

The Role of Socioeconomic and Regulatory Factors in Industrial Digitalization: A Narrative Review

Rr. Hawik Ervina Indiworo

Universitas Persatuan Guru Republik Indonesia Semarang, Indonesia

Correspondent: hawikervina@upgris.ac.id

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ABSTRACT: This narrative review investigates the multi-dimensional nature of digital transformation in industrial sectors, focusing on regulatory policies, socioeconomic conditions, and technological innovations. The study aims to analyze the enabling and limiting factors that influence digitalization processes in both advanced and developing economies. Literature was gathered from Scopus, PubMed, and Google Scholar using keywords such as "Digital Transformation," "Industry 4.0," "SMEs," and "Blockchain," applying Boolean logic and strict inclusion-exclusion criteria. Findings indicate that proactive policies, such as state-sponsored infrastructure and digital education programs, significantly enhance industrial readiness for digital technologies. Countries like Germany and Japan demonstrate how comprehensive policy frameworks facilitate seamless adoption of innovations. In contrast, regions with inadequate infrastructure and lower digital literacy face major implementation barriers. Socioeconomic disparities further shape perceptions and outcomes of digital investments, with small enterprises often perceiving high risks and uncertain returns. Technological tools like IoT, big data, and blockchain prove instrumental in improving operational efficiency and decision-making, yet their effectiveness is context-dependent. Systemic issues such as misaligned regulations and lack of skilled labor continue to impede progress. The review underscores the urgency for integrative policies, skill development, and cross-sector collaboration to ensure equitable and effective digital transformation. It calls for future research into scalable models and policy innovations tailored to specific industrial contexts..

Keywords: Digital Transformation, Industrial Policy, Industry 4.0, SMES, Blockchain, Digital Economy, Technology Adoption.



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INTRODUCTION

In recent years, the accelerating pace of digitalization has profoundly reshaped industrial landscapes across both developed and developing economies. This transformation is characterized not only by the integration of advanced technologies such as big data, artificial intelligence, and the Internet of Things, but also by a broader reconfiguration of organizational processes, business

models, and socio-economic interactions. Contemporary scholarship acknowledges digital transformation as a strategic imperative for industries seeking to maintain competitiveness in volatile market conditions (Yukhno, 2021; Manesh et al., 2021). This evolution reflects a paradigmatic shift where digital tools are no longer supplementary, but foundational to organizational agility and market responsiveness. However, despite growing global enthusiasm for digital innovation, the journey towards comprehensive digital adoption remains uneven and fraught with structural and contextual challenges.

Recent literature highlights that the success of digital transformation depends heavily on a firm's capability to align technological integration with its strategic goals and operational realities (Techanamurthy et al., 2025). Particularly in emerging economies, industries confront persistent constraints, including financial limitations, skill shortages in information and communication technologies (ICT), and underdeveloped digital infrastructures. These constraints are more pronounced among small and medium-sized enterprises (SMEs), which often lack the resources and institutional support required to implement and sustain digital strategies. As Techanamurthy et al. (2025) assert, SMEs in Malaysia demonstrate low readiness levels despite national initiatives, revealing gaps between policy frameworks and ground-level execution.

From a macroeconomic standpoint, digitalization intersects with broader economic volatility, particularly in developing countries where technological investments are often vulnerable to shifts in currency valuation and commodity pricing. Mottaeva and Kopteva (2021) point out that such volatility can deter long-term investment in innovation, especially among enterprises serving affluent clients whose purchasing power is directly impacted. Moreover, the push towards environmentally sustainable practices through digital innovation introduces additional complexities. Liu et al. (2024) note that industries face difficulties in adopting circular economy principles due to conflicting priorities between economic growth and environmental sustainability. These insights suggest that digital transformation is not a neutral technological process but one that is deeply embedded in socio-economic, political, and ecological systems.

Data trends over the last five years substantiate the growing significance of digitalization in enhancing industrial performance. Сапотницька et al. (2023) report that big data analytics and digital platforms enable firms to optimize operations while offering tailored, consumer-centric services. Sharma et al. (2024) further emphasize that digital tools play a pivotal role in facilitating sustainable business models within the circular economy, especially in mitigating climate change challenges. Grytsenko and ЛІПІОБ (2024) argue that digital competitiveness increasingly determines a firm's position in global markets, reinforcing the strategic relevance of data-driven decision-making and intelligent systems.

Despite these benefits, digital laggards risk obsolescence as market dynamics shift rapidly toward digital ecosystems. Mustapha et al. (2023) contend that firms failing to adopt digital solutions may lose relevance due to their inability to meet evolving customer demands or respond to competitive pressures. Consequently, digital transformation has moved beyond an optional enhancement to become a critical component of organizational survival and relevance.

The challenges of digitalization, however, extend beyond technological adoption. Structural issues such as inequality in access and regional disparities amplify the difficulties faced by certain industries and communities. Kivarina and Yurina (2024) highlight a research gap regarding how SMEs, especially in agriculture and rural industries, adapt to digital technologies. The predominant focus on large enterprises in existing literature has led to an underrepresentation of the nuanced challenges and coping mechanisms of smaller firms. Furthermore, evaluations of digital strategies frequently lack longitudinal depth, making it difficult to assess their long-term impact on organizational performance and industry sustainability (Kő et al., 2021).

These gaps underscore the need for a more inclusive and context-sensitive approach to understanding digital transformation. Particularly, the uneven distribution of digital resources exacerbates socio-economic inequalities. In the agricultural sector, for instance, smallholder farmers without access to smart technologies struggle to match the productivity and market access of their technologically equipped counterparts (Mottaeva & Kopteva, 2021). Shinkevich et al. (2019) describe how digitalization in rural China stimulates industrial revitalization but simultaneously marginalizes those unable to bridge the digital divide.

At a regional level, disparities in digital infrastructure contribute to economic stratification. Rana et al. (2025) argue that investments in digital infrastructure, when appropriately contextualized, can substantially improve regional economic outcomes. However, when such investments are uneven, they tend to reinforce existing disparities between urban and rural areas, affluent and marginalized communities. Naqvi et al. (2019) affirm that the effectiveness of digital transformation initiatives depends on the alignment between technological capacity and contextual relevance. Hence, challenges in digital transformation are not only technical but inherently socio-political.

In addition to these practical challenges, several conceptual and methodological limitations are evident in current research. A significant proportion of studies emphasize macro-level transformations, with limited attention to micro-level adaptations, particularly among SMEs. As Kivarina and Yurina (2024) observe, the exclusion of SMEs from mainstream discourse restricts the applicability of findings and hampers policy relevance. There is also insufficient analytical focus on how organizational culture, managerial commitment, and human capital affect digital readiness and sustainability outcomes (Kő et al., 2021).

Given these considerations, this narrative review seeks to synthesize contemporary literature on industrial digitalization with a specific focus on the structural, organizational, and socio-technical factors influencing its adoption and impact. The primary objective is to illuminate critical dimensions of digital transformation, including digital readiness, organizational culture, resource availability, inequality in access, and environmental implications. By doing so, the review aims to construct a comprehensive analytical framework that can guide future empirical research and inform policy-making.

The scope of this review is both thematic and geographical. Thematically, it addresses the intersection of digitalization with organizational transformation, technological investment, and environmental sustainability. It critically explores how different organizational forms navigate

digital challenges and opportunities. Geographically, the review concentrates on emerging and developing economies where digital infrastructure and capabilities vary widely. Emphasis is placed on SMEs, rural communities, and agriculture-based industries, which are frequently underrepresented in digital transformation discourses. By incorporating diverse regional contexts, the review contributes to a more holistic understanding of global digitalization patterns.

In conceptual terms, this review is grounded in the Technology Innovation Theory, which posits that innovation serves as a key driver of industrial productivity and competitiveness (Сапогніцька et al., 2023). The review also draws upon the Digitalization Framework, which identifies core elements of digital transformation such as infrastructure, process integration, and data utilization (Manesh et al., 2021). These theoretical lenses facilitate a multi-dimensional analysis of digitalization, enabling the identification of interrelated barriers and enablers.

Through the synthesis of recent empirical studies and theoretical contributions, this review aspires to fill the existing gaps in the literature and propose directions for more equitable and effective digital transformation. The ultimate aim is to support the formulation of inclusive strategies that enhance digital readiness and foster sustainable industrial development in diverse socio-economic settings. By focusing on the often-overlooked experiences of SMEs and rural industries, this study seeks to democratize the discourse on digital transformation and advocate for policies that promote technological equity and resilience.

METHOD

This narrative review employs a structured and rigorous approach to gather, screen, and synthesize academic literature related to digitalization and digital transformation in industrial contexts. Given the multidisciplinary nature of the topic—intersecting technology, economics, management, and sustainability—a comprehensive methodology was essential to ensure relevance, reliability, and scholarly value. The review's methodological design emphasizes transparency and replicability, adhering to widely accepted academic standards for literature synthesis.

The literature search was conducted using three academic databases: Scopus, PubMed, and Google Scholar. Although PubMed focuses on health sciences, it contributed interdisciplinary insights relevant to industrial digitalization methodology. Google Scholar was used as a supplementary source to capture grey literature and additional citations not indexed in the other two databases.

The initial search phase involved the identification of core keywords reflecting the scope of the study. Primary terms included “Digital Transformation,” “Industry 4.0,” “Digital Economy,” “Small and Medium Enterprises (SMEs),” “Digital Technologies,” “Big Data,” “Blockchain,” “Agro-industrial Digitalization,” and “Sustainability.” These terms were selected based on their recurrence in recent academic publications and their conceptual alignment with the study’s thematic concerns. Boolean search operators were utilized to construct complex queries that could retrieve focused yet comprehensive results. For example, combinations such as “Digital

Transformation” AND “SMEs” or “Blockchain” AND “Digital Economy” allowed the search to target studies that investigate specific relationships between digitalization technologies and industrial sectors.

To broaden the scope and capture semantic variations, the operator OR was applied. Terms like “Digital Transformation” OR “Industry 4.0” ensured that studies using synonymous terminology were not excluded. Furthermore, the NOT operator was used to filter out irrelevant domains. For instance, queries like “Digital Transformation” AND “Agriculture” NOT “Mining” were employed to focus the review on agro-industrial sectors and avoid confounding data from unrelated industries.

Following the search, the results were subjected to a series of inclusion and exclusion criteria to determine their eligibility for full-text review. The inclusion criteria were defined to ensure the relevance, academic quality, and contemporary nature of the selected studies. Only peer-reviewed journal articles were considered, as these represent the highest standard of academic credibility. Articles had to explicitly address digital transformation within industrial contexts, with attention to both large-scale enterprises and SMEs. Particular consideration was given to research focusing on technologies such as big data, Internet of Things (IoT), and blockchain, as these are widely regarded as the cornerstones of Industry 4.0. Additionally, studies discussing the social and economic impacts of digitalization in specific sectors—notably agriculture, manufacturing, and healthcare—were prioritized.

Conversely, exclusion criteria were applied to remove studies that lacked methodological rigor or contextual relevance. Articles that were not peer-reviewed, such as opinion pieces, non-scholarly essays, or blog posts, were excluded from the analysis. Similarly, studies that did not engage with digital transformation in industrial or sectoral contexts were omitted. Literature that provided only generic overviews without empirical data or theoretical analysis was also removed. Moreover, publications focused on outdated or obsolete technologies that no longer align with current digital transformation trends were considered irrelevant for this review.

After applying these criteria, a preliminary list of 134 articles was compiled. Each article underwent a two-step screening process involving title and abstract review followed by full-text analysis. During the title and abstract review, relevance to the core themes was the primary determinant of selection. In the subsequent full-text evaluation, articles were assessed for methodological soundness, theoretical framing, and contribution to the understanding of digital transformation processes. The final selection consisted of 72 articles that met all inclusion criteria and offered robust insights across various dimensions of the review.

The types of studies included in the review spanned a range of methodological approaches, enriching the diversity of perspectives captured. Empirical studies using quantitative methods, such as surveys and statistical modeling, provided measurable evidence on the impact of digital technologies. Qualitative research, including case studies and interviews, offered in-depth exploration of organizational experiences and contextual challenges in adopting digital innovations. Mixed-methods research combining both qualitative and quantitative techniques was

particularly valuable in capturing the multifaceted nature of digital transformation. Additionally, several conceptual and theoretical papers were included to provide foundational frameworks and critical analysis, especially concerning digital readiness, organizational culture, and policy implications.

The review also incorporated comparative and sector-specific analyses that examined digital transformation across geographical regions and industries. Studies focusing on developing countries and rural economies were emphasized to ensure that the review addresses digital inequality and inclusion—a theme often overlooked in mainstream literature. Articles examining agro-industrial sectors received special attention due to the growing relevance of digitalization in enhancing agricultural productivity and sustainability.

To maintain analytical rigor, the selected studies were systematically categorized according to thematic relevance. Emerging themes included digital readiness, organizational culture and change management, access to technology, investment and resource mobilization, and sustainability. Each theme was further subdivided into sub-themes that reflected specific issues, such as training and upskilling, policy and governance frameworks, and infrastructure disparities. The thematic synthesis enabled a coherent analysis of the literature and ensured that the findings are organized in a logically progressive manner.

To evaluate the quality of included studies, the review adapted a qualitative assessment rubric that considered clarity of research questions, methodological transparency, theoretical grounding, and relevance to the central topic. This evaluative process was crucial for ensuring that only studies with substantive contributions were integrated into the narrative synthesis.

In conclusion, the methodology applied in this narrative review reflects a meticulous and systematic approach to literature selection and analysis. By leveraging advanced search strategies, well-defined inclusion and exclusion criteria, and a robust screening and synthesis process, the review ensures a comprehensive and balanced representation of scholarly discourse on digital transformation in industry. This methodological foundation supports the subsequent analysis and enhances the validity and reliability of the review's conclusions.

RESULT AND DISCUSSION

The findings of this narrative review reveal three major thematic categories that shape the discourse and implementation of digital transformation in industrial sectors: (1) the role of policy and regulatory frameworks; (2) the impact of socio-economic conditions; and (3) the emergence and effectiveness of technological innovations. Each of these themes contributes to the understanding of both enablers and barriers to digitalization across diverse geographic and sectoral contexts. Synthesizing studies from various regions and industries, the results illuminate how digital readiness, technological capacity, and institutional support interact to define the success or failure of digital transformation initiatives.

Governmental policies and regulatory frameworks play a critical role in shaping the trajectory of industrial digitalization. Studies consistently emphasize that proactive regulation—particularly those facilitating research and development (R&D), technology incubation, and digital infrastructure investment—correlate with higher levels of technological adoption, especially among small and medium enterprises (SMEs) (Yukhno, 2021). In economies where governments have enacted structured national digital strategies, such as Germany’s “Industrie 4.0” and Japan’s Society 5.0 initiatives, the industrial sector has shown greater preparedness and adaptability to digital disruption. These strategies include a combination of financial incentives, workforce digital training, and public-private innovation clusters, creating an ecosystem that promotes sustained technological integration (Kivarina & Yurina, 2024).

In contrast, countries without comprehensive digitalization policies or with fragmented governance structures tend to experience uneven adoption rates and limited industry-wide transformation. The lack of cohesive policy direction often results in SMEs struggling with regulatory uncertainty, inadequate access to funding for digital investments, and minimal guidance on best practices. This disparity highlights the global digital divide not merely in terms of infrastructure, but also in terms of institutional commitment and strategic foresight. Cross-national comparisons underscore the critical importance of aligning digital policy with industrial modernization goals to ensure inclusive and sustainable development.

Beyond regulatory concerns, socio-economic conditions significantly shape how digitalization unfolds within different regions and sectors. Empirical studies show that regions with well-developed educational systems and high ICT penetration are more likely to implement digital technologies effectively (Mottaeva & Kopteva, 2021). For instance, areas with a robust vocational education framework tend to produce a digitally competent workforce, easing the integration of new technologies into industrial processes. Conversely, regions lacking such infrastructure face severe obstacles in skill development and knowledge transfer, which are essential for sustaining digital transformation.

Social disparities also manifest in the perception and reception of digitalization. Firms with strong economic foundations are more inclined to view digitalization as a strategic opportunity rather than a risk. According to Kő et al. (2021), firms with sufficient financial and organizational capital are better positioned to invest in digital platforms, training, and process reengineering, thereby accelerating transformation outcomes. In contrast, SMEs—especially those in rural or economically disadvantaged regions—often perceive digital technologies as costly and complex, lacking the internal capabilities or external support to implement them effectively. This perception further entrenches digital inequality, reinforcing the advantage of already-dominant market players while marginalizing those with limited resources.

Cultural factors also mediate how digitalization is received and adapted. Organizational resistance to change, hierarchical management styles, and lack of innovation culture are frequently cited as internal barriers, particularly in traditional manufacturing or agro-industrial settings (Kivarina & Yurina, 2024). These socio-cultural dimensions often intersect with economic status, producing complex layers of digital readiness that vary not only between countries but also within subnational regions and industry types.

The literature further indicates that technological innovation is both a driver and a consequence of industrial digitalization. Among the most frequently cited innovations are the Internet of Things (IoT), big data analytics, and blockchain technologies. Each of these technologies addresses specific challenges in industrial management and supply chain optimization. IoT, for instance, enhances machine connectivity and enables real-time data collection, thereby facilitating predictive maintenance, process automation, and operational transparency (Сапотницька et al., 2023). The proliferation of IoT devices in smart factories is associated with significant improvements in output consistency, energy efficiency, and equipment utilization.

Big data analytics complements IoT by allowing organizations to analyze vast volumes of structured and unstructured data. Leventsov et al. (2023) demonstrate that big data-driven models can predict market demand, optimize production schedules, and personalize customer engagement, leading to increased operational agility. These capabilities are particularly valuable in volatile market environments where rapid decision-making confers a competitive advantage. However, the effective implementation of big data systems requires robust digital infrastructure and skilled data analysts—resources that are unevenly distributed, particularly in emerging economies.

Blockchain technology, though relatively nascent in industrial application, offers transformative potential, especially in enhancing transparency, traceability, and security within supply chains. Luo et al. (2023) argue that blockchain can significantly reduce transaction fraud, streamline verification processes, and build trust among stakeholders. In sectors like agriculture and food logistics, blockchain enables end-to-end monitoring from farm to consumer, thereby improving compliance with safety standards and enhancing consumer confidence. Nevertheless, the adoption of blockchain faces technological and institutional barriers, such as the need for interoperable platforms, legal frameworks, and widespread stakeholder buy-in.

Evidence also supports the argument that these digital technologies are not isolated solutions but function more effectively when integrated into comprehensive digital ecosystems. Mottaeva and Kopteva (2021) emphasize that IoT and big data jointly enhance industrial responsiveness and resilience by aligning operational data with strategic goals. Firms that effectively combine these technologies report significant reductions in downtime, inventory costs, and energy consumption, thus achieving both economic and environmental benefits.

Despite these advancements, the literature warns that technological diffusion remains uneven across regions and sectors. Industrial sectors with high capital intensity and regulatory incentives are more likely to adopt cutting-edge technologies, while low-margin sectors such as small-scale agriculture or artisanal manufacturing lag behind. This asymmetry exacerbates existing economic disparities and challenges efforts to promote inclusive growth.

Globally, the comparative analysis reveals divergent digital transformation trajectories. In Western Europe and East Asia, digital industrial policies are deeply embedded in broader economic strategies, with strong government-industry-academic collaboration. Germany's Industrie 4.0 and Japan's Society 5.0 exemplify national frameworks that align technological innovation with workforce development and sustainability goals. These models contrast sharply with those in

countries lacking coordinated policy initiatives, where digitalization tends to be fragmented and driven by isolated actors rather than systemic reform (Kivarina & Yurina, 2024).

The review also highlights that the environmental and social implications of digital transformation are increasingly important metrics of success. While early literature emphasized productivity and profitability, recent studies advocate for a more holistic assessment that includes sustainability indicators. For instance, digital technologies that reduce carbon footprints, enable circular production models, or improve labor conditions are viewed as vital components of responsible digital transformation (Rantala et al., 2019).

In sum, the results indicate that successful industrial digitalization hinges on a complex interplay of policy, socio-economic, and technological factors. Policies that provide direction, resources, and incentives are essential for guiding industries toward digital maturity. Socio-economic structures determine both the capacity and inclination of firms to engage in digital transformation. Meanwhile, technological innovations offer the tools and pathways through which digitalization can be realized, provided that institutional, infrastructural, and human capital requirements are met. This multifaceted perspective underscores the necessity of integrated approaches that consider the systemic nature of industrial digital transformation, particularly in contexts marked by economic and institutional diversity.

The process of industrial digitalization does not operate in isolation but is deeply embedded within broader systemic factors. The reviewed literature consistently emphasizes the interconnectedness between structural elements such as regulatory frameworks, institutional support, socio-economic disparities, and technological readiness. Yukhno (2021) highlights how insufficient policy support can obstruct the pace of digital transformation, particularly for small and medium enterprises (SMEs) that lack the resources to navigate complex digital ecosystems. Regulatory stagnation, as illustrated in several emerging economies, limits the capacity for innovation, reinforcing a cycle of technological dependency and low competitiveness. Similarly, Kő et al. (2021) argue that strategic misalignments between managerial goals and IT policies can hinder effective technology integration, further illustrating how systemic inertia can cascade across operational levels.

Beyond institutional barriers, socio-economic factors also play a pivotal role. Mottaeva and Kopteva (2021) provide empirical evidence that regions with inadequate educational infrastructure and limited digital literacy experience slower digital adoption. This discrepancy often results from historical underinvestment in public services and a lack of targeted policies aimed at capacity-building. The resulting digital divide is not only technological but also socio-cultural, where attitudes toward innovation differ according to resource availability and perceived risk. Kő et al. (2021) support this by showing that economically stronger firms perceive digitalization as a strategic investment, whereas less affluent enterprises view it as a costly risk, often exacerbated by a lack of skilled labor and minimal government incentives.

The international comparison of regulatory responses further illustrates these systemic disparities. In countries like Germany and Japan, a cohesive digital policy strategy has resulted in enhanced industrial preparedness. These countries have not only established robust digital infrastructures but have also synchronized educational reforms with industrial needs (Kivarina & Yurina, 2024). In contrast, countries with fragmented policy frameworks often exhibit inconsistent levels of

digital readiness, with certain sectors advancing while others stagnate. This uneven development suggests that holistic and inclusive policy models are essential for fostering balanced digital growth across different regions and sectors.

From a policy perspective, the implications are significant. Integrated policy frameworks that prioritize infrastructure development and digital literacy are vital. Yukhno (2021) and Manesh et al. (2021) emphasize that policies should extend beyond technical innovation to encompass human capital development. The success stories of Germany and Japan demonstrate how targeted investments in education and vocational training can cultivate a digitally capable workforce. Additionally, Meng et al. (2013) illustrate how public-private partnerships in these nations have facilitated innovation through research and development (R&D) subsidies, demonstrating the catalytic role of collaborative governance in overcoming digital barriers.

However, the case of less developed countries serves as a cautionary tale. Mottaeva and Kopteva (2021) show that even where digital tools are available, the absence of coordinated support systems—such as accessible funding, training programs, and regulatory clarity—limits the effectiveness of digitalization efforts. This reinforces the need for multi-level governance models that can adapt to local contexts while maintaining coherence with national digital agendas.

In addressing the persistent obstacles to digitalization, the literature proposes a range of strategic interventions. Central among these is the need for increased investment in digital infrastructure, particularly in underserved areas. Manesh et al. (2021) and Techanamurthy et al. (2025) argue for the prioritization of broadband expansion, mobile connectivity, and affordable access to digital tools. These are not merely technical enhancements but socio-economic enablers that can bridge regional disparities and empower marginalized sectors to participate in the digital economy.

Another prominent strategy involves enhancing digital competencies through targeted training and reskilling programs. Given the fast pace of technological change, continuous learning is essential. Liu et al. (2024) recommend government-funded training initiatives that align with industry needs, thereby creating a pipeline of skilled professionals ready to support digital transformation.

Technological innovations themselves offer solutions to many of the barriers identified. Big data analytics, for instance, enables firms to adapt their operations in real-time, improving responsiveness to market fluctuations (Sapotnińska et al., 2023). Blockchain technology, as discussed by Luo et al. (2023) and Bruel and Godina (2023), presents opportunities to enhance transparency and efficiency within supply chains, a particularly pressing issue in globalized markets. Nevertheless, the literature cautions against viewing technology as a panacea. Babkin et al. (2023) stress that successful implementation depends heavily on organizational readiness and ecosystem alignment, which include regulatory harmonization, cross-sector collaboration, and stakeholder engagement.

Despite the promise of these innovations, their adoption remains uneven. Liu et al. (2024) identify significant challenges in aligning technological capabilities with strategic goals, especially in SMEs where digital maturity is often low. These firms require tailored support mechanisms, such as simplified digital tools, advisory services, and financial incentives, to mitigate the risks associated with digital transition.

The review also brings to light important limitations in the existing body of literature. Many studies focus predominantly on high-income countries, limiting the generalizability of findings to low- and middle-income contexts. There is also a tendency to prioritize technological solutions over institutional or behavioral dimensions, which are equally critical for sustainable digitalization. Additionally, methodological diversity remains limited, with a dominance of qualitative case studies and conceptual analyses. Future research should aim to incorporate mixed-method approaches and longitudinal designs to better capture the dynamic interplay between systemic factors and digital innovation over time.

Furthermore, the interplay between digitalization and sustainability is an underexplored area. While some studies hint at the potential of digital tools to support environmental goals, there is a lack of comprehensive analysis on how digital transformation can align with broader sustainability agendas. This presents a valuable avenue for future inquiry, particularly in sectors like agriculture and energy where digital technologies could optimize resource use and reduce environmental footprints.

In sum, the discussion underscores that digitalization is not merely a technical challenge but a systemic one, shaped by interlocking social, economic, and political dynamics. The literature calls for an integrated approach that combines policy reform, capacity-building, technological innovation, and context-specific strategies. Achieving meaningful digital transformation requires not only the deployment of new tools but also the restructuring of existing systems to support their effective and equitable use.

CONCLUSION

This narrative review has revealed that digital transformation in industrial sectors is not merely a technological shift but a complex interplay of systemic, regulatory, economic, and technological factors. Proactive policies, such as those seen in Germany and Japan, clearly demonstrate the impact of strong governmental support on digital adoption. Conversely, developing nations continue to struggle due to weak regulatory frameworks, limited infrastructure, and insufficient investment in digital education and skills development. Social and economic conditions significantly influence the pace and success of industrial digitalization, particularly in regions with poor access to digital tools and human capital.

Technological innovations such as IoT, big data, and blockchain have emerged as critical enablers, offering new efficiencies and transparency, particularly in operational management and supply chain integrity. However, the effectiveness of these tools heavily depends on systemic readiness, regulatory alignment, and cross-sector collaboration.

Urgent interventions are needed to close existing gaps, particularly in digital policy, training programs, and industry-government-academia synergies. Future research should explore longitudinal impacts of policy reforms, scalability of digital tools in SMEs, and adaptive strategies for tech adoption in diverse cultural and economic contexts.

Ultimately, fostering an inclusive digital economy requires a holistic, integrative strategy—one that combines technological deployment with socio-institutional reforms, capacity building, and sustained public investment.

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