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LEVERAGING DIGITAL TRANSFORMATION TO ENHANCE SUPPLY CHAIN RESILIENCE IN EMERGING ECONOMIES

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ABSTRACT

This paper explores the connection between digital transformation and supply chain resilience (SCR) in emerging markets, which includes the enabling technologies, strategic mechanisms, and contextual barriers that impact the connection. The study is based on a systematic review of 25 peer-reviewed studies they had available, which were published between 2021 and 2026 and include evidence from various economic contexts, such as Southeast Asia, Latin America, Sub-Saharan Africa, and Eastern Europe. The results validate the impact that digital transformation, comprising of artificial intelligence (AI), blockchain, the Internet of Things (IoT), advanced data analytics, can have on supply chain resilience, particularly in terms of visibility, flexibility and adaptability. The adoption of such technologies in emerging markets, however, is hindered by financial access barriers, infrastructural gaps, lack of digital literacy and the lack of institutional backing. It seems that LSEs get most value from a holistic approach to digital integration, whereas SMEs can make a significant difference in terms of resilience with digital interventions that are low cost and targeted. The paper proposes a conceptual framework that connects the digital transformation capabilities and the digital transformation dimensions of the supply chain resilience, and proposes three research propositions that can be tested in the empirical study. Governments, development agencies and enterprise managers in resource constrained supply chain environments are provided with policy recommendations.

KEYWORDS: Digital Transformation, Supply Chain Resilience, Emerging Markets, Industry 4.0, Smes, Blockchain, Artificial Intelligence.

1. INTRODUCTION

In recent years the world-supplied by supply chains has been experiencing unparalleled disruptions due to the COVID-19 pandemic, geopolitical tensions, climate-related shocks and changing consumer demand patterns. These disruptions have revealed significant gaps in global and regional supply chains, driving a pressing need for businesses to build more resilient, flexible, and technology-driven business processes. In this context, digital transformation has become one of the most influential strategic levers that can be easily accessed by both supply chain managers and policymakers [1, 2].

Digital transformation is the adoption of digital technologies like AI, blockchain, IoT, cloud computing, and sophisticated analytics into the main value chains and processes of business. These technologies provide real-time visibility, predictive intelligence, automated decision-making, and better coordination of supply chain activities between suppliers, manufacturers, logistics providers and end customers, specifically. This leaves the supply chain more resilient to anticipate, absorb and recover from disruption – the key pillars of resilience.

SCR is defined in the literature as the ability of a supply chain to withstand, absorb, react to and recover from supply chain disruptions without compromising the core capabilities and assets of the supply chain [25]. Resilience can be thought of both as a reactive attribute – the capacity to bounce back from disruption – and as a proactive attribute – being able to detect risk, create redundancy and develop adaptive flexibility. Digital technologies also reinforce these two aspects of resilience: they give businesses a clearer view into disruptions that can happen sooner and allow them to act more quickly, as well as be more flexible in their supply chains [6, 7].

The emerging markets are a more complicated setting to grasp these dynamics. Some countries are experiencing unique supply chain issues, including credit, technology, infrastructure, and regulatory instability, and exposure to external economic shocks, like Brazil, India, Nigeria, Vietnam, Thailand, Pakistan, and Eastern Europe and Central Asia [18, 19]. Meanwhile, many of these markets are fast digitalizing, as mobile penetration, fintech growth and the expansion of ecommerce platforms all contribute to this [12, 17]. This convergence represents a fascinating opportunity and a major challenge for digital transformation to be a key enabler of supply chain resilience in emerging markets, but it is not without its structural constraints

which are not necessarily prevalent in research undertaken in developed economies [5, 7].

Some of the most prevalent challenges to digital transformation and SCR in emerging markets are the following:

- Financial resource constraints: The initial investment in digital technologies is often high, making technology adoption more difficult, particularly for SMEs in resource constrained environments where uncertainty over ROI is high and access to digital finance is low [18, 19].
- Limited returns from technology investment and from the effectiveness of supply chain tools that rely on seamless connectivity and exchange of logistics data, due to technological infrastructure gaps: Unreliable connectivity, limited logistics data systems, and inadequate digital infrastructure [7, 8].
- Lack of human capital and skills: Human capital and digital and supply chain skills shortages play a dampening role on the resilience benefits of digitalization [9, 22].
- Digital supply chain environments suffer from systemic friction in the form of institutional and regulatory barriers, including weak legislation, lack of public-private coordination and inadequate data governance structures [21, 4].
- Resistance towards the digital adoption: Companies that have analogue processes might not embrace new technologies because they are afraid of incompatibility, disruption of stable processes and uncertainty about the competitive results [6, 23].

Limited access to high quality supply chain data, and the lack of technical standards to facilitate "system-to-system" communications reduce the effectiveness of data-driven approaches to resilience [11, 12].

Even if digital transformation is a priority for individual enterprises, the lack of alignment with suppliers may lead to coordination problems and loss of trust across the network, thereby compromising the network's overall capabilities [6, 15].

Lack of government support: Even though digitalization of the supply chain is of major importance, many emerging market governments lack policy frameworks, investment incentives, or regulatory guidance to support digitalization at the enterprise level [20, 24].

Although both digital transformation and supply chain resilience are already receiving significant

focus in the academic research literature, academic studies examining their relationship in emerging market settings are limited. Most of the existing research is either drawn from developed economies or from certain sectors of the economy, with little insights to the impact of digital capabilities on resilience in the context of institutional failure, infrastructure gaps and resource limitations [21, 4]. Limited systematic examination of moderating effects of firm size, sector and geographic context have also been conducted [15, 10].

In this paper, the authors seek to fill these gaps by conducting a systematic review of the literature to integrate the evidence on the mechanisms, technologies and context that affect the digital transformation-SCR relationship in emerging markets. The paper is organized as follows: Section 2 provides a description of methodology, Section 3 presents and discusses the results, and Section 4 provides conclusions, policy recommendations, and directions for future research.

2. METHODOLOGY

To synthesise the evidence from a wide variety of sources, transparently and reproducibly, we chose a methodology which is a systematic literature review (SLR). The SLR method is particularly suitable for interdisciplinary research areas, where knowledge and evidence is spread across different journals and disciplines, as it will be the case in the digital transformation and supply chain resilience field in emerging markets [24, 8].

2.1. Research Questions (RQ):

RQ1: How is digital transformation related to supply chain resilience in emerging markets and how does the relationship move in either direction?

RQ2: What are the most important digital technologies and organizational strengths for improving supply chain resilience in emerging market situations?

The principal barriers and enabling conditions for the digital transformation-SCR relationship in resource-constrained economies will be discussed.

2.2. Research Propositions (RP):

1. RP1 (technology-resilience link): In emerging markets, digital transformation positively and significantly impacts supply chain resilience, which is influenced by firm size and sector.
2. RP2 (network technologies): Technologies with high network externalities, such as blockchain and IoT platforms (in particular)

bring higher resilience benefits in emerging markets than standalone digital tools.

In explanatory importance, institutional and infrastructural barriers are the most important constraints on digital-resilience pathways in emerging economies, more so than financial barriers at the firm level, RP3 (institutional barriers).

The literature search focused on the Scopus, Web of Science and Google Scholar databases and proceeded by using the following combinations of keywords: digital transformation AND supply chain resilience, emerging markets AND supply chain digitalization, SME AND digital technology AND supply chain. Studies focusing on the period 2021-2026 were prioritized. Twenty-five studies were included if they met the following criteria:

1. The presence of digital transformation as an independent variable (a) or a mediating and/or a moderating variable (b).
2. Make supply chain resilience or performance as an outcome variable
3. A comparative developing economy/emerging market focus. Studies that were not specifically focused on developed markets or that were not clearly defined by their constructs to align with the core constructs were omitted.

The studies chosen represent a broad spectrum of geographic and sectoral case studies from manufacturing, healthcare, agriculture, automotive, construction and various SME-related studies in Asia, Africa, Latin America and Eastern Europe. The synthesis was done thematically, and the results were grouped under the themes of results which are discussed in Section 3.

The geographic distribution of the studies reviewed are presented in figure 1, which demonstrates the diversity of emerging market contexts covered.

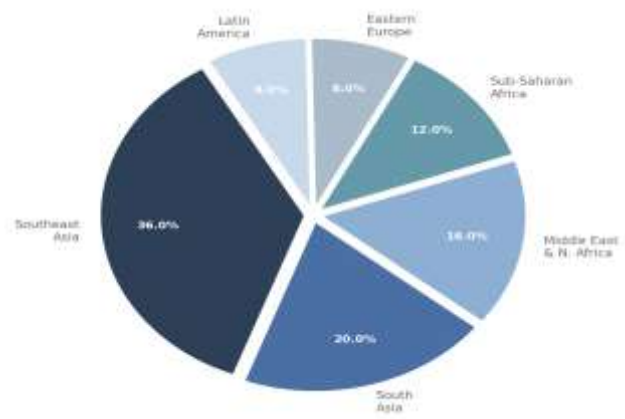


Figure 1: Geographic distribution of reviewed studies by emerging market region (n = 25).

The majority of reviewed studies are concentrated in Southeast Asia (36%), reflecting the region's rapid digital supply chain development. South Asian studies account for 20% of the sample, followed by Middle East and North Africa contexts (16%), Sub-Saharan Africa (12%), and Eastern Europe and Latin America (8% each). This distribution underscores both the global relevance of the research question and the relative underrepresentation of African and Latin American contexts, a gap that future empirical research should seek to address.

3. RESULTS AND DISCUSSION

The findings confirm that barriers broadly documented in global literature on supply chain digitalization are consistently present in emerging market contexts, occurring with a frequency and intensity that reflects the structural conditions characteristic of developing economies. The subsections below address each research question in turn.

Result 1 – RQ1: What is the nature and direction of the relationship between digital transformation and supply chain resilience in emerging markets?

The preponderance of evidence confirms a positive and statistically meaningful relationship between digital transformation and supply chain resilience. It has been documented that digital transformation directly enhances SCR by improving information flow, adaptive capacity, and inter-organizational coordination [1]. Furthermore, this relationship is mediated by supply chain agility digital tools enable faster reconfiguration of supply networks in response to disruption, amplifying resilience gains beyond what direct technology effects alone would predict [2]. A mixed-methods investigation of manufacturing enterprises confirms that digital transformation positively influences both reactive and proactive dimensions of resilience, indicating that its effects extend across the full resilience lifecycle from preparation and absorption to recovery and adaptation [3].

In emerging market contexts, it has been established that when digital transformation directly addresses specific challenges navigating infrastructure gaps, informal supplier networks, and regulatory uncertainty, it generates not only operational resilience but also measurable gains in social and economic performance [4]. Complementary evidence demonstrates that digital technologies function simultaneously as enablers of sustainability and resilience in emerging economies, suggesting a positive reinforcing dynamic that can accelerate both ecological and operational

transformation [5].

However, the relationship is not uniformly positive across all deployment contexts. An important qualification has been raised: the positive effect of digital transformation on SCR can be attenuated when digital integration substitutes rather than complements trust-based supplier relationships [6]. In emerging markets, where relational contracts and informal networks often provide foundational supply chain coordination, digital systems that displace these social structures may reduce resilience in the near term. It has also been highlighted that the benefits of digital transformation for SCR are conditional on baseline digital infrastructure enterprises in markets with low internet penetration or unreliable power supply may experience substantially reduced returns on digital investment relative to counterparts in more developed environments [7].

Result 2 – RQ2: Which digital technologies most significantly enhance supply chain resilience in emerging markets?

Figure 2 presents the absolute frequency with which each of the eight identified barriers to digital transformation and SCR was cited across the 25 reviewed studies. Financial resource limitations emerged as the single most prevalent constraint, cited in 18 of the 25 studies (72%).

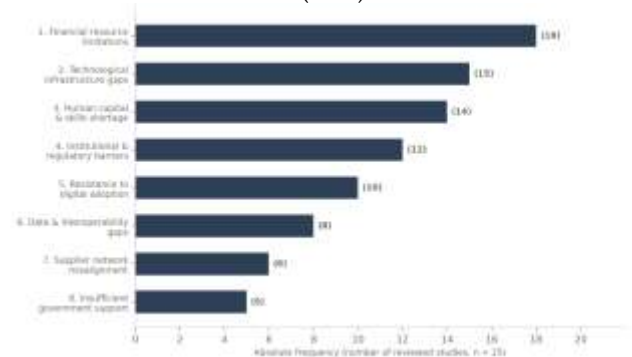


Figure 2 Absolute frequency of barriers to digital transformation and SCR identified across reviewed studies (n = 25).

Legend:

1. Financial resource limitations (most significant barrier)
2. Technological infrastructure gaps
3. Human capital & skills shortage
4. Institutional & regulatory barriers
5. Resistance to digital adoption
6. Data & interoperability gaps
7. Supplier network misalignment
8. Insufficient government support (least significant barrier)

The most significant barrier financial resource

limitations was identified in 18 studies (72%), reflecting the well-documented difficulty that SMEs and micro-enterprises face in accessing capital needed for digital investment [18, 20]. Technological infrastructure gaps ranked second, cited in 15 studies (60%), confirming that baseline connectivity, power reliability, and logistics data systems remain major constraints across emerging markets [7]. Human capital shortages encompassing both digital skills gaps and organizational readiness deficits appeared in 14 studies (56%) [9, 22]. Institutional and regulatory barriers were identified in 12 studies (48%), underscoring the systemic nature of governance constraints [21]. Resistance to digital adoption, data and interoperability gaps, supplier network misalignment, and insufficient government support round out the barrier profile, each cited with decreasing frequency but remaining consistently present across diverse geographic and sectoral contexts.

Artificial intelligence (AI) and machine learning emerge as the most potent enterprise-level enablers of resilience, particularly for demand forecasting, disruption sensing, and real-time inventory optimization [8, 9]. It has been empirically demonstrated that AI-driven supply chain transformation positively influences supply chain performance across multiple dimensions resilience, responsiveness, and cost efficiency [10]. Blockchain technology addresses one of the most common sources of fragility in developing economies: the inability to verify product provenance, supplier compliance, and payment settlement in real time [11]. Blockchain adoption has been documented as a significant driver of resilience during COVID-19 disruptions in emerging economy enterprises, though adoption remained low due to cost and technical complexity barriers [12].

The Internet of Things (IoT) is highlighted as a critical enabler of real-time supply chain visibility – arguably the most foundational precondition for resilience [8]. It has been demonstrated that IoT-enabled digital transformation significantly enhances agricultural supply chain resilience and productivity in developing country contexts, offering a compelling case for sector-specific digital investment strategies [13]. For SMEs, cloud-based solutions are particularly valuable because they reduce upfront capital requirements, enabling access to sophisticated analytics without expensive on-premise infrastructure [14]. It has further been established that organizational readiness for digital transformation shapes resilience outcomes as decisively as technology adoption itself, reinforcing

that human and cultural dimensions of transformation are at least as important as technological investment [16].

Result 3 – RQ3: What are the principal barriers and how do they vary by enterprise size?

Figure 3 presents a comparative analysis of barrier intensities across three enterprise size categories: micro/small enterprises, medium enterprises, and large enterprises based on synthesized evidence from the reviewed studies. The analysis reveals both a common barrier profile across all size categories and meaningful size-specific patterns that have important implications for differentiated policy responses.

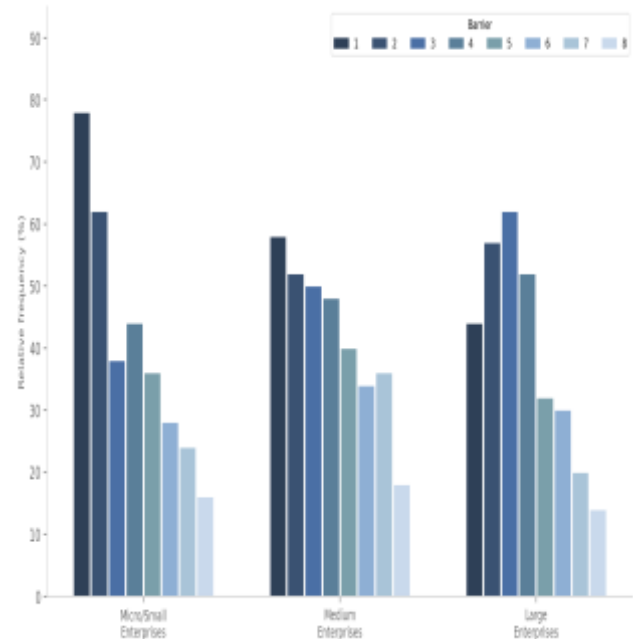


Figure 3 Barriers to digital transformation and SCR by enterprise size category (relative frequency, %).

Legend:

1. Financial resource limitations
2. Technological infrastructure gaps
3. Human capital & skills shortage
4. Institutional & regulatory barriers
5. Resistance to digital adoption
6. Data & interoperability gaps
7. Supplier network misalignment
8. Insufficient government support

Key findings from the size-differentiated analysis:

- Financial resource limitations are the dominant barrier for micro and small enterprises (78%), reflecting their acute capital constraints and limited access to digital finance instruments. The intensity of this barrier

decreases with enterprise size, though it remains significant even for large enterprises (44%) [18, 20].

- Human capital and skills shortages become proportionally more significant as enterprise size increases, peaking among large enterprises (62%). This pattern suggests that as the scale of digital operations grows, so do the demands for specialized technical expertise, creating recruitment and retention challenges that are distinct from the financial pressures facing smaller firms [9].
- Resistance to digital adoption and data/interoperability gaps are present at relatively consistent levels across all size categories, suggesting that these represent systemic barriers rooted in the broader digital ecosystem rather than firm-specific characteristics [6, 23].
- Supplier network misalignment peaks among medium-sized enterprises (36%), potentially reflecting the complex coordination challenges these firms face as they transition between informal SME-style supply chain relationships and the more formalized digital integration expected by large enterprise partners [15].
- Insufficient government support is the least significant barrier across all size categories, indicating that enterprises perceive internal operational and human capital constraints as more pressing than external policy limitations, though this does not diminish the structural importance of public sector support [20, 24].

The pattern is consistent with findings from comparable studies on digital transformation barriers. Small and medium-sized enterprises across the reviewed contexts most frequently encountered the same top-three barriers: financial limitations, infrastructure gaps, and human capital shortfalls. Large enterprises more often reported human capital and institutional barriers as their primary constraints, while organizational and supplier-related challenges were spread more evenly across size categories [4, 17].

4. RESULT 4: CONTEXTUAL MODERATORS – SECTOR AND GEOGRAPHIC CONTEXT

Sectoral context significantly shapes both the digital technologies most relevant to SCR and the barriers encountered in their deployment. Agricultural supply chains benefit most from IoT and traceability solutions [13]. Manufacturing supply chains derive the greatest resilience value from AI-driven demand sensing and digital twin technologies

[10]. Healthcare supply chains require end-to-end data integration and regulatory compliance capabilities, operating within institutional environments that impose additional governance demands on digital transformation programs [21].

Geographic and cultural context further moderate the digital transformation–SCR relationship in ways that remain incompletely understood. Important differences have been documented between SMEs and large enterprises across Southeast Asian markets in the drivers of digital supply chain transformation, highlighting that factors such as consumer digitalization, regulatory change, and competitive pressure operate differently across national contexts [12]. The findings from Thailand's local digital economy, broader emerging market SME studies, and healthcare supply chain research in developing countries collectively reinforce the importance of avoiding one-size-fits-all prescriptions [16, 17, 21]. Table 1 provides a structured summary of key findings and policy implications organized by research question.

Table 1: Summary of key findings by research question.

RQ1: DT-SCR relationship	Positive but contextually conditional; strongest when digital tools complement rather than replace relational governance; conditional on baseline infrastructure availability [1, 3, 6]	Sequence infrastructure-building before advanced technology deployment; preserve relational supply chain norms during digital transition
RQ2: Key enabling technologies	AI, blockchain, IoT, and cloud analytics are the primary enablers; cloud tools most accessible for SMEs; sector-specific technology hierarchies apply [8, 10, 13]	Invest in cloud and mobile-first platforms for SMEs; develop sector-specific technology adoption roadmaps; build shared digital infrastructure to reduce cost
RQ3: Barriers & enablers	Financial, institutional, and human capital barriers are mutually reinforcing; firm size and sector moderate barrier intensity; institutional barriers most systemic [18, 21, 9]	Coordinated policy responses required; digital finance instruments for SMEs; workforce development programs; strengthen public-private institutional frameworks

Table 2: Principal barriers to digital transformation and SCR in emerging markets.

Financial & Resource Barriers	High upfront technology costs; limited digital finance access; vicious cycle of disruption and underinvestment	[18], [12], [19], [20]
Institutional & Regulatory Barriers	Regulatory uncertainty; weak digital infrastructure; absent interoperability standards; poor public-private coordination	[21], [19], [4]
Human Capital Barriers	Shortage of digitally skilled workers; limited organizational readiness; absence of systematic digital training	[22], [14], [9]
Technological & Systemic Barriers	Poor digital infrastructure; technology incompatibility; resistance to new systems; fragmented supplier networks	[7], [6], [23]

5. CONCLUSIONS

In this paper, this relationship is critically reviewed and analyzed by systematically summarizing and integrating evidence from 25 peer-reviewed articles and summarizing the major mechanisms, technologies, barriers, and contextual moderators. The analysis validates the ability of the digital transformation to be a very strong and widely applicable enabler of supply chain resilience, in many respects by using the full spectrum of features: visibility, predictive, adaptive coordination, and trust-mediated supplier engagement [1, 2, 3].

Artificial Intelligence, Blockchain, IoT and cloud-based Analytics are the most important technologies for SCR in emerging markets [8]. With their scalable and cost-efficient use, cloud tools represent the most widely available route to resilience improvements, whereas blockchain and IoT represent high opportunity areas for specific sectors, such as agrifood, healthcare and manufacturing, but have not yet been adopted due to the need for structured policy support. Figure 2 shows that the most prevalent systemic barrier (mentioned in 72% of the

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reviewed studies) is financial resource limitation, followed by technological infrastructure gaps (60%) and human capital shortages (56%).

Figure 3 also indicates that there is a significant variation in the barrier profile across enterprise size. Financial limitations are more pronounced in micro and small businesses than in large businesses, and human capital is more critical in the latter. Medium sized companies face the most complex barrier environment, with financial, human capital and supplier coordination barriers. The results call for two types of policy mechanisms: the first one being tailored to the needs of small and medium enterprises – with SME-specific policies prioritizing affordable, interoperable digital tools and shared infrastructure; and the second tailored to the needs of larger enterprises – with SME policies focusing on talent development and coordination of the policy ecosystem [4, 17].

The analysis also verifies that, whilst fewer in absolute terms than financial constraints, institutional and regulatory constraints exist and are more structurally entrenched and difficult to tackle at the level of the individual firm. They must be addressed through synchronized policy measures related to digital finance instruments, public-private institutional arrangements and programs of training and upskilling the workforce for new market supply chain conditions [19,21].

There are several limitations to this study. It is a systematic literature review and thus afflicted with publication bias and geographic skewness of available literature, such as the Central Asian and Sub Saharan African contexts. The research propositions are to be tested through primary empirical studies (questionnaire surveys, chi-square and regression analysis) in emerging market contexts in the future. Long-term follow-up research on the development of digital-resilience relationships over time and cross-national comparative research would significantly contribute to research in this area.

Even with these constraints, this paper makes a significant contribution to the study of the impact of digital transformation on supply chain resilience in emerging markets. The concepts here and their implications are a starting point for learning and thinking as well as for strategy development in this significant and dynamic field.

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