Digital Transformation and Supply Chain Efficiency: A Synthesis of Evidence on Technologies, Capabilities and Sustainable Performance

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Abstract

Digital transformation (DT) has moved from a discretionary investment to a core requirement for firms that manage complex, multi-tier supply chains. This paper synthesises recent evidence on how DT affects supply chain efficiency and, more broadly, sustainable supply chain performance across the economic, environmental and social dimensions of the triple bottom line. It draws on a PRISMA-based systematic literature review of 625 peer-reviewed articles published between 2020 and 2025 and indexed in Scopus, together with the primary studies that review cites. The synthesis shows that DT improves efficiency mainly through real-time visibility, data-driven planning and cross-organisational integration, but that these gains are contingent rather than automatic. Efficiency outcomes depend on the technologies deployed (integrated IoT, blockchain, AI and big data analytics rather than stand-alone systems), on organisational capabilities (digital leadership, digital culture, dynamic capabilities and collaboration) and on environmental conditions (regulation, turbulence and stakeholder pressure).

Keywords: digital transformation; supply chain efficiency; sustainable supply chains; triple bottom line; organisational capabilities; systematic literature review

1. Introduction

The digital economy has reshaped how goods are sourced, produced, distributed and sold. Digital transformation, understood here as the integration of digital technologies into business processes (Rêgo et al., 2024), now sits at the centre of how firms compete and how they organise their supply chains. Technologies such as social media, artificial intelligence (AI), big data analytics, cloud computing, the Internet of Things (IoT) and smart devices allow firms to participate in, and benefit from, the dynamics of the digital economy (Yang & Lin, 2025).

The COVID-19 pandemic accelerated this shift. Digital adoption moved from a strategic option to a survival mechanism: agricultural entrepreneurs in China turned to e-commerce and social media to keep selling during lockdowns (Cao et al., 2024), and Malaysian food operators rapidly integrated online delivery platforms into their operations (Jahari et al., 2022; Kee et al.,1 2025). At the macro level, remote work, e-commerce and digital payments became everyday practice within a few months.

Review of literature

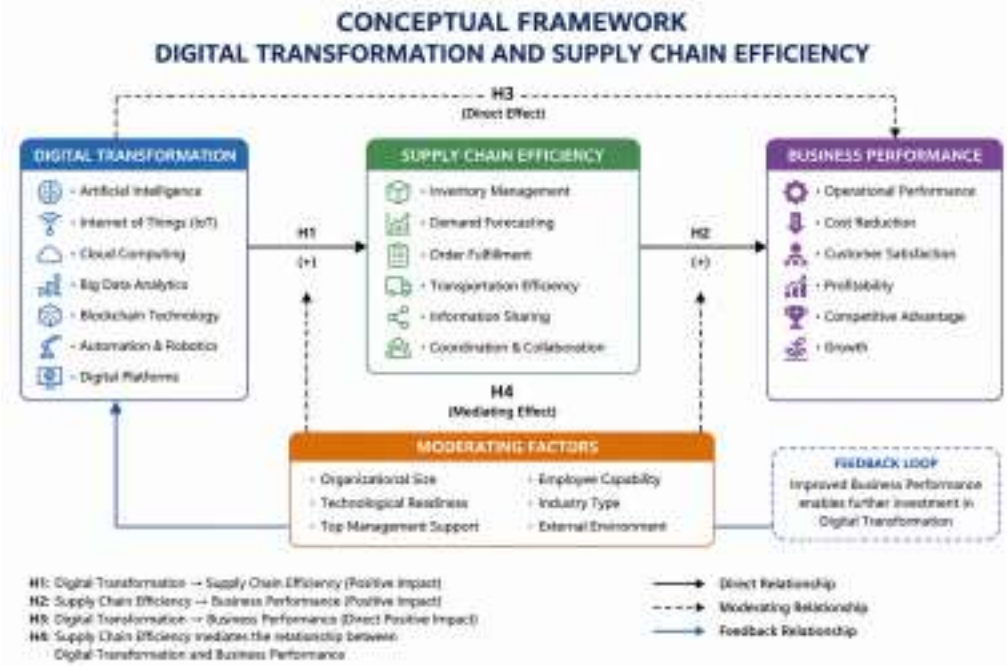
He, Fan, and Fan (2024) examined the relationship between digital transformation and supply chain efficiency using data from Chinese A-share listed companies between 2007 and 2022. The main objective of the study was to determine whether digital transformation could improve the efficiency of corporate supply chains and to identify the mechanisms through which this improvement occurs. The researchers used large-scale secondary panel data and conducted empirical analysis, including baseline regression, robustness tests, mechanism analysis, and heterogeneity analysis. The study found that digital transformation has a significant positive effect on supply chain efficiency. The researchers identified corporate governance and market competition as important mechanisms through which digital transformation improves supply chain efficiency. The study also found that the impact differs according to firm characteristics such as environmental performance, firm size, and information disclosure quality. Improved supply chain efficiency was further

associated with lower future external transaction costs and stronger market and financial performance.

Dauda et al. (2024) investigated how digital supply chain transformation contributes to operational efficiency in the U.S. manufacturing sector. The study focused particularly on technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and predictive analytics. The researchers adopted a mixed method approach. Quantitative performance data from five leading manufacturing firms were examined using publicly available information, while qualitative case study analysis was used to understand the digital strategies adopted by the companies. The study examined indicators such as forecast accuracy, inventory turnover, and downtime. The findings showed that companies that prioritize digital technologies can achieve better operational outcomes. Digital technologies support improved forecasting, inventory management, and reduction of operationaldowntime. However, the study also highlighted that digital transformation is not

identical for every organization and that firms need strategies suited to their specific operational requirements.

Conceptual Framework



2. Conceptual Background ***2.1 Evolution of digital transformation research*** Early work conceptualised digital transformation as the digitisation and automation of business operations, with digital tools supporting efficiency, cost reduction and productivity (Westerman et al., 2014; Fitzgerald et al., 2013). .

Table 1 summarises these phases.

Table 1. Phases in the evolution of digital transformation research

Phase	Conceptualisation	Main focus	Key sources
Early digitisation	Digitisation and automation of business operations; digital tools as supporting tools	Operational efficiency, cost reduction, productivity	Westerman et al. (2014); Fitzgerald et al. (2013)
Strategic and organisational	Reshaping of business models, value creation and inter organisational relationships	Structural reconfiguration, organisational change, capability development	Baiyere et al. (2020); Zoppelletto et al. (2023)

Source: synthesised from the studies cited in Section 2.1.

2.2 Supply chain efficiency in a digital setting

Traditional supply chains often run on fragmented data, limited visibility and reactive decisions. Digitalisation allows real-time monitoring, predictive planning and integrated coordination across supply chain stages (Karuppiah et al., 2024).

Table 2 contrasts traditional and digitally transformed supply chains on the dimensions that matter most for efficiency.

Table 2. Traditional versus digitally transformed supply chains

Dimension	Traditional supply chain	Digitally transformed supply chain
Data	Fragmented data across partners	Integrated, real-time data shared across partners
Visibility	Limited visibility along the network	Real-time monitoring, transparency and traceability

Source: synthesised from Karuppiah et al. (2024), Liu and Chi (2024) and Tavana et al. (2022).

2.3 Digital transformation and sustainability

A growing body of work links digital technologies to environmental, economic and social objectives (Mohaghegh et al., 2025; Li, 2022). Digital tools enable real-time tracking of emissions, better traceability and data-driven decisions.

Table 3. Theoretical lenses used to explain digital transformation outcomes

Theory	Core idea	Implication for supply chain efficiency
Resource-based view	Value arises when firms combine digital assets with complementary human and organisational resources	Technology alone rarely delivers advantage
Dynamic capabilities	Firms sense change, seize opportunities and reconfigure processes as conditions shift	Agility and process reconfiguration mediate the effect of digital transformation

Source: synthesised from the theoretical grounding of the reviewed studies (Section 4.2.1).

3. Methodology

This paper is a literature-based synthesis. Its evidence base is a systematic literature review (SLR) of digital transformation and sustainable supply chain research that followed the PRISMA guidelines for transparency, rigour and reproducibility (Liberati et al., 2009), supplemented by the primary studies cited in that review.

3.1 Evidence base and selection criteria

The underlying review searched Scopus, selected for its broad coverage of abstracts across fields (Marikyan et al., 2019).

Table 4. Search and selection criteria of the underlying review

Element	Specification
Database	Scopus
Period	2020 to 2025 (2020 treated as a structural break because of COVID 19)
Document type and language	Peer-reviewed journal articles written in English; conference papers, book chapters and non-academic publications excluded

4
Source: Chieh and Mohezar (2025), reconstructed from the review protocol.

3.2Analytic approach of this paper

This paper re-organises that evidence around supply chain efficiency. Findings were arranged under the three research questions, and cross-cutting patterns were used to build the conceptual framework in Section 6.

4.1 Research landscape and thematic clusters (RQ1)

Table 5. Documents published per year (approximate, 2020 to 2025)

Year	Documents	Share of sample	Trend
2020	about 23	about 4%	Early stage of interest
2021	about 41	about 7%	Growth after the pandemic shock
2022	about 71	about 11%	Steady growth
2023	about 111	about 18%	Rapid growth
2024	about 201	about 32%	Peak year
2025	about 178	about 28%	Lower count; likely indexing delay (partial year)
Total	625	100%	

Source: approximate values read from Figure 2 of Chieh and Mohezar (2025). The review's text describes 2024 as exceeding 220 publications, so exact counts should be confirmed against the Scopus export.

Source: adapted from Chieh and Mohezar (2025).

4.2 Effects on supply chain efficiency and sustainable performance (RQ2) Studies broadly agree that digital transformation improves sustainable supply chain performance, but the mechanisms and strength of the effect differ by dimension.

Table 6. Evidence on environmental performance

Study	Technology or practice	Reported effect
De la Calle et al. (2025); Sun et al. (2024); Meng et al. (2025)	IoT and big data analytics	Real-time monitoring of resource consumption, carbon emissions and waste along the supply chain
Meng et al. (2025)	Supply chain agility and integration as mediators	Effect on organisational sustainable performance runs through agility and integration
Karuppiah et al. (2024)	Circular economy in a digitally advanced supply chain	Real-time monitoring, predictive planning and integrated coordination replace fragmented data and reactive decisions

5 Source: synthesised from the studies cited in Section 4.2.2.

4.2.3 Social performance

Evidence on social outcomes is less developed. Emerging studies show that digital transformation can support monitoring of labour conditions, supplier compliance and ethical sourcing (Casciani et al., 2022), and that automating hazardous tasks can improve workplace safety, particularly in manufacturing (Ghobakhloo et al., 2025).

Table 7 Evidence on social performance

Study	Focus	Reported effect or concern
Casciani et al. (2022)	Fashion industry supply chains	Monitoring of labour conditions, supplier compliance and ethical sourcing
Ghobakhloo et al. (2025)	Human-centric, resilient manufacturing (Industry 5.0)	Automation of hazardous tasks improves workplace safety
Nosratabadi et al. (2023)	Social sustainability in EU-27 countries	Digital divides, job displacement and concentration of power in digital platforms; uneven benefits across regions

the studies cited in Section 4.2.3.

4.3 Enabling technologies, capabilities and conditions (RQ3)

Table 8 Characteristics of technologies that enable sustainable supply chain performance

Characteristic	Why it matters	Implication
Real-time data capture	Allows continuous monitoring and quick response	Visibility of waste, emissions and logistics movement
Supply chain integration	Allows data to flow across partners and tiers	Multi-tier visibility and shared data for emissions and traceability
Advanced analytics	Turns data into predictive decisions	Forecasting, predictive maintenance and planning

Source: synthesised from Schöggl et al. (2023) and Hamedani et al. (2025).

5. Survey Data Analysis (Synthetic Sample)

5.1 Data and analytical approach

This section analyses the 15-item questionnaire in Appendix A using a file of 120 records. Each record is labelled SYNTHETIC_SAMPLE_NOT_REAL_RESPONSE, so the dataset is synthetic.

5.2 Response distributions

Table 9Response frequencies, n (%): visibility, tracking and automation items

Item	A	B	C	D	E
Q1 Real-time visibility	27 (22.5%)	29 (24.2%)	30 (25.0%)	26 (21.7%)	8 (6.7%)
Item	**A**	**B**	**C**	**D**	**E**
Q3 Tracking of goods movement	21 (17.5%)	35 (29.2%)	32 (26.7%)	23 (19.2%)	9 (7.5%)
Q4 Automation reducing manual work	18 (15.0%)	31 (25.8%)	37 (30.8%)	26 (21.7%)	8 (6.7%)
Q6 Automation impact on efficiency	24 (20.0%)	30 (25.0%)	37 (30.8%)	16 (13.3%)	13 (10.8%)

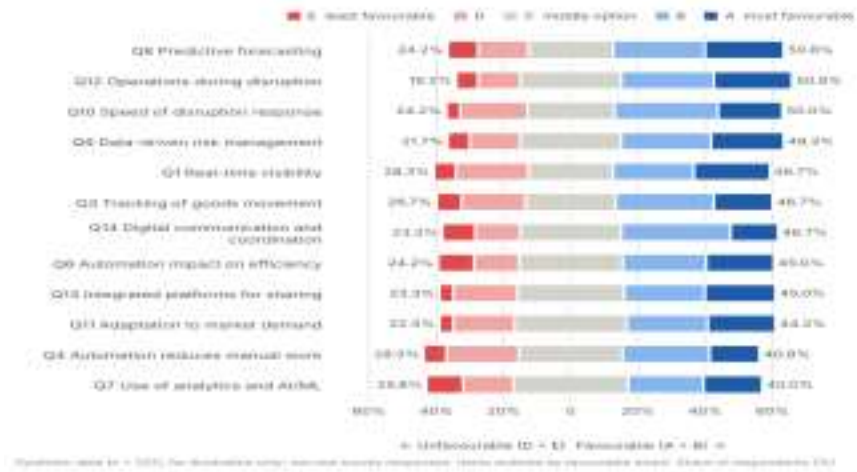


Figure 1. Distribution of responses on the twelve ordinal items

Note: segments show the share of respondents choosing each option from A (most favourable) to E (least favourable); labels at the bar ends give the unfavourable (D + E) and favourable (A + B) shares. Source: author's analysis of the synthetic dataset (n = 120).

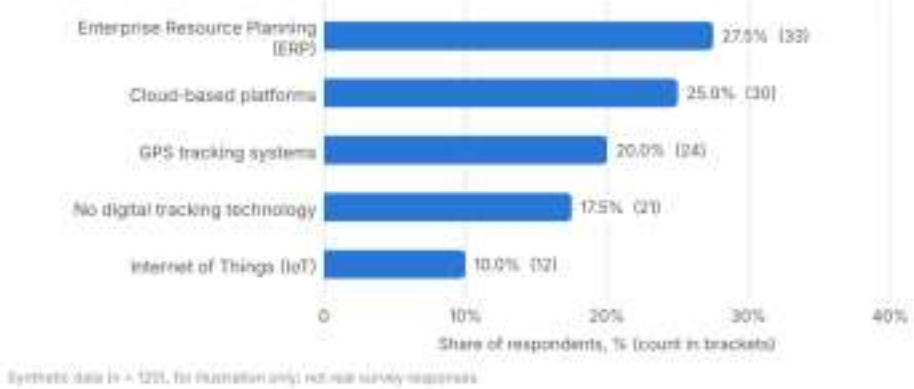


Figure 2. Technology mainly used to track inventory and logistics in real time (Q2) Source: author's analysis of the synthetic dataset (n = 120).

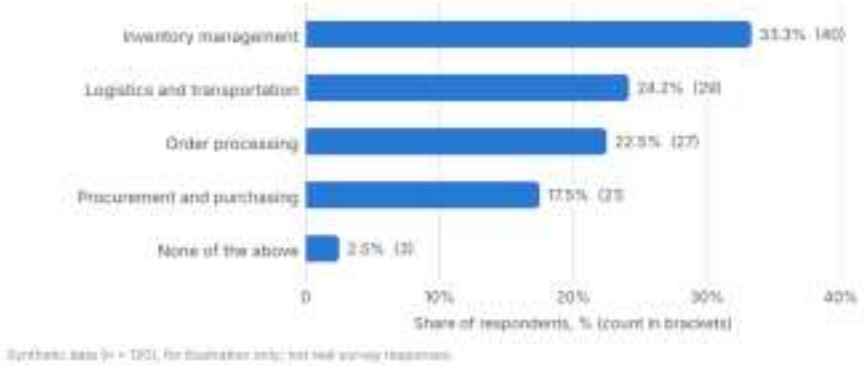


Figure 3. Supply chain process that benefited most from automation (Q5) Source: author's analysis of the synthetic dataset (n = 120).

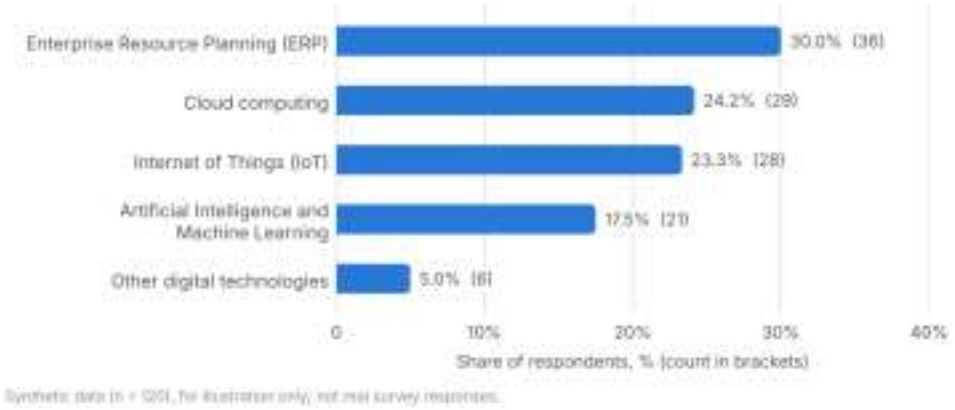


Figure 4. Technology most important for integration and collaboration (Q15) Source: author's analysis of the synthetic dataset (n = 120).

Figure 5 compares the five construct scores with the scale midpoint. All five bars extend beyond the midpoint, but the gap between the highest (agility, responsiveness and resilience, 3.42) and the lowest (process automation and efficiency, 3.25) is small.

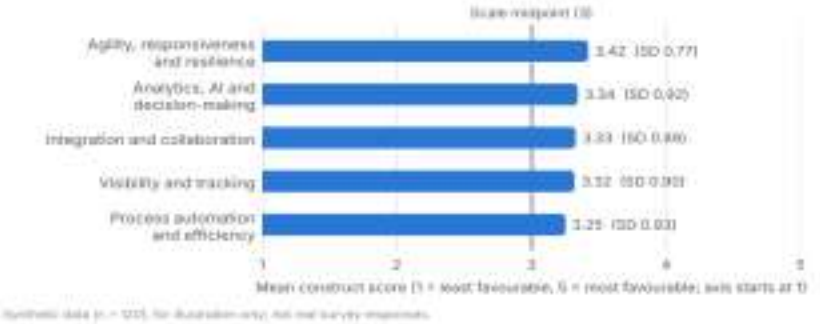


Figure 5. Mean construct scores compared with the scale midpoint

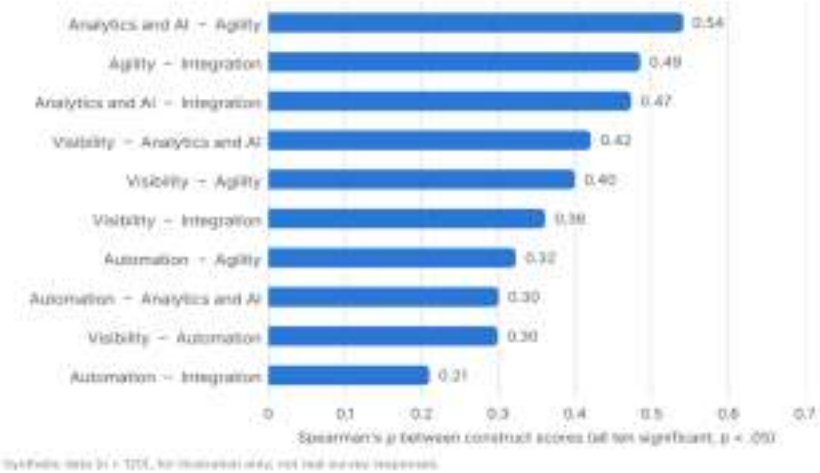


Figure 6. Spearman correlations between construct scores

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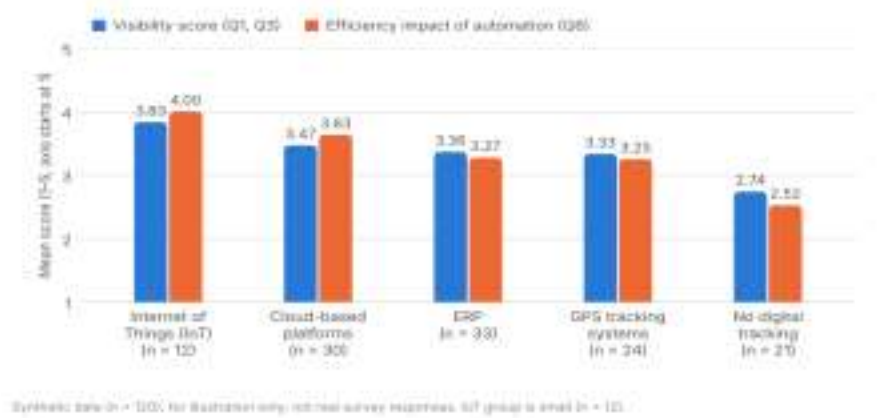


Figure 7. Visibility and efficiency scores by tracking technology (Q2)

6. Discussion

Across the three research questions, the evidence points to digital transformation as a socio-technical process. Efficiency and sustainability outcomes do not follow from adopting technology; they emerge from the interaction of technological characteristics, organisational capabilities and environmental context.

7. Implications

7.1 Theoretical implications

The synthesis supports capability-based and contextual explanations of digital transformation outcomes. It extends resource-based and dynamic capabilities arguments to supply chains by showing that integration, agility and inter-organisational trust operate.

7.2 Managerial implications

• Prioritise technologies that capture real-time data, integrate across partners and support advanced analytics over stand-alone or legacy systems.

• Invest in employee upskilling, digital leadership and a learning culture alongside technology spending.

8. Limitations and Future Research

Several limitations apply. The evidence base draws on a single database (Scopus), one subject area and English-language journal articles, so relevant work elsewhere may be missing. The 2025 data are incomplete. The cluster structure reflects the review's own grouping choices.

9. Conclusion

Digital transformation can raise supply chain efficiency, and it can do so while advancing environmental and, to a lesser and less certain extent, social goals. The evidence from 2020 to 2025 shows, however, that these results are conditional. They depend on integrated, real-time technologies, on leadership, culture, agility and collaboration inside and across firms, and on regulatory and market conditions.

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