PATTERNS OF DIGITAL TRANSFORMATION TECHNOLOGY ADOPTION IN THE MANUFACTURING SUPPLY CHAIN: AN EMPIRICAL ASSESSMENT

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Abstract—*This empirical study explores the determinants and patterns of digital transformation technology (DTT) adoption within manufacturing supply chains in the Coimbatore district. Using chi-square tests and ANOVA, the study examines associations between organisational characteristics, supply chain management (SCM) components, and technology adoption behaviour. The results show that factors such as organisational age, turnover, ERP/SCM usage duration, software vendor selection, and the level of SCM customisation significantly impact DTT usage duration and customer growth outcomes. The findings enhance supply chain digitisation literature by identifying the organisational drivers that influence the adoption and perceived importance of SCM components.*

Keywords: *Digital Transformation Technologies, Supply Chain Management, Manufacturing Industry, ERP Systems, SCM Software, Technology Adoption Patterns.*

INTRODUCTION

Digital transformation has become one of the most significant forces reshaping modern manufacturing supply chains. The rapid development of Industry 4.0 technologies—including the Internet of Things (IoT), artificial intelligence (AI), cloud computing, blockchain, and advanced analytics—has transformed how organisations plan, source, produce, distribute, and serve customers. Unlike earlier periods of gradual technological change, the current digital age represents a fundamental shift that changes organisational structures, supply chain processes, competitive strategies, and inter-organisational relationships. As global markets grow more volatile, interconnected, and driven by technology, manufacturing firms that do not adapt face risks of operational inefficiencies, reduced competitiveness, and diminished customer responsiveness.

Digital transformation technologies (DTT) have been particularly influential in supply chain management (SCM), where they facilitate end-to-end visibility, synchronisation of activities, predictive decision-making, inventory optimisation, supplier integration, and real-time customer communication. The shift from traditional, functionally siloed supply chains to digitally connected networks has enabled manufacturers to reduce lead times, increase production flexibility, minimise risk, and improve service fulfilment. Several studies confirm that digital technologies are now vital for developing agile, resilient, and sustainable supply chains capable of withstanding disruptions such as demand fluctuations, global crises, and supply shortages.

In the Indian context, manufacturing plays a major role in economic growth, employment, and regional industrial development. The Government of India's initiatives, such as "Make in India," "Digital India," and the emerging "Industry 4.0" movement, have sped up the adoption of digital practices among manufacturing companies. However, digital maturity remains inconsistent due to differences in organisational age, infrastructure standards, technological preparedness, financial resources, and management outlooks. Industrial centres like Coimbatore—famous for textiles, pumps, engineering parts, and precision manufacturing—offer a distinctive environment where traditional production methods coexist with advanced digital technologies. Consequently, organisations within this area display a broad range of digital adoption behaviours that deserve empirical study.

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Despite the increasing academic interest in digital transformation, several gaps remain in the literature. First, there is a lack of empirical evidence on how organisational characteristics—such as establishment year, turnover, scope of operations, ERP usage, SCM usage, vendor ecosystem, and customisation level—shape patterns of DTT adoption in Indian manufacturing. Second, although many studies recognise the importance of digitalisation, limited research examines how DTT adoption affects specific supply chain outcomes such as customer expansion, order volume, and the perceived importance of SCM components. Third, existing research predominantly focuses on technological capabilities, without adequately exploring the relationships among organisational structure, supply chain maturity, and software ecosystems.

This study addresses these gaps by empirically analysing the relationship between organisational profile variables and digital transformation adoption patterns among manufacturing firms in the Coimbatore district. Using chi-square tests and ANOVA, the research examines both the factors influencing and the effects of DTT adoption, including customer growth and the prioritisation of key SCM components—Planning, Sourcing, Manufacturing, Logistics, and Customer Service. It further reveals how technological readiness (ERP/SCM duration), system customisation, and vendor selection impact the depth and sustainability of digital transformation.

The importance of this study lies in its ability to offer new empirical insights into capability-driven digital transformation in emerging economies. Understanding these drivers is essential for helping organisations develop realistic digital roadmaps, allocate resources effectively, enhance supply chain resilience, and attain operational excellence. The findings also provide practical guidance for policymakers, technology vendors, and manufacturing leaders seeking to accelerate digital adoption across India's industrial landscape.

LITERATURE REVIEW

Digital transformation has become a critical driver of competitiveness in modern supply chain ecosystems, enabling firms to enhance integration, visibility, responsiveness, and data-driven decision-making across all operational layers. Scholars widely acknowledge that digital supply chains are reshaping traditional manufacturing processes. Büyüközkan and Göçer (2018) emphasise that digital technologies strengthen end-to-end supply chain integration through improved connectivity, real-time analytics, and automated decision support systems. Similarly, Ivanov et al. (2019) observed that digital transformation enhances supply chain resilience by improving the adaptability of planning systems and offering predictive insights during disruptions, making digitally mature supply chains more agile.

From a strategic perspective, Matt, Hess, and Benlian (2015) argue that digital transformation is not just a technological upgrade but a comprehensive organisational change process that requires strategic alignment, leadership vision, and ongoing capability development. Rogers' (2003) diffusion of innovation theory further supports that prior experience with information systems greatly speeds up the adoption of new technologies, indicating that firms with strong ERP or SCM foundations transition more easily into digital transformation technologies (DTT). In accordance with this, Zheng et al. (2021) found that ERP-enabled digital readiness offers a structural backbone for advanced digital initiatives, facilitating a smoother move towards automated and interconnected supply chain environments.

The Indian manufacturing landscape presents distinct challenges and opportunities. Singh and Hess (2020) observe that digital readiness among Indian manufacturers varies due to infrastructural constraints, legacy systems, and fragmented adoption strategies. Christopher (2016) emphasises that the performance of supply chains increasingly relies on technological responsiveness, especially in rapidly evolving markets such as India's automotive and textile sectors. Kache and Seuring (2017) reinforce this by highlighting the importance of big data analytics in boosting supply chain decision-making, leading to enhanced forecasts, better supplier coordination, and improved logistics synchronisation.

Digital transformation also provides operational and customer-focused benefits. Gunasekaran et al. (2017) found that the integration of digital tools enhances cost efficiency, customer satisfaction, and process transparency. Pagani (2013) explains how digital ecosystems improve manufacturing competitiveness through interconnected platforms that optimise value creation beyond organisational boundaries. Tortorella et al. (2020) further show that Industry 4.0 readiness varies considerably across firms depending on organisational maturity, managerial commitment, and technological competence, which collectively affect the success of digital transformation initiatives.

The adoption and integration of ERP–SCM systems are crucial for success in digitalisation. Sharma and Bhagwat (2018) assert that strong ERP–SCM integration is vital for operational excellence among Indian manufacturers. Li and Wang (2017) highlight the advantages of cloud-based supply chain systems in enhancing flexibility, scalability, and cross-

functional collaboration. Herold et al. (2021) emphasise that digital leadership and employee digital literacy are essential enablers of transformation, as leadership commitment influences both technological adoption and organisational culture.

Advanced technologies such as analytics, IoT, and smart products are also redefining supply chain roles. Srinivasan and Swink (2018) find that analytics capabilities provide firms with a competitive advantage by enhancing inventory optimisation, production scheduling, and market responsiveness. Jeble et al. (2018) highlight IoT as a vital enabler of smart warehousing, automated tracking, and real-time visibility. Porter and Heppelmann (2014) explain how smart, connected products reshape supply chain roles by facilitating predictive maintenance and automated replenishment systems. Narayanan et al. (2021) further demonstrate that digital maturity is strongly linked to operational agility, helping firms respond swiftly to customer demands and market fluctuations.

At the organisational level, the preparedness of IT infrastructure is crucial in shaping digital transformation outcomes. Gupta and Kohli (2019) argue that firms with robust IT infrastructure, vendor support, and system customisation capabilities are better equipped to adopt DTT effectively. Kumar and Rajesh (2020) reinforce this by demonstrating that digital adoption significantly enhances customer retention and operational performance in manufacturing settings.

Overall, the reviewed literature confirms that organisational characteristics, technological maturity, leadership, vendor ecosystems, and supply chain integration capabilities influence digital transformation. Nonetheless, empirical studies connecting these factors—particularly ERP duration, SCM customisation, software selection, and organisational profile variables—to digital transformation adoption patterns within Indian manufacturing remain scarce. This gap highlights the importance of the present study, which investigates these relationships in a detailed and region-specific context.

STATEMENT OF THE PROBLEM

Despite growing recognition of digital transformation as a strategic necessity, manufacturing organisations show considerable variation in their adoption levels, pace, and outcomes. While some firms quickly implement digital tools and integrate them effectively into supply chain processes, others face delays due to organisational age, financial constraints, lack of technological readiness, or limited IT capabilities. Existing literature highlights enablers of digital transformation, but empirical evidence linking organisational characteristics—such as turnover, ERP usage, SCM usage, vendor selection, and customisation—to technology adoption patterns in Indian manufacturing remains scarce. This study addresses this gap by examining how these organisational factors influence digital transformation adoption and its outcomes related to SCM efficiency, customer growth, and operational improvements.

RESEARCH METHODOLOGY

This study employed a quantitative research design with data collected from 210 manufacturing firms in the Coimbatore District. Chi-square tests examined the associations between organisational parameters and the duration of DTT adoption. ANOVA was used to assess differences in the significance of SCM components across customer and order outcomes.

RESULTS AND DISCUSSION

The empirical analysis reveals strong, multidimensional relationships between organisational characteristics and the patterns of digital transformation technology (DTT) adoption. Chi-square tests were applied to evaluate associations between organisational profile variables and DTT adoption duration. At the same time, ANOVA was used to assess differences in the perceived importance of supply chain components. The findings underscore that digital transformation is not uniformly experienced across manufacturing firms but is instead shaped by organisational age, technological readiness, software ecosystems, and strategic supply chain maturity.

Influence of Organisational Age, Turnover, and Business Scope

The duration of DTT usage varies significantly across organisations with different structural attributes. Older firms—particularly those established before 1991—demonstrate the highest proportion of long-term digital adoption (70.8%). This indicates that organisational legacy, resource stability, and accumulated knowledge enhance digital absorption capacity, echoing Rogers's (2003) arguments on innovation diffusion and organisational preparedness. Similarly, annual turnover exhibits a statistically significant association with DTT duration. Firms earning more than 200 crores report 66.7% long-term DTT adoption, suggesting that financial capacity is a strong enabler of sustained digital transformation.

Table 1: Summary of Chi-square Findings: Structural Variables and DTT Duration

Organisational Factor	χ² Value	p-value	Interpretation
Year of Establishment	48.422	<0.001	Older firms sustain DTT longer
Annual Turnover	31.756	0.002	Financially strong firms adopt longer
Scope of Business	14.908	0.002	International firms show stronger digital maturity

The scope of business operation also shapes digital readiness. International-level firms demonstrate higher long-term adoption, indicating that global competition acts as a catalyst for technological advancement. From a critical perspective, these findings challenge the notion that digital transformation is purely technology-driven; instead, they confirm that organisational structure, market exposure, and financial health are foundational to digital success.

ERP Experience, SCM Maturity, and Vendor Ecosystems

Technological readiness emerges as one of the most powerful predictors of DTT adoption. Firms with 11–15 years of ERP usage report an impressive 81% long-term digital adoption. Similarly, organisations with more than 10 years of SCM usage show 71.9% sustained adoption, reinforcing the argument that technological absorptive capacity—built through legacy IT investments—accelerates digital transformation. Vendor selection significantly affects digital performance. SAP and Oracle users exhibit stronger adoption patterns than those using Microsoft or other platforms, reflecting the advantages of advanced analytics, robust ecosystems, and high-quality integration.

Table 2: Summary of Chi-square Findings: Technological Variables and DTT Duration

Technological Factor	χ² Value	p-value	Interpretation
ERP Usage Duration	160.11	<0.001	Strongest predictor of long-term DTT
SCM Usage Duration	107.760	<0.001	Higher SCM maturity accelerates adoption
SCM Software Vendor	28.143	0.001	SAP/Oracle ecosystems support sustained adoption
SCM Customisation	46.157	<0.001	Customised SCM enhances DTT longevity

These results align with earlier research (Matt et al., 2015; Zheng et al., 2021) asserting that digital transformation heavily depends on an organisation's IT infrastructure and prior technological experience. Importantly, the findings suggest that digital transformation should be seen not as a single technological event but as a gradual process rooted in long-term capability development.

Customer Outcomes Show Strong Associations

The extent of customer increase after DTT adoption demonstrates several significant relationships with organisational characteristics.

Table 3: Significant Predictors of Customer Growth After DTT Adoption

Predictor Variable	χ² Value	p-value	Interpretation
Year of Establishment	18.253	0.006	Both old & new firms see significant growth
Annual Turnover	19.234	0.014	Mid-sized firms grow fastest
Scope of Operations	8.405	0.015	National firms show sharper growth
ERP Usage Duration	35.677	<0.001	Longer ERP usage leads to higher DTT outcomes
SCM Usage Duration	17.216	0.002	Short-term users see rapid gains

SCM Software Vendor	26.532	<0.001	Oracle has the strongest customer growth
SCM Customisation	27.128	<0.001	Standard modules lead to fast early growth

Firms established either very early (pre-1991) or very recently (post-2010) exhibit strong customer growth, indicating a bimodal distribution of digital benefits—experienced firms leverage stability, while younger firms utilise agility. Turnover, scope, ERP experience, SCM experience, vendor ecosystem, and levels of customisation also significantly impact customer growth. Mid-sized firms (51–100 crores) report the highest increase in customers (67.6%). These findings emphasise that digital transformation initially presents as improved customer visibility, responsiveness, and engagement—outcomes closely linked to digital-enabled interfaces, analytics, and CRM integration.

Order Outcomes Show No Significant Relationship

Unlike customer outcomes, increases in order volume do not significantly correlate with most organisational or technological factors. Firms report similar order increases regardless of turnover, ERP experience, or levels of customisation. This suggests that market expansion (customer growth) may respond quickly to digital transformation, while capacity-related metrics (order volume) rely on external factors such as market demand, production capacity, and competitive dynamics. From a critical perspective, this highlights a structural gap: digital transformation may enhance market visibility more rapidly than operational scalability.

Influence of DTT Duration on SCM Prioritisation

ANOVA analyses indicate that the perceived importance of all SCM components—Planning, Sourcing, Manufacturing, Logistics, and Customer Service—varies significantly with DTT duration. Firms with 2–3 years of DTT usage consistently assign the highest importance scores across SCM components. This "mid-phase optimisation effect" implies that firms experience the greatest operational improvements once initial digital adoption challenges stabilise.

Influence of Customer Growth on SCM Prioritisation

Customer growth also significantly influences SCM component priorities. Organisations experiencing substantial customer increases assign greater importance to all SCM functions, indicating that digitalisation encourages greater operational discipline to support new customers.

Table 4: ANOVA Summary: SCM Component Importance

SCM Component	F-Value	p-value	Interpretation
Planning	32.173	<0.001	Highly Significant
Sourcing	34.147	<0.001	Highly Significant
Manufacturing	36.208	<0.001	Highly Significant
Logistics	38.640	<0.001	Strongest Sensitivity
Customer Service	27.448	<0.001	Customer-Centric Impact

Interestingly, an increase in order volume does not impact SCM priorities, suggesting that internal process focus is shaped more by customer effects than by variations in order volume.

Critical Interpretation and Theoretical Implications

The findings overall support a multi-layered model of digital transformation influenced by: (1) Structural readiness – age, stability, financial robustness, (2) Technological absorptive capacity – ERP/SCM duration, customisation, (3) Vendor ecosystem synergy – SAP/Oracle effects, (4) Market-driven outcomes – customer growth rather than order increase. These results align with diffusion of innovation theory, resource-based view (RBV), and dynamic capabilities theory, reinforcing that digital transformation success depends on organisational capabilities, not technology alone. A key insight from the study is the delay between customer growth and order scalability, indicating that digital transformation initially enhances visibility and engagement, while operational impact materialises later.

CONCLUSION

The study concludes that the adoption of digital transformation technologies (DTT) in manufacturing supply chains is heavily influenced by organisational structure, technological readiness, and system-related capabilities. Older firms, organisations with higher turnover, and those operating in broader markets exhibit greater digital maturity, reflecting the importance of financial strength and strategic experience in supporting digital initiatives. Technological capabilities—particularly long-term ERP and SCM use—are the strongest indicators of sustained DTT adoption, showing that digital transformation gradually builds on previous system experience. Vendor ecosystems and system customisation also impact adoption depth, with SAP, Oracle, and customised SCM platforms enabling more stable and integrated digital use. While customer growth benefits from digital adoption, increases in orders have little connection with organisational variables, suggesting that digitalisation improves customer engagement before operational scale can be achieved. Additionally, digitally mature firms value core SCM components more highly, emphasising the role of digital tools in enhancing supply chain integration. Overall, the findings stress that capability building—rather than just technology acquisition—fuels meaningful digital progress, highlighting the importance of developing ERP/SCM maturity and investing in scalable digital architectures. Future research could investigate sectoral differences, long-term effects, and managerial perspectives to deepen understanding of digital transformation pathways.

REFERENCES

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[2]   Christopher (2016) reported that SCM performance is highly dependent on technological responsiveness.

[3]   Gunasekaran et al. (2017) found digital transformation improves cost efficiency and customer satisfaction.

[4]   Gupta & Kohli (2019) emphasised the role of IT infrastructure readiness in technology adoption decisions.

[5]   Herold et al. (2021) stressed digital leadership as a determinant for transformation success.

[6]   Ivanov et al. (2019) highlighted that digital tools improve supply chain resilience and real-time visibility.

[7]   Jeble et al. (2018) highlighted IoT as a significant enabler for smart warehousing.

[8]   Kache & Seuring (2017) identified big data analytics as a key driver of supply chain decision-making.

[9]   Kumar & Rajesh (2020) observed digital adoption boosts customer retention in manufacturing.

[10]   Li & Wang (2017) highlighted cloud adoption benefits for supply chain flexibility.

[11]   Matt, Hess & Benlian (2015) discussed the strategic role of digital transformation in redefining organisational processes.

[12]   Narayanan et al. (2021) found digital maturity strongly correlates with operational agility.

[13]   Pagani (2013) emphasised digital ecosystems as enablers of manufacturing competitiveness.

[14]   Porter & Heppelmann (2014) discussed smart connected products reshaping supply chain roles.

[15]   Rogers (2003) argued that prior technological experience facilitates faster adoption of new innovations.

[16]   Sharma & Bhagwat (2018) found ERP–SCM integration essential for operational excellence in Indian firms.

[17]   Singh & Hess (2020) observed that Indian manufacturers face uneven digital readiness due to infrastructural gaps.

[18]   Srinivasan & Swink (2018) identified analytics capability as a competitive advantage.

[19]   Tortorella et al. (2020) noted Industry 4.0 readiness varies across organisational maturity levels.

[20]   Zheng et al. (2021) found ERP-enabled digital readiness enhances digital transformation efficiency.

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