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Integrating corporate social responsibility and digital transformation: evidence on supply chain resilience and sustainability

Abstract

Research background and purpose: This study examines the role of digital transformation and corporate social responsibility (CSR) in enhancing supply chain resilience. It focuses on how these two factors interact to strengthen firms' ability to cope with disruptions and maintain operational continuity.
Design / methodology / approach: Data was collected through a structured questionnaire administered to 120 professionals working in manufacturing, logistics, and retail supply chains. A quantitative approach was adopted to examine the proposed relationships between CSR, digital transformation, and supply chain resilience. The data was analyzed using Partial Least Squares approach (PLS-SEM) to assess both measurement and structural models, and bootstrapping techniques were applied to test the significance of the hypothesized relationships.
Findings: The findings provide valuable insights into the role of digital transformation and CSR in enhancing supply chain resilience. They highlight that both digital capabilities and responsible practices significantly contribute to resilience outcomes. Moreover, the results show that CSR strengthens the impact of digital transformation, offering practical guidance for managers seeking to build more resilient and sustainable supply chains.
Value added and limitations: This study provides valuable insights for managers by highlighting how the alignment between digital transformation and CSR initiatives can enhance supply chain resilience and sustainability. However, several limitations should be acknowledged. First, the focus on a limited sample and specific sectors may restrict the generalizability of the findings. Second, the cross-sectional design prevents establishing causal relationships and capturing the evolution of the CSR–DT–SCR dynamics over time. Finally, the use of self-reported data may introduce potential bias. Future research could address these limitations by adopting longitudinal designs, expanding the sample across different contexts, and incorporating objective and multi-source data.

Keywords: *corporate social responsibility, digital transformation, supply chain resilience, dynamic capabilities, institutional theory*

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1. Introduction

Global supply chains are currently navigating a historical period characterized by unprecedented levels of turbulence, uncertainty, and systemic fragility. Over the past decade, and particularly following the COVID-19 pandemic, firms have witnessed the intensification of multiple, overlapping disruptions arising from pandemics, geopolitical tensions, climate-related hazards, energy crises, cyber-attacks, and sudden market fluctuations. These disruptions are no longer episodic or geographically constrained but have become continuous, multidimensional phenomena with cascading effects across global production and distribution networks (Shekarian et al., 2022; Queiroz et al., 2023). The simultaneous nature of these shocks such as pandemic-related shutdowns coinciding with port congestion, raw material shortages, and extreme weather events has exposed structural vulnerabilities embedded within supply chains optimized primarily for cost efficiency and global scale. This new environment has fundamentally shifted managerial priorities. Whereas supply chains once focused on lean operations, just-in-time production, and global outsourcing, contemporary conditions require a strategic pivot toward resilience, adaptability, and sustainable competitiveness. Supply Chain Resilience (SCR) has therefore emerged as a critical organizational capability enabling firms to anticipate, withstand, recover from, and even transform in response to disruptions. SCR is not limited to the ability to "bounce back"; rather, it embodies the capacity to bounce forward, learning from disruptions and embedding new, adaptive practices that strengthen long-term performance. The Dynamic Capabilities Theory (DCT) provides a powerful lens to conceptualize resilience as a dynamic, higher-order capability comprising three core processes: sensing environmental changes, seizing opportunities or threats, and reconfiguring internal and external resources accordingly (Tan et al., 2018; Chittipaka et al., 2022). Organizations that excel in dynamic capabilities possess an elevated ability to interpret weak signals, mobilize cross-functional knowledge, and adjust supply chain configurations with speed and precision. Consequently, SCR can be interpreted as a concrete manifestation of dynamic capabilities applied specifically to complex supply networks.

Amid this transformation, two strategic mechanisms have gained increasing prominence: Digital Transformation (DT) and Corporate Social Responsibility. Although frequently examined as distinct research streams, emerging scholarship demonstrates that DT and CSR are increasingly interconnected forces shaping modern supply chain resilience (Ivanov, 2020). DT equips organizations with advanced technological tools such as Artificial Intelligence (AI), blockchain, Internet of Things (IoT), cloud computing, and predictive analytics that enable enhanced visibility, data-driven decision-making, automation, and risk anticipation. These technologies help firms detect emerging threats earlier, model disruption scenarios, optimize inventory and logistics in real time, and

coordinate recovery actions across global networks (Shekarian et al., 2022; Queiroz et al., 2024).

In parallel, CSR provides the social, ethical, and institutional foundation that shapes organizational legitimacy, trustworthiness, and stakeholder alignment. CSR practices such as responsible sourcing, environmental stewardship, fair labor treatment, and transparent reporting strengthen relational capital with suppliers, customers, regulators, and communities (Hosseinzadeh et al., 2024). This relational capital becomes vital during crises, when cooperation, trust, and moral legitimacy significantly influence access to shared resources, priority support from suppliers, and public acceptance of operational changes. Moreover, CSR mitigates social and regulatory risks that often trigger supply chain disruptions, such as community protests, or sanctions for environmental non-compliance.

From the perspective of Institutional Theory (IT), the integration of CSR and DT is increasingly shaped by coercive pressures (such as due diligence regulations, sustainability reporting requirements, and carbon disclosure mandates), normative pressures (industry standards, professional norms), and cognitive pressures (societal expectations for fairness, transparency, and ethical conduct) (DiMaggio & Powell, 1983). The growing institutionalization of sustainability exemplified by regulatory frameworks like the EU Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CSDDD) means that firms are no longer merely encouraged to adopt CSR and digital tools; they are expected to do so. In this sense, CSR and DT have become both strategic and institutional imperatives.

Despite the growing body of research on supply chain resilience, prior studies have largely examined DT and CSR as separate and independent drivers of resilience. Research grounded in DCT has predominantly focused on the technological foundations of resilience, emphasizing digital visibility, analytics, and agility as key enablers of adaptive supply chains. In parallel, studies informed by Institutional Theory (IT) have highlighted the role of CSR in fostering legitimacy, stakeholder trust, and relational capital across supply networks. This fragmented treatment has limited our understanding of how technological and ethical capabilities interact in shaping supply chain resilience. Existing research provides insufficient explanation of whether CSR merely complements digital transformation or actively conditions its effectiveness. This gap is theoretically significant, as resilience increasingly depends not only on internal operational agility but also on external legitimacy and institutional alignment. Without integrating these dimensions, current explanations of supply chain resilience remain incomplete.

Building on these complementary theoretical foundations, this study conceptualizes the integration of CSR and DT as a multidimensional driver of SCR. Drawing on Dynamic Capabilities Theory, DT is viewed as an internal adaptive mechanism that enables firms to sense disruptions, seize opportunities, and reconfigure resources in

volatile environments. From an Institutional Theory perspective, CSR represents an external legitimacy mechanism that aligns organizational practices with regulatory, normative, and societal expectations. Integrating these lenses provides a comprehensive understanding of SCR as a capability that emerges from the alignment of internal agility with external legitimacy. This integrated perspective lays the groundwork for a deeper exploration of the mechanisms through which CSR and DT jointly influence supply chain resilience. Accordingly, the following section provides an enriched and systematic review of the literature, consolidating existing knowledge and identifying the theoretical gaps that justify the need for an integrated conceptualization of CSR, DT, and SCR. This study aims to examine the individual and combined effects of Digital Transformation and Corporate Social Responsibility on Supply Chain Resilience, addressing an important gap in the literature. This paper is structured as follows. Section 2 presents the literature review and hypotheses development. Section 3 outlines the research methodology. Section 4 reports the empirical results. Section 5 discusses the findings. Finally, Section 6 concludes the study with implications and future research directions.

2. Literature review

Supply Chain Resilience is widely defined as a firm's ability to anticipate, absorb, respond to, and recover from disruptions while maintaining operational continuity and long-term competitiveness. Unlike traditional risk management approaches that emphasize robustness or efficiency under stable conditions, resilience focuses on adaptability, learning, and transformation in the face of uncertainty. Recent supply chain research increasingly conceptualizes resilience not as a static attribute but as a dynamic capability that evolves through repeated exposure to disruptions and continuous organizational learning (Ivanov, 2020; Queiroz et al., 2023; Shekarian et al., 2022).

Drawing on DCT, SCR can be understood as the outcome of a firm's capacity to sense environmental changes, seize emerging opportunities or threats, and reconfigure internal and external resources accordingly. These micro foundations enable firms to respond proactively to disruptions such as pandemics, geopolitical conflicts, and climate-related shocks. Empirical evidence suggests that resilient supply chains are characterized by enhanced visibility, flexibility, redundancy, and inter-organizational coordination, which collectively support faster recovery and strategic adaptation (Chittipaka et al., 2022; Dubey et al., 2023). Importantly, recent disruptions have revealed that resilience is not solely determined by internal operational capabilities. External factors such as institutional pressures, stakeholder expectations, and social legitimacy increasingly shape how supply chains respond to crises and how recovery strategies are supported or constrained. This observation suggests that SCR is a multidimensional construct influenced by both technological

capabilities and institutional mechanisms, calling for a more integrated theoretical perspective. Building on Dynamic Capabilities Theory, Digital Transformation can be understood as a core organizational capability that enhances firms' ability to sense disruptions, seize adaptive responses, and reconfigure supply chain processes under conditions of uncertainty. By improving visibility, agility, and predictive capacity across supply chains, DT enables firms to maintain operational continuity and recover more effectively from disruptions. Accordingly, the following hypothesis is proposed(Rahmoune & Alsaggaf, 2025d):

H1. Digital Transformation positively influences Supply Chain Resilience

Corporate Social Responsibility plays a critical role in enhancing supply chain resilience by strengthening organizational legitimacy, stakeholder trust, and relational capital across supply networks. From an Institutional Theory perspective, CSR reflects firms' responses to regulatory, normative, and societal pressures that encourage responsible sourcing, ethical labor practices, and environmental stewardship (Scott, 2014). Empirical evidence indicates that firms with strong CSR engagement tend to develop more collaborative and trust-based relationships with suppliers, regulators, and local communities, which become particularly valuable during periods of disruption by facilitating cooperation, flexibility, and access to critical resources (Dubey et al., 2023; Hosseinzadeh et al., 2025). By reducing social, reputational, and regulatory risks, CSR contributes to a supportive institutional environment that enhances firms' ability to withstand, adapt to, and recover from supply chain shocks. Accordingly, the following hypothesis is proposed:

H2. Corporate Social Responsibility positively influences Supply Chain Resilience.

Although Digital Transformation enhances supply chain resilience by strengthening dynamic capabilities, its effectiveness may depend on the institutional context in which digital initiatives are embedded. From an Institutional Theory perspective, Corporate Social Responsibility provides a normative and relational framework that shapes how digital technologies are perceived, governed, and utilized by supply-chain stakeholders (Frank et al., 2019; Queiroz et al., 2023; Ivanov & Dolgui, 2024). CSR enhances legitimacy, trust, and stakeholder alignment, thereby reducing resistance to digital change and facilitating inter-organizational collaboration (Dubey et al., 2023; Dubey et al., 2024). When digital transformation is supported by strong CSR practices, firms are more likely to deploy technologies responsibly, share information transparently, and coordinate adaptive responses during disruptions. Consequently, CSR can be viewed as a boundary condition that amplifies the resilience benefits of digital transformation. Accordingly, the following hypothesis is proposed:

H3: Corporate Social Responsibility positively moderates the relationship between Digital Transformation and Supply Chain Resilience, such that the effect of Digital Transformation on Supply Chain Resilience is stronger at higher levels of Corporate Social Responsibility.

2.1. CSR as a driver of ethical and relational strength

The role of Corporate Social Responsibility within supply chains extends far beyond mere compliance or reputation management. In modern supply networks, CSR functions as an infrastructural element that shapes expectations, behaviors, and the moral boundaries within which firms operate. Practices such as ethical sourcing, fair labor treatment, and environmental stewardship solidify the social foundation upon which resilient supply networks depend. CSR also enhances relational capital a form of intangible asset that strengthens trust between supply chain actors. Suppliers tend to collaborate more openly with organizations that demonstrate ethical conduct and commitment to long-term partnerships. Communities and regulators provide greater support to companies perceived as socially responsible, particularly during crises. Traditional risk mitigation strategies often prioritize internal vulnerabilities, but CSR encourages firms to consider broader societal and environmental risks. For example, engaging in community development, supporting worker welfare, and ensuring environmental conservation can reduce the likelihood of social unrest, labor disruptions, or ecological damage events that frequently spill over into supply chain disruptions.

2.2. DT as a catalyst for predictive and systemic visibility

Digital Transformation reinvents how supply chains detect, interpret, and respond to disruptions. Technologies such as IoT sensors enable real-time monitoring of goods, equipment, and environmental conditions. AI-driven analytics detect anomalies and forecast risks with increasing accuracy. Blockchain enhances traceability across multi-tier networks, addressing long-standing challenges such as counterfeit products, opaque subcontracting, and unethical sourcing.

These tools collectively create a digitally empowered sensing capability, which dramatically expands the quantity and quality of information available to decision-makers. Instead of reacting to disruptions after they occur, firms can anticipate bottlenecks, simulate scenarios, and implement preventive measures. Predictive analytics can warn of supplier fragility, transportation delays, or geopolitical escalation before they affect operations. Digital platforms also facilitate rapid reconfiguration an essential element of resilience. Cloud-based systems allow instant adjustments to production schedules, inventory distribution, and transportation

plans. Digital collaboration tools reduce the friction traditionally associated with multi-tier coordination, enabling quicker alignment across geographically dispersed stakeholders.

2.3. The institutional dimension of DT and CSR integration

Institutional Theory plays a pivotal role in understanding why and how firms adopt CSR and DT. Organizations do not simply innovate because it is strategically beneficial; they innovate because they must conform to the expectations of their institutional environment. Coercive pressures include governmental regulations on carbon emissions, labor standards, and data transparency. Normative pressures arise from industry associations, certification schemes (e.g., ISO 14001), and professional norms. Cognitive pressures reflect societal beliefs about what constitutes legitimate corporate behavior in the digital age. CSR and DT therefore become institutionalized expectations. Firms that fail to integrate sustainability into their operations risk losing investor confidence, facing regulatory sanctions, or damaging their brand image. Similarly, firms that do not adopt digital tools may appear outdated, inefficient, or opaque qualities increasingly incompatible with contemporary norms of accountability. The intersection of these institutional expectations creates a dual legitimacy requirement: firms must be *responsible* and *technologically competent*. This dual requirement drives the strategic integration of CSR and DT, as neither dimension alone is sufficient to meet the evolving definition of legitimacy.

2.4. Synergistic mechanisms: how CSR amplifies DT

The integration of CSR and DT yields a synergy that surpasses the sum of its parts. CSR establishes the ethical and relational framework that guides responsible deployment of technology. Without such a framework, digital transformation can raise concerns about privacy, surveillance, or inequitable access to technological benefits. CSR mitigates these risks by embedding digital initiatives within a broader ethical vision. Conversely, DT enhances the effectiveness of CSR programs by enabling measurable, data-driven approaches. Digital tools facilitate environmental monitoring, social auditing, carbon tracking, and sustainability reporting. Blockchain ensures that CSR claims such as fair wages or sustainable sourcing are verifiable rather than symbolic. AI can identify patterns of non-compliance in supplier behavior, alerting firms to potential ethical risks. In essence, CSR humanizes DT, ensuring that technology serves societal well-being, while DT operationalizes CSR, making ethical commitments quantifiable and enforceable. This interaction creates a robust foundation for building resilience rooted in transparency, accountability, and shared values.

Building on the synergy between CSR and DT, recent research increasingly conceptualizes supply chain resilience not merely as an operational response to disruptions but as a *dual-capability framework* combining technological intelligence and ethical legitimacy. In this framework, DT equips organizations with the advanced sensing, predictive, and reconfiguration capabilities necessary to manage volatility, while CSR provides the normative and relational grounding that ensures responsible, transparent, and stakeholder-aligned adaptation. This dual-capability model suggests that resilience is most effective when firms integrate both dimensions simultaneously. Technology alone cannot foster trust, social acceptance, or legitimacy; similarly, CSR without digital enablement risks remain symbolic or superficial. By merging the two, companies create adaptive systems that not only anticipate and mitigate disruptions but also maintain strong institutional support, regulatory compliance, and societal approval.

Moreover, this dual framework reflects the growing recognition that resilience is not solely an internal organizational attribute but also a *network-level phenomenon*. Collaborative CSR practices such as shared sustainability standards, joint social audits, and community partnerships enhance relational resilience across supply chains. Likewise, digital platforms facilitate ecosystem-wide data sharing, improving collective responsiveness during crises. When multiple actors align on both CSR commitments and digital infrastructures, resilience becomes systemic rather than isolated benefiting the entire supply chain rather than individual firms.

2.5. Strengthening multi-tier supply chain visibility through integrated CSR–DT systems

One of the most persistent challenges in global supply networks is the lack of visibility beyond first-tier suppliers. Many disruptions originate deep within supply chains, where monitoring practices and institutional pressures are weaker. Integrating CSR and DT significantly enhances multi-tier visibility. For instance, blockchain-enabled traceability systems can record the provenance, environmental footprint, and labor conditions associated with raw materials..

Digital technologies also support dynamic supplier risk assessments that consider CSR-related variables such as worker safety, community relations, or environmental vulnerabilities. These indicators, often overlooked in traditional risk models, are predictive of disruptions: factories with poor labor practices may face strikes, regulatory penalties, or reputational crises that ripple across the entire supply network. By integrating CSR criteria into digital risk monitoring tools, firms can detect such vulnerabilities early and engage suppliers proactively.

2.6. Institutional pressures for sustainable and digitally responsible supply chains

The institutional environment surrounding global supply chains is undergoing rapid transformation. Stakeholders including governments, investors, NGOs, and consumers demand greater transparency, sustainability, and accountability. Many jurisdictions have introduced mandatory due diligence laws (e.g., the EU Corporate Sustainability Due Diligence Directive), compelling firms to document and address social and environmental risks across their entire supply chain. These institutional pressures amplify the need for integrated CSR-DT systems. Without digital infrastructures, companies struggle to meet reporting requirements, monitor supplier compliance, or provide verifiable data. Likewise, firms lacking CSR commitments face increased scrutiny and risk sanctions, legal liabilities, or reputational damage (Islam & Van, 2021; Rahmoune, 2025).

2.7. Dynamic capabilities as the engine of integrated resilience

From a Dynamic Capabilities perspective, the integration of CSR and DT enhances a firm's ability to sense, seize, and reconfigure in response to environmental volatility.

- sensing is strengthened through digital tools that provide real-time data on operational and social conditions,
- seizing is enhanced by CSR frameworks that guide ethical decision-making and stakeholder alignment during crises,
- reconfiguring becomes more effective when technology enables rapid restructuring of supply chain processes and CSR ensures these changes maintain institutional legitimacy.

In essence, digitalization amplifies the speed and accuracy of dynamic capabilities, while CSR shapes their direction and ensures their acceptance. The combination fosters organizational transformations that are not only efficient and agile but also sustainable, ethical, and aligned with long-term societal expectations.

2.8. Building organizational learning through CSR–DT integration

Another key benefit of integrating CSR and DT lies in enhancing organizational learning. Responsible practices encourage firms to evaluate long-term risks, engage in reflective decision-making, and integrate stakeholder insights into strategic planning. Digital tools complement these processes by providing data-driven feedback loops that help firms learn from past disruptions, model future scenarios, and continuously improve resilience strategies. As firms encounter new institutional pressures such as the rise of ESG reporting standards they accumulate knowledge about sustainable

compliance, responsible technology deployment, and stakeholder expectations. Over time, this accumulated knowledge becomes a strategic asset, enabling superior adaptive behavior. The resilience that emerges from this learning is deeper, more proactive, and more aligned with societal values.

Data collection was carried out using a structured questionnaire developed specifically for this study. A total of 120 usable responses were obtained from professionals directly engaged in supply-chain functions, including planning, procurement, logistics coordination, risk management, and digital operations. The sample represents three major sectors of contemporary supply-chain ecosystems: manufacturing (40%), logistics and transport services (35%), and retail and distribution (25%). These industries were intentionally selected because they are among the most exposed to disruptions and therefore provide a rich context for studying resilience-related phenomena. Respondents were targeted based on their operational responsibilities and decision-making roles, ensuring that the data reflected informed perspectives derived from practical experience. To ensure conceptual alignment and content validity, all constructs were operationalized using established scales adapted from prior research. Items were measured using five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree), a format widely used in behavioral and organizational studies for capturing attitudinal and perceptual data. The measurement items drew on validated instruments recommended by Hair et al. (2022) and other scholars in the fields of digitalization, sustainability, and supply-chain management. Before launching the main survey, a pilot test was conducted with a small group of industry practitioners and academic experts. Their feedback helped refine item phrasing, enhance clarity, and improve contextual relevance, thereby strengthening the reliability of the final instrument. The relationship between CSR and DT has attracted increasing attention in recent years, particularly in the context of supply chain resilience. Rather than being viewed as separate strategic initiatives, these two dimensions are increasingly considered complementary. Digital technologies such as artificial intelligence, blockchain, and big data analytics support the implementation of CSR practices by improving transparency, traceability, and stakeholder engagement (Dubey et al., 2024). Recent studies further show that digital transformation enhances firms' ability to monitor sustainability performance and respond more effectively to disruptions in complex supply networks (Dubey et al., 2023; Li et al., 2025; Wu et al., 2024). In addition, digital technologies contribute to strengthening resilience by improving information flows and enabling faster decision-making across supply chains (Wu et al., 2025). From an international perspective, firms that integrate CSR within digitally enabled supply chains tend to demonstrate higher resilience, particularly in environments characterized by institutional uncertainty. While firms in developed economies, especially in Europe, are often driven by regulatory compliance and sustainability reporting requirements, firms in emerging markets increasingly rely

on digital transformation to overcome institutional gaps and enhance flexibility. Despite these developments, there is still limited empirical evidence on how CSR and DT interact with each other. Most prior studies examine these dimensions separately, which makes it difficult to fully capture their combined effects. This study addresses this gap by proposing and empirically testing an integrated framework linking CSR, DT, and supply chain resilience.

3. Methods

3.1. Research context and data collection

This study adopts a quantitative, cross-sectional research design to examine the relationships between DT, CSR, and SCR. The empirical setting includes firms operating in manufacturing, logistics and transportation, and retail and distribution sectors. These sectors were selected due to their high exposure to supply chain disruptions and their increasing engagement in digital transformation and sustainability initiatives (Cui et al., 2023; Wu et al., 2024). Data were collected through a structured survey targeting professionals directly involved in supply chain activities, including planning, procurement, logistics, risk management, and digital operations. These respondents were considered appropriate as they possess relevant expertise and are actively engaged in decision-making processes related to supply chain management. A non-probability purposive sampling technique was employed to ensure that participants held positions relevant to the study context, which is consistent with prior supply chain research relying on knowledgeable respondents (Li et al., 2020). The questionnaire was distributed electronically, accompanied by a cover letter explaining the purpose of the study, ensuring confidentiality, and providing clear instructions. Follow-up reminders were sent to increase participation. A total of 120 valid responses were collected and retained for analysis, providing an adequate basis for empirical testing. The sample size of 120 is considered adequate for Partial Least Squares approach (PLS-SEM) analysis, as it satisfies the minimum requirements based on the "10-times rule" and statistical power considerations (Hair et al., 2021).

3.2. Measurement instrument and adaptation

The measurement instrument was developed based on established and validated scales from prior literature on digital transformation, corporate social responsibility, and supply chain resilience. All constructs were measured using multiple items assessed on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). To ensure content validity and contextual relevance, a systematic adaptation process was conducted (Hair et al., 2021). First, the original measurement items were

carefully reviewed to assess their suitability for the supply chain context. Several modifications were introduced to better reflect the operational reality of supply chains. Specifically:

- items referring to "organizational performance" were adapted to explicitly capture "supply chain resilience and continuity",
- generic terms such as "firm processes" were replaced with "supply chain processes",
- digital transformation items were refined to emphasize their role in information sharing, coordination, and data-driven decision-making across supply chain partners,
- CSR-related items were contextualized to reflect responsible practices within supply chain activities, including environmental and social considerations.

Second, ambiguous or redundant items were reworded or removed to improve clarity and ensure consistency across constructs. Third, a pilot test was conducted involving academic experts and industry practitioners with experience in supply chain management and digital technologies. Participants evaluated the questionnaire in terms of clarity, relevance, and completeness. Based on their feedback, minor revisions were made, ensuring face and content validity (Hair et al., 2021).

3.3. Data analysis

Structural Equation Modeling using the PLS-SEM was employed to test the proposed research model. This method is particularly suitable for studies involving complex models with latent constructs and relatively small sample sizes (Hair et al., 2021). PLS-SEM enables the simultaneous assessment of both the measurement model, including the reliability and validity of constructs, and the structural model, reflecting the hypothesized relationships among constructs, and is widely applied in information systems and supply chain research (Benitez et al., 2019). The measurement model was first evaluated in terms of internal consistency reliability, convergent validity, and discriminant validity, prior to assessing the structural model.

3.4. Common method bias

Given that data were collected using a single survey instrument, several procedural remedies were implemented to reduce the risk of common method bias, including ensuring respondent anonymity, using clear and concise wording, and separating constructs conceptually (Conway & Lance, 2010). In addition, Harman's single-factor test was conducted following the approach of Podsakoff et al. (2003). The results indicated that no single factor accounted for the majority of the variance, suggesting that common method bias is not a serious concern in this study.

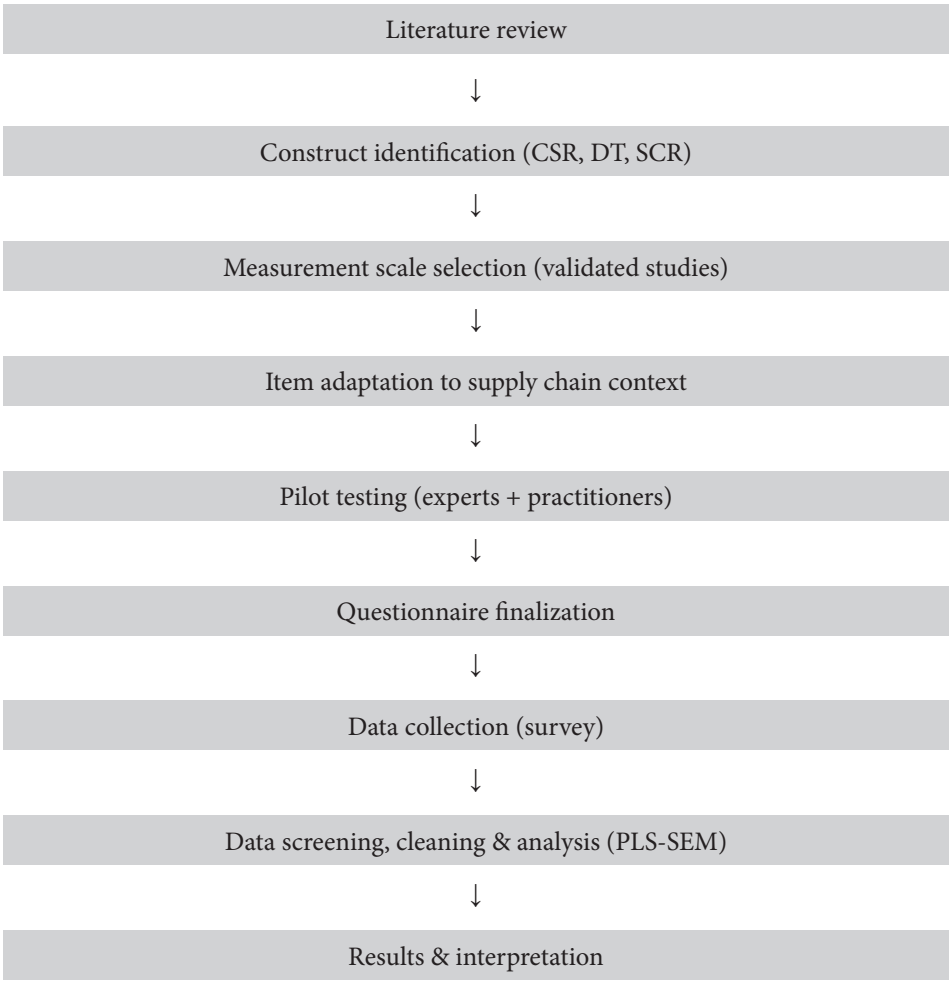

Figure 1. **Research procedure**

Source: own study

The research procedure adopted in this study begins with an extensive literature review, followed by construct identification and measurement scale selection from validated studies. The measurement items were then adapted to the supply chain context and refined through pilot testing. After finalizing the questionnaire, data were collected, screened, and analyzed using PLS-SEM, leading to the interpretation of results.

4. Results and analysis

4.1. Descriptive statistics and correlation analysis

After conducting initial data screening procedures which included checking for missing responses, assessing outliers, and verifying normality assumptions a total of 120 valid questionnaires were retained for statistical analysis. The final sample presents a balanced representation of key industries involved in contemporary supply chains, comprising manufacturing firms (40%), logistics and transportation companies (35%), and retail organizations (25%). This distribution reflects a diverse range of operational contexts and ensures that the findings are not biased toward a single sector. Such heterogeneity is particularly valuable for research on supply chain resilience, as different industries exhibit varying levels of exposure to disruptions and differing levels of digital maturity.

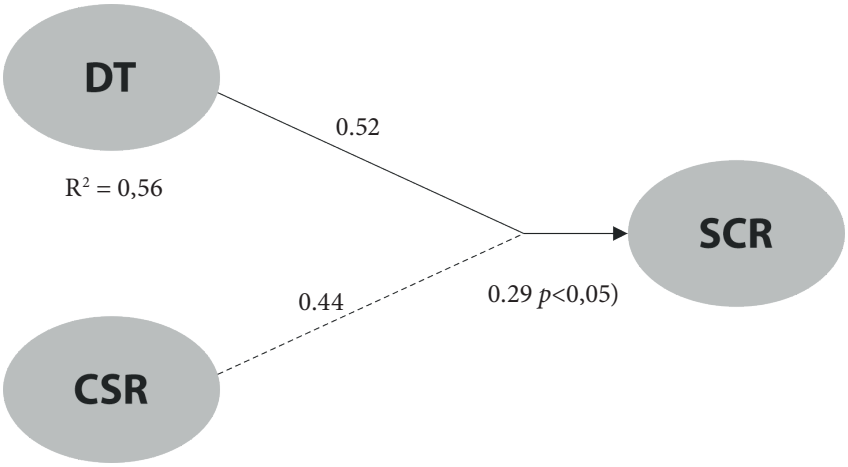

Figure 2. **Conceptual model**

Source: own study

The Figure 2 illustrates the structural equation model (SEM) developed to examine the relationships among the three core latent variables of the study: Digital Transformation, Corporate Social Responsibility, and Supply Chain Resilience. The model captures not only the direct effects of these constructs but also the underlying dynamics that connect technological capabilities with ethical practices in shaping organizational resilience. The results show that Digital Transformation exerts a strong and positive

influence on SCR (β = 0.52), underscoring the critical role of digital technologies in building responsive and adaptive supply-chain systems. This substantial effect suggests that organizations with higher levels of digital maturity characterized by real-time data visibility, predictive analytics, process automation, and integrated information systems are significantly better equipped to manage disruptions, coordinate across partners, and maintain operational continuity. In other words, digital transformation serves as a key enabler of agility and preparedness, strengthening the firm's ability to sense risks and respond effectively, in line with the micro foundations of dynamic capabilities.

Corporate Social Responsibility also demonstrates a positive and statistically significant effect on SCR (β = 0.29, p < 0.05). Although more modest than the effect of DT, this relationship highlights the growing importance of ethical governance, stakeholder engagement, and sustainability-oriented practices in reinforcing organizational resilience. Firms that invest in CSR through responsible sourcing, fair labor practices, environmental stewardship, and transparent communication tend to cultivate stronger stakeholder trust and legitimacy. These social and relational assets become crucial during periods of disruption, enabling firms to mobilize support, coordinate more effectively with partners, and maintain their reputation in turbulent conditions. Moreover, the model reveals that CSR positively influences DT (β = 0.44), offering an important insight into how ethical orientation drives technological adoption. This finding suggests that socially responsible firms are more inclined to invest in digital tools that enhance transparency, traceability, and accountability. CSR may stimulate digital transformation by creating institutional pressure to improve reporting accuracy, monitor supplier compliance, or reduce environmental impact through technology-enabled solutions. Thus, CSR not only contributes directly to resilience but also reinforces the organization's technological progression, creating a virtuous cycle in which ethical commitment and digital innovation mutually strengthen one another. Collectively, these relationships highlight the interconnected nature of DT, CSR, and SCR, illustrating how technological capability and social responsibility converge to build stronger, more adaptive, and more legitimate supply-chain systems.

Table 1. **Descriptive statistics and correlation matrix for the study constructs**

Variable	Mean	SD	1	2	3
1. Digital Transformation	3.89	0.64	—		
2. Corporate Social Responsibility	3.78	0.61	0.56**	—	
3. Supply Chain Resilience	3.92	0.58	0.63**	0.59**	—

Source: own study

The correlations indicate strong positive relationships among DT, CSR, and SCR, suggesting conceptual alignment and low risk of multicollinearity (VIF < 3.0).

4.2. Measurement model evaluation

The evaluation of the measurement model followed the established guidelines proposed by Hair et al. (2022), focusing on internal consistency reliability, convergent validity, and discriminant validity. As reported in Table 2, all constructs demonstrated strong psychometric properties, indicating that the measurement items adequately captured the theoretical domains they were intended to represent.

Internal consistency reliability was assessed through Cronbach's alpha and Composite Reliability. For all three constructs-Digital Transformation, Corporate Social Responsibility, and Supply Chain Resilience -Cronbach's alpha values exceeded the recommended threshold of 0.70, ranging from 0.84 to 0.88. Similarly, CR values were all above 0.88, confirming that the items consistently measured the underlying constructs. These findings reflect a high level of internal coherence within each scale.

Convergent validity was examined using the Average Variance Extracted (AVE). All constructs achieved AVE values above the minimum acceptable level of 0.50, with DT at 0.61, CSR at 0.59, and SCR at 0.64. Outer loadings further reinforced convergent validity, with all individual item loadings falling between 0.74 and 0.89 well above the recommended cutoff of 0.70. This demonstrates that each indicator contributed substantially to its respective latent construct.

Table 2. **Construct reliability and convergent validity**

Construct	Cronbach's α	CR	AVE	Loading Range
Digital Transformation (DT)	0.86	0.9	0.61	0.74 – 0.88
Corporate Social Responsibility (CSR)	0.84	0.89	0.59	0.75 – 0.86
Supply Chain Resilience (SCR)	0.88	0.91	0.64	0.76 – 0.89

Source: own study

Table 2 presents the results of the reliability and convergent validity assessment for the three constructs included in the study: DT, CSR, and SCR. All constructs demonstrate strong psychometric properties, indicating that the measurement scales used were both robust and theoretically coherent.

Internal consistency reliability was first evaluated using Cronbach's alpha and CR. As shown in the table, Cronbach's alpha values ranged from 0.84 to 0.88 across the constructs, which exceeds the commonly accepted threshold of 0.70 recommended for

exploratory and confirmatory research. Likewise, the CR values ranging from 0.89 to 0.91affirm that the indicators consistently measure the corresponding latent construct, providing further evidence of internal consistency.

Convergent validity was assessed using the AVE, with all constructs achieving values above the minimum recommended level of 0.50. Specifically, AVE values ranged from 0.59 for CSR to 0.64 for SCR, demonstrating that each latent variable explains a majority of the variance in its observed indicators. In addition, the outer loadings of all measurement items fell between 0.74 and 0.89, well above the acceptable threshold of 0.70. These strong loadings confirm that each item makes a meaningful contribution to its respective construct.

4.3. Structural model and hypothesis testing

The structural model was assessed using the PLS-SEM approach with a bootstrapping procedure to evaluate path significance and model robustness. The results are presented in Table 3.

Table 3. **Structural Path coefficients (bootstrapping results)**

Hypothesis	Path	β	t-value	p-value	Result
H1	DT → SCR	0.52	7.63	< 0.001	Supported
H2	CSR → SCR	0.44	5.89	< 0.001	Supported
H3	CSR × DT → SCR	0.29	2.34	0.021	Supported

Source: own study

The model explains 56 % of the variance in Supply Chain Resilience ($R^2 = 0.56$), which reflects a moderate-to-strong explanatory power according to Chin (1998). Effect-size analysis indicates that DT exerts the largest influence on SCR ($f^2 = 0.34$, large), followed by CSR ($f^2 = 0.21$, medium), while the interaction term ($f^2 = 0.09$) contributes a small-to-medium additional effect. The predictive relevance statistic ($Q^2 = 0.31$) obtained through blindfolding confirms strong model predictive capability, and the global model fit (SRMR = 0.056) falls below the 0.08 threshold, indicating satisfactory overall fit. These results provide robust empirical support for all three hypotheses. Specifically, DT exhibits the strongest direct effect on SCR, suggesting that digital investments substantially enhance a firm's ability to sense disruptions, coordinate responses, and recover efficiently. CSR also exerts a significant positive influence, validating its role as a source of institutional legitimacy and stakeholder trust in turbulent environments. Importantly, the interaction between CSR and DT

is positive and significant ($\beta = 0.29$, $p < 0.05$), confirming that CSR strengthens the impact of DT on resilience outcomes. This finding implies that digital initiatives yield greater resilience benefits when embedded within socially responsible and ethically governed frameworks. Together, these results illustrate that the integration of CSR and DT yields complementary advantages DT provides technological agility, while CSR embeds legitimacy and moral accountability resulting in resilient supply chains that are both operationally effective and institutionally sustainable.

4.4. Interpretation of findings

The empirical results provide strong and coherent support for all the hypothesized relationships, offering important theoretical and practical insights into the dynamics linking DT, CSR, and SCR. Among the explanatory variables, Digital Transformation emerged as the most influential driver of resilience, confirming its central role as a critical dynamic capability. This finding aligns closely with the Dynamic Capabilities Theory, which emphasizes that firms operating in turbulent environments must continuously enhance their sensing, integration, and reconfiguration abilities in order to remain competitive and adaptive. The high path coefficient associated with DT indicates that organizations equipped with advanced digital tools such as predictive analytics, real-time monitoring systems, and intelligent automation are significantly better positioned to anticipate disruptions, manage operational volatility, and coordinate rapid recovery strategies.

Corporate Social Responsibility also demonstrated a positive and meaningful effect on SCR, reaffirming its relevance as a mechanism that strengthens ethical governance, stakeholder trust, and long-term legitimacy. This outcome echoes Institutional Theory, which posits that organizations gain resilience not only through operational capabilities but also through alignment with societal norms, regulatory expectations, and shared ethical values. Firms actively engaging in CSR tend to cultivate more cooperative relationships with suppliers, regulators, and communities, all of which serve as valuable relational assets during periods of uncertainty or crisis. CSR thus enhances resilience by creating a supportive institutional environment and by reducing social or reputational risks that could otherwise disrupt supply-chain continuity. Importantly, the significant moderation effect of CSR ($\beta = 0.29$, $p < 0.05$) reveals that CSR amplifies the positive relationship between DT and SCR. This suggests that digital transformation efforts yield stronger resilience benefits when they are embedded within a broader framework of ethical and sustainable management practices. In other words, digital tools are most effective when guided by a responsible governance philosophy that ensures transparency, accountability, and equitable stakeholder engagement. Without such a foundation, digitalization may enhance efficiency but fail to translate into legitimacy or long-term adaptability. The interplay between CSR

and DT thus generates a synergistic mechanism in which ethical legitimacy reinforces technological agility, leading to a form of resilience that is not only operationally robust but also socially sustainable and institutionally coherent. Taken together, the findings highlight that modern supply chains require a dual capability approach: technological innovation to navigate complexity and speed, and ethical responsibility to maintain trust and institutional alignment. This integrated perspective provides a more holistic understanding of resilience in the digital era.

4.5. PLS predictive power summary

For completeness, the model's predictive performance was assessed using PLS-predict. The observed Q^2 value of 0.31 confirmed high predictive relevance, while all construct cross-validated redundancies were positive. No significant collinearity (VIF < 3) was detected, supporting the robustness of the estimated model. Collectively, these results demonstrate that combining Dynamic Capabilities (via DT) with Institutional Legitimacy (via CSR) creates a resilient supply-chain ecosystem capable of enduring systemic shocks while maintaining stakeholder trust and regulatory compliance.

5. Discussion

A notable contribution of this study lies in the demonstration of CSR's moderating effect on the relationship between DT and SCR. The results indicate that firms which integrate responsible governance practices with digital transformation initiatives achieve superior resilience outcomes compared to firms that focus solely on technological innovation. This synergy suggests that technological capabilities are most effective when aligned with ethical norms, stakeholder expectations, and institutional pressures. In other words, dynamic organizational capabilities such as agility, adaptability, and learning appear to be amplified when coupled with institutional legitimacy derived from CSR. The alignment of CSR and DT therefore supports the development of resilience as a multifaceted, ethically grounded, and strategically coherent organizational capability. From a managerial perspective, the findings highlight the importance of pursuing digital transformation not as a purely technological initiative but as part of a broader organizational strategy grounded in responsibility, transparency, and stakeholder engagement. Managers should prioritize governance frameworks that ensure digital tools are deployed ethically, inclusively, and sustainably, mitigating potential risks such as data misuse, privacy concerns, or social inequity. For policymakers, the results underscore the value of regulatory incentives that encourage responsible digitalization and sustainability-oriented governance. Regulations promoting ethical data practices, carbon disclosure, supply-chain due diligence, and human rights compliance can

reinforce resilient and socially accountable supply chains. The findings of this study are consistent with prior research highlighting the role of digital transformation in enhancing supply chain resilience (Dubey et al., 2023). Firms with stronger digital capabilities are better able to anticipate disruptions and respond effectively. Similarly, the results confirm that Corporate Social Responsibility contributes to resilience by strengthening stakeholder trust and institutional legitimacy. This supports existing studies showing that socially responsible firms are more capable of maintaining stability during disruptions. Importantly, this study shows that CSR also strengthens the impact of digital transformation. This suggests that digital technologies are more effective when combined with responsible management practices, offering a more integrated understanding of supply chain resilience.

6. Conclusion and implications

This study advances theoretical and empirical understanding of how CSR and DT jointly enhance Supply Chain Resilience in contemporary global environments characterized by uncertainty, disruption, and institutional pressures. The findings confirm that CSR not only exerts a direct positive effect on SCR but also strengthens the influence of DT by embedding social, ethical, and environmental values into digital practices. Together, CSR and DT form a synergistic framework that supports the development of supply chains that are technologically capable, ethically grounded, and institutionally legitimate. Theoretically, the research contributes to the integration of Dynamic Capabilities Theory and Institutional Theory by illustrating how technological capabilities (associated with dynamic sensing and adaptation) interact with institutional legitimacy mechanisms (associated with CSR) to enhance resilience. This integration enriches existing literature by showing that resilience is neither purely operational nor purely relational but instead emerges from the interplay between agility and legitimacy. The study thus offers a novel conceptualization of resilience as a dual-capability system that combines digital intelligence with normative alignment. From a practical perspective, the study provides actionable insights for managers aiming to design supply chains capable of withstanding disruptions while maintaining ethical standards and social responsibility. Firms are encouraged to align digital initiatives with CSR strategies, invest in responsible digital governance, strengthen transparency mechanisms, and promote multi-tier collaboration. Such practices not only mitigate operational risks but also enhance stakeholder trust, which is crucial during crises. Additionally, the findings suggest that organizations must view resilience as a strategic imperative and an ongoing capability-building process rather than a one-time intervention. Future research should explore longitudinal approaches to capturing the evolving interactions between CSR, DT, and SCR. Industry-specific investigations may reveal sectoral differences, such as those between high-tech industries that exhibit rapid digital adoption and traditional

manufacturing sectors that may face stronger institutional pressures. Leadership commitment, organizational culture, and cross-national regulatory contexts also represent promising areas for further exploration. Researchers may also examine additional mediators and moderators including governance systems, digital maturity, supply-chain complexity, and environmental uncertainty to deepen understanding of the mechanisms linking responsible digitalization to resilience.

Beyond managerial relevance, the findings of this study carry important social and public policy implications. The results suggest that supply chain resilience should not be viewed solely as an operational or firm-level concern, but also as a societal issue linked to employment stability, environmental protection, and ethical governance. By demonstrating that Corporate Social Responsibility amplifies the resilience benefits of Digital Transformation, this study highlights the role of responsible digitalization in promoting socially sustainable supply chains. Policymakers can leverage these insights by encouraging the adoption of digital technologies that enhance transparency, traceability, and accountability across supply networks, particularly through sustainability reporting standards, due diligence regulations, and ethical data governance frameworks. Moreover, public institutions and regulators may support resilience by incentivizing CSR-aligned digital investments that reduce social and environmental risks, strengthen stakeholder trust, and enhance crisis preparedness at the system level. Such policy interventions contribute not only to resilient supply chains but also to broader societal objectives related to sustainable development, social equity, and institutional trust.

7. Limitations and future research directions

While this study provides valuable insights into the joint influence of CSR and DT on SCR, several limitations must be acknowledged. First, the research employed a cross-sectional design, which restricts causal inference. Although the structural model establishes statistically significant relationships, longitudinal data would better capture the evolving nature of CSR–DT–SCR dynamics over time, particularly as firms adapt to new institutional and technological pressures. Second, the sample size, though adequate for PLS-SEM, was limited to 120 respondents from manufacturing, logistics, and retail sectors. Future research should consider larger and more diverse samples, potentially comparing results across industries or regions to enhance generalizability. Third, the study relied on self-reported data, which may be influenced by social desirability or perceptual bias. Incorporating objective performance indicators or multi-source datasets could help validate the robustness of these findings. Fourth, while this study integrated Dynamic Capabilities Theory and Institutional Theory, future investigations could explore complementary frameworks such as Contingency Theory, Stakeholder Resource Theory, or Sociotechnical Systems Theory to broaden theoretical understanding of responsible digitalization in supply-chain contexts.

Finally, the moderating role of CSR opens avenues for examining mediating mechanisms, for example, organizational learning, digital maturity, leadership commitment, or collaborative governance that may further explain how responsible digital initiatives enhance resilience. Expanding research along these lines would contribute to a more holistic understanding of sustainable and ethically grounded supply-chain ecosystems. By addressing these limitations, future studies can deepen theoretical development and provide stronger empirical evidence to guide both scholars and practitioners in designing resilient, digitally enabled, and socially responsible global supply networks.

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Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author used ChatGPT (OpenAI) to improve language clarity and formatting. The author reviewed and edited the content and takes full responsibility for the final version.

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