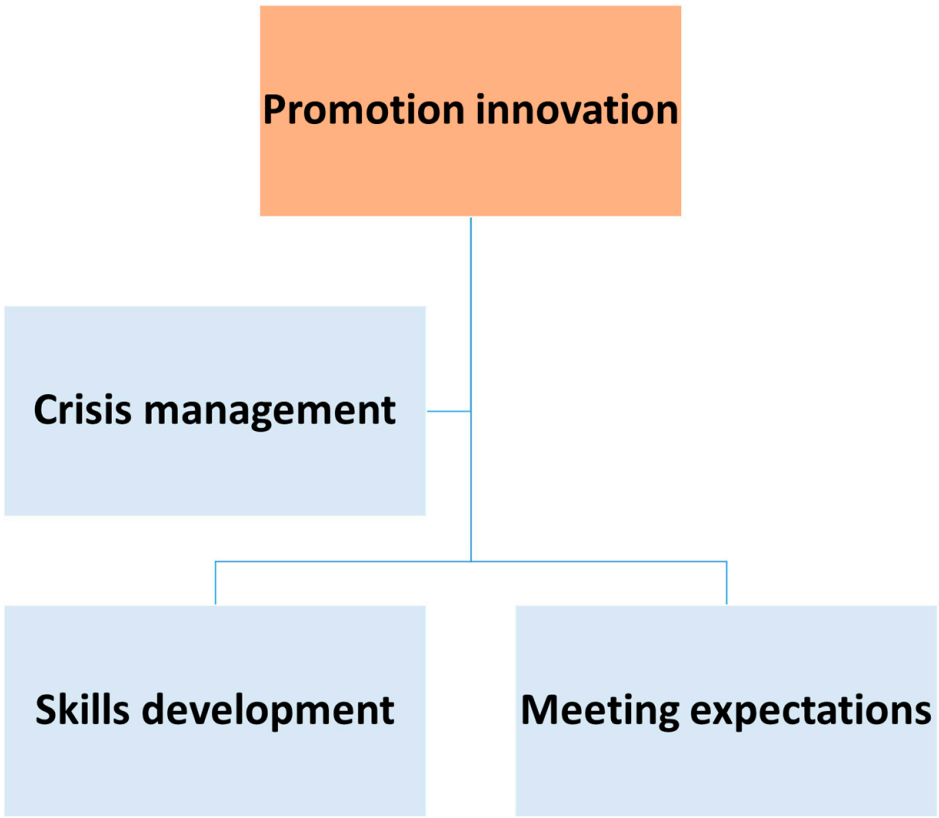

Figure 7. The main roles of stakeholders to promote sustainability through DX.

4.3.1. Crisis Management

The crisis brought on by the pandemic has catalyzed the inclusion of sustainability DX. For that reason, key stakeholders should recognize the value of DX and sustainability in driving innovation [108]. Furthermore, to ensure long-term growth and viability, MSMEs must initialize the creation of sustainability DX innovations [109].

The most crucial implication for any organization is to ensure that stakeholders are well-informed about new policies and changes in business operations, particularly during times of crisis [81,110]. By sharing information through digital or physical means, stakeholders can actively contribute to crisis management [108]. This action was evident during the COVID-19 pandemic, where organizations that effectively managed the situation demonstrated high levels of digital adoption [108] and utilized digital platforms for effective communication [111]. Therefore, sustainable DX should prioritize establishing direct communication channels with stakeholders and employing technologies that enable prompt responses to contingencies [112].

Public stakeholders play a crucial role in crisis management for MSMEs because they can promote investment in digital technology infrastructure, break down market barriers, and establish crisis protection funds, providing vital support for the survival of thousands of jobs [96,113]. On the other hand, private stakeholders have the potential to enhance environmental management, attract skilled human resources, and drive innovation in new product development [96].

4.3.2. Meeting Expectations

MSMEs must collaborate more closely with private stakeholders (customers, partners, and employees) to achieve sustainability through DX [114]. This approach fosters a two-way dialog that aligns the expectations of all stakeholders, and the use of technologies plays a key role. Technology enables the collection of more information and the ability to meet stakeholder expectations [112]. To enhance stakeholder involvement, organizations must raise awareness and articulate sustainability requirements and progress indicators verified, which must be present in the organizational culture and endorsed by senior management. As a result, organizations can enhance their sustainability efforts and achieve more outstanding market share gains by leveraging technology and fostering collaboration [115].

Public stakeholders are interested in adopting ICTs in industrial production for environmental sustainability [116]. Under this situation, several countries' digital and industrial policies take care of the impacts of ICTs on environmental sustainability in the industry, such as enhanced energy efficiency and resource management [117]. However, expectations vary between countries, and all policies have no shared theme. The suggestion is that policies move beyond awareness and incorporate a systemic understanding of the interlinked direct and indirect impacts of ICTs, along with targeted measures to promote environmentally sustainable industries [116].

4.3.3. Promoting Innovation

DX, along with its impact on business models, brings forth innovations that result in changes in consumer expectations and behaviors, evidencing that these innovations play a crucial role in achieving sustainability [95].

Innovation is crucial in addressing the challenges and implications of environmental, economic, human, and social uncertainty [99]. Private and public stakeholders are highly motivated to reduce costs, strengthen their market position, improve their competitive advantage, and foster an innovative spirit and executive ability [94,113]. Therefore, stakeholders can drive innovation in processes, organizations, and products, generating long-term value for MSMEs [118].

According to [119], transitioning from traditional services to innovative ones has resulted in stakeholder groups and networks utilizing digital technologies to foster innovation, learning, and collaborative problem-solving, creating an ecosystem of opportunities for MSMEs. Considering this, it is crucial to establish trust-based partnerships for the exchange of information and advice, as relying solely on this approach may pose challenges related to information sharing and the presence of free riders, potentially impacting long-term sustainability.

In consequence, the benefits of sustainability through DX for an organization are as follows [120]:

- Process innovation aims to reduce the use of raw materials, hazardous waste, and climate impact in production while improving employees' work efficiency.
- Organizational innovation involves reorganizing interactions and adopting a new management approach with an environmental focus embedded in the organizational culture and supported by top management.
- Product innovation focuses on designing reusable, easily recyclable, and more durable products.

A significant level of innovation can be achieved by synergistically combining these elements, leading to sustainable businesses [113].

In promoting innovation, policymakers may also be interested in assessing its impact on employment in terms of quantity and quality. Labor protection requests or regional unemployment rates can measure this at the macro level. At the micro level, MSMEs can measure this by considering variables related to internal activities, such as the acquisition and development of skills, and external activities, such as collaboration. Policymakers interested in promoting innovation among MSMEs may focus on tracking digital and

economic measures. At the macro level, a specific platform connecting regulatory agencies, SMEs, suppliers, and other stakeholders can serve as a digital variable [121]. Policymakers can also monitor the financing approved for each MSME to support innovation, which is an economic measure. At the micro level, MSMEs can track the economic dimension of R&D infrastructure by considering variables related to internal and external activities.

4.3.4. Skills Development

Learning is essential in facilitating change and the adoption of ICT, effectively reducing resistance to change [122]. Internal and external stakeholders play a significant role in supporting this process by empowering users to effectively manage technology through training in necessary skills and fostering confidence [119]. This support is crucial for promoting the widespread adoption of value-creating innovations [108]. In addition, it involves building confidence in soft skills for effective communication and interaction [123].

It is necessary to mention that universities must participate in sustainable DX by including courses that address sustainability in all disciplines and from different perspectives [124]. Once universities begin to incorporate sustainability topics into their study programs [125], they will become a high-value stakeholder for MSMEs, positively impacting the improvement of our environment [126]. In this context of digital changes, universities must participate in the transformation of people, training human beings to be more aware of their environment so that the day they start their professional life in MSMEs, they can contribute to (1) the rapid adoption of new technologies, (2) raising awareness of sustainability, and (3) reducing resistance to change [103].

4.4. Leading Technologies That Positively Impact Sustainable through DX in MSMEs

The integration of leading technologies in MSMEs offers a range of benefits, including improved financial performance, enhanced resource efficiency, greater production flexibility, and the opportunity to establish innovative business models that foster interaction between stakeholders [127]. According to the available academic articles, we identify six leading technologies that MSMEs can adopt to achieve sustainability through DX, as shown in Figure 8.

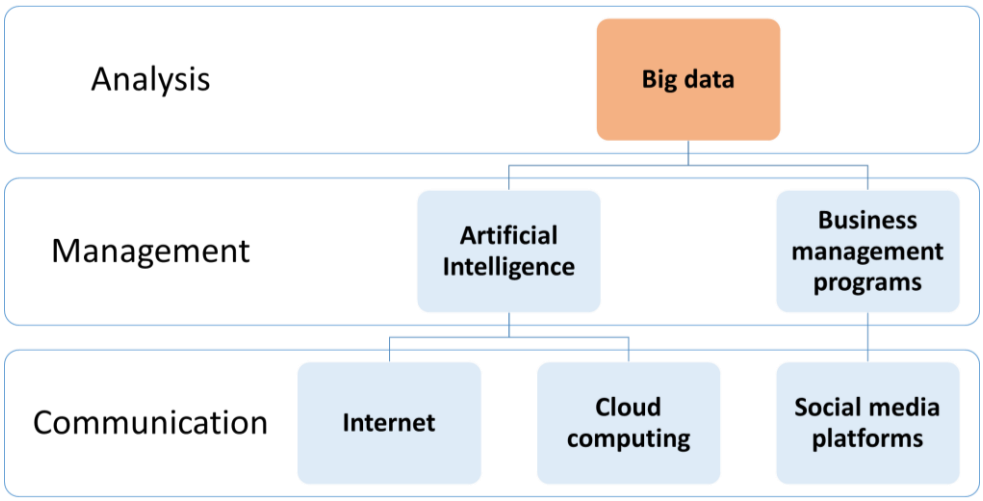

Figure 8. Leading technologies to boost sustainability through DX.

4.4.1. Artificial Intelligence

AI significantly has the following impacts: waste management, emission reduction, energy efficiency, and increased renewable energy. It forecasts waste generation, assists waste collection, categorizes waste, minimizes CO_2 emissions, predicts emission levels, and forecasts energy consumption [128,129]. Additionally, AI supports MSMEs in tracking key performance indicators, such as budget versus actual spending and supplier perfor-

mance [93,130], allowing them to identify areas for improvement, implement sustainable practices, and enhance their overall procurement efficiency [91,98].

AI also enhances the information processing capabilities of MSMEs. AI enables efficient communication and collaboration with supply chain partners by providing seamless system access across platforms [16,105]. Real-time data sharing and analysis empower MSMEs to make informed decisions, optimize their supply chain operations, and foster sustainable practices [124,131].

Furthermore, AI contributes to MSMEs' adoption of circular economy principles [91]. By utilizing AI technologies, MSMEs can reduce energy and water consumption, promote recycling and waste reduction, and achieve higher resource efficiency [110]. These practices align with sustainability goals and help MSMEs improve their environmental performance and contribute to a more sustainable future [80,85].

4.4.2. Big Data

Integrating big data in MSMEs with a specific focus on customer data analysis fosters the implementation of advanced technologies, resulting in enhanced operational efficiency, heightened market performance, and sustainable business excellence [91,132,133]. In addition, big data offers valuable insights into emerging trends and customer preferences [85], particularly within marketing, making it an indispensable tool for informed decision-making and effective problem-solving [134,135].

Big data enables the study of relationships between individuals, institutions, and entities, resulting in integrated business data that enhance the agility of MSMEs [136]. By utilizing data insights, MSMEs can make informed decisions regarding financial and strategic considerations [87]. Moreover, big data assists MSMEs in identifying trends and customer preferences, providing accurate results for marketing purposes [132]. This technology is crucial for MSMEs to remain engaged with customers and develop effective strategies [133]. The utilization of big data serves as capital, enabling quick problem-solving, fostering innovation, and driving business growth, aligning with previous research findings [98,116].

4.4.3. Business Management Software

Business management software, such as CRM (Customer Relationship Management) and ERP (Enterprise Resource Planning), offers significant benefits for MSMEs in pursuing sustainability through DX [133]. One key advantage is the ability to streamline operations by automating processes and improving efficiency [91].

Another crucial benefit is the enhanced data management provided by CRM and ERP systems. These platforms centralize critical business data, ensuring its accuracy, accessibility, and analysis [131]. As a result, MSMEs can make informed decisions that align with sustainability goals, track environmental performance metrics, and identify areas for improvement [107].

4.4.4. Cloud Computing

Cloud computing offers numerous advantages to MSMEs in their endeavor to achieve sustainability through DX [98]. This technology unlocks many benefits that can significantly enhance their operations and contribute to building a more sustainable future [121].

Cloud computing delivers substantial cost savings for MSMEs, eliminating the need for expensive hardware and infrastructure investments [110]. The owners or top managers can opt for cloud services on a pay-as-you-go model, reducing upfront costs and enabling cost-effective scalability. This financial flexibility empowers MSMEs to allocate resources efficiently and invest in other areas that drive sustainability [121]. Furthermore, the energy efficiency offered by cloud services is a compelling factor [116]. Cloud providers leverage economies of scale and employ optimization techniques to maximize energy usage within their data centers.

As a result, MSMEs utilizing cloud services can enjoy more energy-efficient operations compared to traditional on-premises infrastructure, leading to reduced energy consumption and a smaller carbon footprint [81,133]. With cloud computing, MSMEs aiming to adapt to ever-changing business requirements can benefit from its flexibility and scalability [133]. This agility minimizes resource waste and enables efficient allocation of resources, promoting sustainability in resource management [91].

Another critical advantage of cloud computing is the improvement in collaboration and productivity [89]. Cloud-based collaboration tools and applications facilitate seamless teamwork, enabling employees to access shared files, collaborate in real time, and communicate effortlessly, regardless of location [105]. This streamlined collaboration enhances workflows, reduces the need for travel, and increases overall efficiency, ultimately contributing to sustainable business practices [128].

4.4.5. Social Media Platforms

Social media platforms have emerged as powerful tools with significant contributions to organizations, particularly in stakeholder management [81]. These platforms offer convenience, enabling users to access them at any time and from any location, primarily through smartphones. In project management, social media has increasingly been utilized for communication with public and private stakeholders [123].

Engaging public stakeholders is one of the most common applications of social media, as it facilitates communication and interaction with a broader audience. Strategic utilization of social media can influence project communities and shape stakeholder perceptions [110]. However, social media implementation for stakeholder management should go beyond basic practices and encompass more comprehensive approaches [136]. Challenges associated with social media usage, such as the risk of a perceived lack of responsiveness, must be addressed to ensure effective stakeholder engagement. Social media also serves as a valuable tool for analyzing the connectivity and relationships among project stakeholders [109].

The main contribution of social media in organizations lies in its ability to facilitate communication, engagement, and analysis of stakeholder networks [110]. By leveraging social media platforms effectively, organizations can enhance stakeholder management strategies, improve project outcomes, and better understand stakeholder perspectives throughout the project life cycle [87].

4.4.6. Internet

The Internet offers numerous benefits for MSMEs in their journey to achieve sustainability through DX [87].

The Internet enables MSMEs to connect with customers, suppliers, and stakeholders worldwide [124,137]. It provides a seamless communication and collaboration platform, breaking down geographical barriers and expanding market reach [110]. This connectivity allows businesses to access a more extensive customer base and build global networks, contributing to sustainable growth [116].

The Internet provides MSMEs with a cost-effective and efficient platform for digital marketing and e-commerce [88]. Businesses can promote their products and services through websites, social media platforms, and online marketplaces, reach a wider audience, and engage with customers [107]. Digital marketing strategies focused on sustainability can raise awareness about eco-friendly practices, encourage responsible consumption, and attract environmentally conscious consumers [89].

The Internet is a vast repository of information and knowledge. MSMEs can leverage online resources, educational platforms, and industry forums to gain insights, learn about sustainable practices, and stay updated on the latest trends and innovations. The access to information empowers businesses to make informed decisions, implement sustainable strategies, and adapt to changing market dynamics.

5. Discussion

To answer the research question of How can owners or senior managers of micro-, small-, and medium-sized enterprises initiate a sustainable digital transformation? A rigorous review of the literature of 59 academic articles allowed obtaining information from different perspectives to offer a comprehensive response. The first objective, to identify the critical capabilities within the organization for achieving sustainability through DX, was pursued in Section 4.2. The second objective, to determine the importance of stakeholders in achieving a successful DX, was developed in Section 4.3. The third objective, to establish the technologies that MSMEs can employ in DX to achieve sustainability, was identified in Section 4.4. In this section, we discuss in detail the relevance of our findings.

5.1. Organizational Culture as a Critical Aspect

This study aims to shed light on the critical organizational capabilities that contribute to achieving sustainability in the context of DX, drawing on the principles of digital capability theory. By examining the intricate changes in the business structure and recognizing the significance of organizational culture as a critical aspect of change, we can better understand the relevance of digital capabilities for MSMEs in their pursuit of sustainability.

MSMEs encounter numerous challenges when adopting ICTs, including limited financial resources [110], a lack of digital skills and knowledge [34], inadequate infrastructure [91], and resistance to change [98]. However, owners or top managers must recognize the potential benefits and opportunities of embracing a sustainability-focused DX strategy driven by their digital capabilities [79,87]. By developing and leveraging these capabilities, MSMEs can overcome challenges and unlock a range of advantages, such as enhanced productivity, improved market competitiveness, expanded customer reach, and overall business growth [71].

Financial constraints pose a significant challenge for MSMEs when investing in ICT infrastructure, software, and training [138]. Nevertheless, owners or top managers should acknowledge the importance of reallocating resources and investing in sustainable DX strategies driven by their digital capabilities. They can explore funding options [85], seek partnerships, or prioritize investments to overcome financial limitations and drive necessary changes in alignment with their digital capabilities [88,116].

The lack of digital skills and knowledge within MSMEs hampers their ability to leverage technology effectively [34]. Owners or top managers should recognize the significance of digital literacy and ensure access to training programs and resources to enhance their digital capabilities [16]. By fostering a learning culture and providing necessary support, MSMEs can sustainably equip their employees with the skills to embrace and utilize ICT tools for operational efficiency and growth driven by their digital capabilities [102,103].

Inadequate infrastructure, particularly in specific regions or remote areas, poses a challenge for MSMEs. Owners or top managers should acknowledge the need to invest in infrastructure improvements that support sustainable DX enabled by their digital capabilities [105,109]. Collaborating with stakeholders [59], including governments, technology providers, and industry associations, can help overcome infrastructure limitations and ensure reliable internet connectivity and essential infrastructure components are in place, aligning with their digital capabilities [122].

Resistance to change is a common hurdle that MSMEs encounter when adopting new technologies [122]. Owners or top managers must embrace a positive mindset and effectively communicate the benefits and opportunities that a sustainability-focused DX strategy brings, leveraging their digital capabilities [28,119]. They should implement change management strategies, involve employees in decision-making processes, establish clear communication channels to address concerns, and promote a culture of openness and innovation driven by their digital capabilities [29,95,139].

Fostering a new organizational culture that aligns with digital capabilities is vital for successfully implementing sustainable digitalization in MSMEs. By cultivating a culture that embraces sustainability principles and leverages DX goals [79], MSMEs can drive

innovation, enhance efficiency, and positively impact the environment [82]. This new culture empowers employees to engage in the transformation process actively and supports the development of sustainable practices. Additionally, an organizational culture that prioritizes sustainability fosters collaboration, transparency, and accountability, enabling MSMEs to build strong relationships with stakeholders [107] and gain support in line with their digital capabilities.

5.2. Promotion Innovation as a Main Role of Stakeholders

Secondly, the research focused on the importance of stakeholders in achieving sustainability through DX, acknowledging the significant role they play in the success of MSMEs. The study carefully examined stakeholder roles and their impact on the business to determine their importance.

Stakeholders are recognized as vital contributors when MSMEs adopt a sustainability-focused DX strategy [107]. Policymakers, industry practitioners, consumers, and non-governmental organizations are all key stakeholders emphasized in the research [119]. Collaborative engagement with stakeholders facilitates the development of effective strategies to achieve sustainable digitalization.

Stakeholders actively advocate for environmental improvement and individual well-being by highlighting the need to reduce carbon footprint, water consumption, and plastic usage [116]. Governments and international entities are implementing stricter legislative measures to eliminate plastic products and promote environmentally friendly alternatives. Successfully implementing these policies requires all stakeholders' cooperation and collaboration. However, MSMEs in developing countries may need help complying with stringent legislation.

The analysis reveals that stakeholders significantly contribute to innovation in MSMEs by offering diverse perspectives, knowledge, and experiences [108,109]. Involving stakeholders in the innovation process enables MSMEs to leverage their expertise and insights into market needs, resulting in more relevant and tailored solutions [96]. Collaboration with stakeholders facilitates effective idea generation and problem-solving, benefiting from the diverse interests and perspectives of the stakeholders involved [61,81,110,140]. MSMEs can gain valuable feedback, identify challenges, and overcome obstacles more efficiently. Engagement with private and public stakeholders fosters collective action, promotes collaboration and synergy, establishes shared governance structures that facilitate the generation of innovative ideas and joint projects, and exchanges knowledge and resources among stakeholders, ultimately leading to more effective innovation.

The main contribution of stakeholders in MSMEs lies in their ability to co-create value, provide diverse perspectives and knowledge, and foster collaboration and collective action [59,68,141]. Active involvement of stakeholders in the innovation process allows MSMEs to maximize their contributions, generate innovative ideas, develop relevant solutions, and enhance competitiveness in the market [142]. Stakeholders play an instrumental role in integrating internal and external activities at micro and macro levels, contributing to effective performance across various areas. Collaborative engagement with stakeholders drives innovation, generates valuable insights, and facilitates the development of effective strategies to address practical challenges in the pursuit of sustainability.

5.3. Big Data as a Leading Technology

Finally, dynamic capabilities theory plays a crucial role in the journey of MSMEs toward sustainability through DX. By integrating the principles of dynamic capabilities and the advantages of various technologies, MSMEs can unlock numerous benefits and drive their competitive edge in the market.

Dynamic capabilities refer to a firm's capacity to generate new knowledge by integrating and reconfiguring its resources. This adaptability and transformation enables firms to acquire new resources and expertise necessary for growth and development, fostering innovation and addressing challenges in a dynamic environment. In sustainable

digitalization, dynamic capabilities empower MSMEs to effectively respond to changing circumstances, transform their operations, and leverage their knowledge to drive innovation, make informed decisions, and align with market demands and opportunities [88].

Integrating dynamic capabilities with technologies such as the Internet and e-commerce offers significant advantages to MSMEs [71]. Leveraging the Internet and e-commerce platforms enables MSMEs to establish a global presence [109], breaking geographical barriers and expanding their market reach [143]. They can promote their products and services to a broader audience, engage with customers, and drive sustainable business practices [144]. Online storefronts reduce the need for physical retail spaces, contributing to environmentally friendly operations by reducing resource consumption and emissions associated with traditional brick-and-mortar retail [101]. Moreover, e-commerce platforms provide valuable data and analytics capabilities, empowering MSMEs to gain insights into customer behavior, tailor their strategies, optimize resource utilization, and enhance operational efficiency [124,145].

Cloud computing, another technology integrated with dynamic capabilities, brings substantial cost savings and scalability to MSMEs. MSMEs can eliminate the need for expensive hardware and infrastructure investments by opting for cloud services. This cost-effective scalability empowers them to enhance collaboration, productivity, and operational efficiency. Cloud services provide seamless access to shared files and real-time communication, regardless of location, reducing the need for travel and contributing to sustainable business practices [81,121,133].

Integrating artificial intelligence (AI) enables MSMEs to address waste management, track key performance indicators, and optimize procurement efficiency. AI technologies support waste forecasting, collection, and categorization, contributing to sustainable waste management practices [128]. Moreover, AI-driven analytics empower MSMEs to gain insights into emerging trends and preferences, enabling them to tailor their strategies and drive innovation [16,105]. MSMEs can foster sustainable business excellence by continuously solving problems and seizing opportunities through AI-enabled decision-making [93,130].

Incorporating big data into MSMEs enhances their operational efficiency and market performance. The analysis of customer data provides valuable insights into customer behavior, enabling MSMEs to align their strategies with market trends. The integrated business data from big data analytics enhances agility, empowers informed decision-making, and contributes to a more sustainable future [98,114,116]. By leveraging big data, MSMEs can improve their environmental performance, optimize resource utilization, and drive sustainable business growth [87,91,132,133].

6. Conclusions

This study provides valuable insights into how owners or senior managers of micro-, small-, and medium-sized enterprises (MSMEs) can initiate a sustainable digital transformation. Through a rigorous review of 59 academic articles, we have gathered information from various perspectives to offer a comprehensive response.

The first objective was to identify critical organizational capabilities that contribute to green digital transformation. The findings highlight that the change or modification of corporate culture is the most vital capacity for MSMEs to initiate the process of achieving sustainability. Cultivating a culture that embraces sustainability principles and aligns with digital transformation goals empowers MSMEs to drive innovation, improve efficiency, and positively impact the environment. These outcomes underscore the importance of focusing on cultural change as a crucial aspect of the digital transformation journey.

Furthermore, digital capabilities are essential for MSMEs embarking on their journey toward sustainability through digital transformation. By harnessing these capabilities and addressing associated challenges, MSMEs can effectively navigate the path to sustainability, unlock new opportunities, and contribute to their growth while positively impacting society and the environment. Digital capabilities provide MSMEs with the tools and resources

to leverage digital technologies, optimize processes, and drive sustainable practices. By utilizing these capabilities, MSMEs can enhance their operational efficiency, expand their market reach, and align their strategies with sustainability goals. By embracing digital transformation and using digital capabilities, MSMEs can position themselves for success in their pursuit of sustainability and actively contribute to a more sustainable future.

Integrating dynamic capabilities with transformative technologies, particularly big data, enables MSMEs to thrive in the digital era. Adopting big data empowers MSMEs to gain valuable insights, make informed decisions, and drive innovation, allowing them to identify emerging trends, improve operational efficiency, and contribute to a more sustainable future. Additionally, integrating dynamic capabilities with technologies offers a range of benefits, including enhanced market competitiveness, improved operational efficiency, expanded market reach, cost savings, waste reduction, data-driven insights, and innovation. Through adopting technologies like the Internet, e-commerce, cloud computing, AI, and big data analytics, MSMEs can establish a global presence, promote sustainable practices, optimize performance, and drive tailored strategies. This integration enables MSMEs to unlock competitive advantages, foster collaboration, and achieve long-term success in their sustainability-driven digital transformation journey.

Lastly, stakeholders play a crucial role in achieving a successful digital transformation. Our research emphasizes the significant contribution of stakeholders in promoting innovation within MSMEs. By involving stakeholders in the innovation process, MSMEs can tap into diverse perspectives, knowledge, and experiences, developing more relevant and tailored solutions. Collaboration with stakeholders fosters effective idea generation, problem-solving, and collective action, ultimately driving innovation and improving competitiveness in the market.

In conclusion, to initiate a sustainable digital transformation, MSMEs should prioritize modifying their organizational culture, adopting big data technologies, and actively engaging stakeholders to promote innovation. By embracing these key elements, MSMEs can position themselves for success in the digital era while driving sustainable growth and contributing to a more environmentally and socially conscious future.

This study acknowledges certain limitations that should be considered when interpreting the findings. Firstly, the systematic literature review (SLR) included 59 papers from the Web of Science Core Collection database. While this database covers a wide range of articles and journals in different areas, it is important to note that valuable research articles may be available in other databases that we did not include in this review. Future studies could incorporate additional databases like SCOPUS for a more comprehensive analysis. Although this study provides valuable insights into understanding the crucial role of stakeholders, the leading technologies, and critical capabilities that MSMEs owners and senior managers should consider to initiate the adoption of sustainability through digital transformation, it is essential to include studies related to internationalization processes adopted by multinational enterprises can be relevant in the context of MSMEs. Future studies can contribute to developing effective strategies and support mechanisms for MSMEs in their international endeavors, expanding the scope of research.

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