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Barriers to Digital Supply Chain Transformation in the Garment Manufacturing Sector: A Henry Garrett Ranking Approach

[1]Senthil S, [2]Pramila C and [*3]Jenifer Vasanth

[1, 2, *3]Assistant Professor, School of Commerce and International Business, Dr. G.R.Damodaran College of Science, Coimbatore, Tamil Nadu, India.

Abstract

The garment manufacturing sector plays a crucial role in global trade and employment, particularly in developing economies like India. In recent years, the adoption of digital supply chain technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain has become vital for improving operational efficiency, transparency, and competitiveness. However, despite their transformative potential, many garment units face significant challenges in implementing these technologies. This study aims to identify and analyze the key obstacles that hinder digital transformation in garment manufacturing units, with a focus on enterprises in Tirupur, Tamil Nadu. Using a descriptive research design and Henry Garrett Ranking Method, data were collected from 120 respondents representing small, medium, and large garment units. The challenges assessed include infrastructural limitations, financial constraints, skill shortages, resistance to change, and policy-related barriers. Findings reveal that *integration problems with existing ERP or legacy systems* ranked as the most critical challenge, followed by *lack of technical skills among employees* and *high initial investment costs*. Conversely, *technology interoperability issues* ranked the lowest. The study highlights that both technological and organizational readiness significantly influence digital adoption success. The results emphasize the need for strategic interventions through government incentives, capacity-building programs, and technology partnerships. By addressing these barriers systematically, garment units can enhance supply chain agility, sustainability, and resilience in an increasingly digitalized global market.

Keywords: Digital, Manufacturing, Supply Chain, Internet of Things, Artificial Intelligence.

1. Introduction

1.1. Background of Digital Supply Chain Technologies in Garment Units

The Ready-Made Garments (RMG) industry stands as a pivotal sector in many developing and emerging economies, serving as a major employment provider and export revenue generator. However, this sector has increasingly encountered intense global competition, pushing garment units toward the integration of digital technologies within their supply chains to gain operational efficiency and enhance competitiveness. Digital supply chain technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain have emerged as critical enablers that support garment manufacturers in streamlining their operations, achieving greater transparency, and meeting the demands of evolving consumer expectations (Babu *et al*., 2022). These technologies provide real-time monitoring and data-driven insights that empower manufacturers to anticipate challenges, optimize resource allocation, and adapt dynamically to market fluctuations. The adoption of advanced digital solutions is not merely an option but a strategic imperative for garment units seeking to sustain their global market position (Thadepalli & Choudhary, 2024). IoT sensors embedded in smart garments facilitate inventory management by providing accurate and timely information about stock levels and garment conditions. AI-driven analytics enable precise demand forecasting, quality control, and supply chain optimization, helping to eliminate inefficiencies and reduce waste. Blockchain technology introduces an immutable ledger system that enhances traceability and authenticity, thereby reinforcing trust across the supply chain (Hui *et al*., 2023). Together, these technologies form an integrated ecosystem that supports smart manufacturing, improves production planning, and elevates customer engagement. Despite these technological advances, the road to digital transformation in garment supply chains is fraught with considerable implementation challenges. These include infrastructural limitations, financial barriers, workforce skill gaps, and organizational resistance, which collectively hinder seamless technology adoption. Understanding these challenges in depth is crucial for

***Corresponding Author:** Jenifer Vasanth

developing effective strategies to harness the full potential of digital supply chain technologies in garment units, ensuring sustained growth and resilience in an increasingly complex and competitive landscape (Susitha *et al*., 2024).

1.2. Significance of Digital Transformation in Garment Supply Chains

Digital transformation in garment supply chains has profound implications for operational efficiencies, agility, and transparency. These factors are increasingly critical given the dynamic nature of global fashion markets, characterized by rapid changes in consumer preferences, supply disruptions, and the necessity for sustainability. Digitalization enhances supply chain visibility, enabling manufacturers to track their raw materials and finished goods accurately throughout the production and distribution phases, thus minimizing inefficiencies and reducing the risk of counterfeiting or poor labor practices. The integration of sophisticated digital tools fosters supply chain agility, allowing garment units to respond rapidly to shifts in demand and to optimize production scheduling and inventory management. Furthermore, the application of digital technologies positively affects logistics and distribution by improving real-time cargo tracking, automating documentation processes, and facilitating seamless communication between supply chain nodes. This results in enhanced reliability, reduced lead times, and improved overall customer experience. For example, AI-driven trend forecasting and virtual garment design streamline product development cycles, enabling faster go-to-market strategies while reducing costs associated with overproduction. The digital engagement platforms also open new avenues for consumer interaction, including personalized recommendations and immersive shopping experiences through augmented and virtual reality technologies. The market forces driving this adoption are multifaceted. Increasing consumer awareness about sustainability and ethical production pressures brands and suppliers to embrace transparent and accountable supply chains. Additionally, global competitive pressures require garment units to adopt technology-enabled processes to optimize operational costs and improve compliance with international standards. Finally, the ongoing digital revolution, accelerated by the COVID-19 pandemic, has normalized remote operations and digital interactions, further emphasizing the need for comprehensive digital transformation strategies within the garment sector.

1.3. Scope and Objectives of the Study

The primary objective of this study is to systematically identify and analyze the major challenges faced by garment units in implementing digital supply chain technologies. By conducting a comprehensive synthesis of existing literature, the study aims to bridge existing knowledge gaps related to technological, organizational, financial, and environmental barriers. This examination goes beyond surface-level technological adoption issues to reveal the complex interdependencies affecting the success of digital transformations in garment supply chains. A key focus is placed on understanding how environmental considerations influence technology adoption decisions, considering the rising importance of sustainable practices in the sector. Furthermore, the study seeks to unravel the multifaceted challenges encountered by garment exporters, particularly in resource-constrained settings, such as technological infrastructure deficits and regulatory complexities.

2. Review of Literature

2.1. Key Technologies Adopted in Garment Supply Chains

The digital supply chain landscape in the garment industry prominently features several key technologies that drive enhancements in operational transparency, efficiency, and quality. Among these, IoT-based smart garments and inventory management technologies have revolutionized stock tracking and product lifecycle monitoring (Wu, 2024). Smart garments embedded with IoT sensors enable detailed monitoring of fabric conditions, usage patterns, and maintenance needs, allowing for better inventory optimization and customer engagement. These innovations afford garment manufacturers and retailers a more granular view of asset location and status, significantly reducing losses from shrinkage and delays in replenishment. Artificial Intelligence (AI) applications play a multifaceted role in forecasting demand, quality control, and supply chain optimization (Sankarprabhu & Chandrasekaran, 2025). Machine learning algorithms analyze complex datasets to predict consumer trends, optimize material procurement, and automate quality assurance processes by detecting fabric defects or stitching inconsistencies with high accuracy. AI-driven analytics contribute to operational decision-making by dynamically adjusting production schedules and inventory levels to minimize waste and ensure timely fulfillment. Blockchain technology is increasingly leveraged to bolster transparency and traceability throughout the garment supply chain (Agarwal *et al*., 2020). By maintaining decentralized, immutable ledgers, blockchain allows all supply chain stakeholders to verify product provenance, compliance with labor standards, and authenticity of raw materials. This transparency not only strengthens consumer trust but also facilitates compliance with global regulatory requirements. The implementation of blockchain solutions thus supports garment units in managing reputational risks and enhancing supply chain governance.

2.2. Emerging Innovations: 3D Body Scanning and Additive Manufacturing

Emerging technologies such as 3D body scanning and additive manufacturing represent transformational innovations poised to disrupt traditional garment supply chains. 3D body scanning technology uses advanced sensors and cameras to capture precise body measurements, enabling the production of custom-fit clothing or improved fit in mass-produced garments (Salman *et al*., 2024). This technology has demonstrated benefits in reducing textile waste by minimizing returns due to fit issues and improving customer satisfaction through personalized apparel offerings. The adoption of 3D scanning also shortens product development cycles by integrating virtual fitting into design processes, thereby accelerating time to market. Additive manufacturing, on the other hand, introduces opportunities for decentralized production and rapid prototyping, particularly for low-demand or specialized garment components (Pant & Palanisamy, 2025). This approach challenges the traditional centralized mass production paradigm by enabling localized, on-demand manufacturing that reduces inventory costs and supply chain complexity. Additive manufacturing allows for greater design flexibility and customization, which align well with contemporary consumer preferences for personalized products. However, its adoption is constrained by technical factors such as material limitations, production speed, and post-processing requirements, as well as economic considerations linked to scale and cost-effectiveness. The

integration of these new technologies faces unique challenges including technological readiness, interoperability with existing systems, and workforce preparedness. Moreover, these innovations require coherent organizational strategies and investment in skills development to fully realize their disruptive potential in garment supply chains (Mahmood *et al*., 2025).

2.3. Digital Platforms and Integration Approaches

Beyond individual technologies, the adoption of integrated digital platforms constitutes a critical dimension of digital supply chain maturity in garment units. Enterprise Resource Planning (ERP) systems facilitate comprehensive coordination across various supply chain functions including procurement, production, inventory management, and distribution. Effective selection of optimal ERP software involves multi-criteria decision-making models that evaluate relative system functionalities and compatibility with existing organizational processes (Heim *et al*., 2022). However, integration challenges persist due to disparate data management systems employed by different stakeholders within the supply chain. Lack of data standardization and interoperability hinders seamless information exchange, thereby limiting the effectiveness of supply chain coordination and collaborative decision-making. These integration issues obstruct efforts to establish end-to-end supply chain visibility, which is vital for achieving efficiency gains and sustainability goals. Digital platforms that enable real-time data sharing and analytics across the supply chain are gaining prominence. Yet, the adoption of such platforms is often limited by technological fragmentation, data security concerns, and organizational silos. Overcoming these issues requires both technological solutions and governance mechanisms that encourage collaboration and trust among supply chain partners (Chowdhury *et al*., 2023).

3. Research Methodology

This study adopts a descriptive research design to systematically identify and analyze the major challenges faced by garment manufacturing units in implementing digital supply chain technologies. The design is appropriate for describing the current scenario, perceptions, and obstacles encountered by industry professionals regarding digital transformation in garment supply chains. The research is conducted among garment manufacturing units in Tirupur, Tamil Nadu, which is widely recognized as the knitwear capital of India. Tirupur serves as an ideal location due to its strong export orientation and growing adoption of digital technologies in supply chain processes. The study employs a probability sampling method, specifically stratified random sampling, to ensure adequate representation of small, medium, and large garment units. Each stratum represents a distinct enterprise size, enabling comparative analysis across categories. A total of 120 respondents including production managers, merchandisers, IT coordinators, and supply chain executives were surveyed. The sample size is considered adequate for descriptive statistical analysis and for applying Henry Garrett ranking to determine the priority of challenges. Primary data has been collected through a structured questionnaire consisting of two sections: Section A: Demographic details of respondents and organizational profile. Section B: Statements related to challenges in implementing digital supply chain technologies, rated using the Henry Garrett ranking technique. Secondary data has been drawn from research journals, industry reports, and government publications to support and validate the primary findings.

4. Findings & Discussion

Challenges Faced by Garment Manufacturing Units in Implementing Digital Supply Chain Technologies

The Challenges faced by garment manufacturing units in implementing digital supply chain technologies were analysed through Henry Garret Ranking Method. The challenges includes ‘Limited digital infrastructure and unreliable internet connectivity’, ‘High initial investment and maintenance costs’, ‘Lack of technical skills among employees’, ‘Resistance to change within the organization’, ‘Data privacy and cybersecurity concerns’, ‘Integration problems with existing ERP or Legacy systems’, ‘Financial limitations of MSME’, ‘Regulatory and policy related obstacles’, ‘Technology interoperability issues’, and ‘Lack of sustainable and environmentally ready technologies.

Number of Respondents Who Ranked the Factors

Table 1: Number of Respondents who ranked the Factors

Challenges/Rank	1	2	3	4	5	6	7	8	9	10
C1 - Limited digital infrastructure and unreliable internet connectivity	13	9	22	10	12	11	12	11	10	10
C2 - High initial investment and maintenance costs	13	15	11	9	21	12	8	14	8	9
C3 - Lack of technical skills among employees	10	20	15	13	7	9	23	3	10	10
C4 - Resistance to change within the organization	14	12	8	20	14	13	9	6	12	12
C5 - Data privacy and cybersecurity concerns	16	10	15	13	17	8	5	12	8	16
C6 - Integration problems with existing ERP or legacy systems	16	18	15	9	7	16	10	14	6	9
C7 - Financial limitations of MSMEs	10	16	3	10	8	12	21	9	19	12
C8 - Regulatory and policy-related obstacles	10	12	7	13	12	11	15	16	14	10
C9 - Technology interoperability issues	10	2	9	10	12	11	8	24	22	12
C1O - Lack of sustainable and environmentally ready technologies	14	6	15	13	10	17	9	11	11	14

Source: *Primary Source*

Percent position = 100(Rij-0.5)/Nj
Rij = 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th ranks
Nj = Total rank given by 272 respondents = 10

Table 2: Percent Position Table

Rank	100(Rij-0.5)	Percent position
1	100(1-0.5)/10	5
2	100(2-0.5)/10	15
3	100(3-0.5)/10	25
4	100(4-0.5)/10	35
5	100(5-0.5)/10	45
6	100(6-0.5)/10	55
7	100(7-0.5)/10	65
8	100(8-0.5)/10	75
9	100(9-0.5)/10	85
10	100(10-0.5)/10	95

Source: *Primary Source*

From Henry Garret table, Garret value is found for the percent position

Table 3: Garret Value table for the percent position

Rank	Percent Position Value	Garret Value
1	5	82
2	15	70
3	25	63
4	35	58
5	45	52
6	55	48
7	65	42
8	75	36
9	85	29
10	95	18

Source: *Primary Source*

For each rank, garret value is multiplied by given value in the table

Table 4: Challenges Faced by manufacturing units

Challenges/Rank	1*82	2*70	3*63	4*58	5*52	6*48	7*42	8*36	9*29	10*18
C1 - Limited digital infrastructure and unreliable internet connectivity	1066	630	1386	580	624	528	504	396	290	180
C2 - High initial investment and maintenance costs	1066	1050	693	522	1092	576	336	504	232	162
C3 - Lack of technical skills among employees	820	1400	945	754	364	432	966	108	290	180
C4 - Resistance to change within the organization	1148	840	504	1160	728	624	378	216	348	216
C5 - Data privacy and cybersecurity concerns	1312	700	945	754	884	384	210	432	232	288
C6 - Integration problems with existing ERP or legacy systems	1312	1260	945	522	364	768	420	504	174	162
C7 - Financial limitations of MSMEs	820	1120	189	580	416	576	882	324	551	216
C8 - Regulatory and policy-related obstacles	820	840	441	754	624	528	630	576	406	180
C9 - Technology interoperability issues	820	140	567	580	624	528	336	864	638	216
C1O - Lack of sustainable and environmentally ready technologies	1148	420	945	754	520	816	378	396	319	252

Source: *Primary Source*

All the calculated values are totalled row wise

Table 5: Challenges faced by garment manufacturing units

Factor/Rank	1*82	2*70	3*63	4*58	5*52	6*48	7*42	8*36	9*29	10*18	Total
C1	1066	630	1386	580	624	528	504	396	290	180	6184
C2	1066	1050	693	522	1092	576	336	504	232	162	6233
C3	820	1400	945	754	364	432	966	108	290	180	6259
C4	1148	840	504	1160	728	624	378	216	348	216	6162
C5	1312	700	945	754	884	384	210	432	232	288	6141
C6	1312	1260	945	522	364	768	420	504	174	162	6431
C7	820	1120	189	580	416	576	882	324	551	216	5674
C8	820	840	441	754	624	528	630	576	406	180	5799
C9	820	140	567	580	624	528	336	864	638	216	5313
C10	1148	420	945	754	520	816	378	396	319	252	5948

Source: *Primary Source*

The total score is divided my number of respondents to calculate average score, then rank the highest average score as I and the least average score with Rank X.

Table 6: Henry Garret Rank Table

Factors	Total	Average Score	Rank
C1	6184/120	51.53	IV
C2	6233/120	51.94	III
C3	6259/120	52.16	II
C4	6162/120	51.35	V
C5	6141/120	51.18	VI
C6	6431/120	53.59	I
C7	5674/120	47.28	IX
C8	5799/120	48.33	VIII
C9	5313/120	44.28	X
C10	5948/120	49.57	VII

Source: *Primary Source*

From the table, it can be inferred that the problem 'C6 - Integration problems with existing ERP or legacy systems' ranks I with an average Garrett score of 53.59, the variable 'C3 - Lack of technical skills among employees' ranks II with an average Garrett Sccore of 52.16, the vairbale 'C2 - High initial investment and maintenance costs' ranks III with an average score of 51.94, the variable 'C1 - Limited digital infrastructure and unreliable internet connectivity' ranks IV with an average score of 51.53, the variable 'C4 - Resistance to change within the organization' ranks V with an average score of 51.35, the variable 'C5 - Data privacy and cybersecurity concerns' ranks VI with an average score of 51.18, the variable 'C10 - Lack of sustainable and environmentally ready technologies' ranks VII with an average score of 49.57, the variable 'C8 - Regulatory and policy-related obstacles' ranks VIII with an average score of 48.33, the variable 'C7 - Financial limitations of MSMEs' ranks IX with an average score of 47.28 and the vairable 'C9 - Technology interoperability issues' ranks X with an average score of 44.28.

The findings indicate that while garment manufacturers recognize the potential of digital supply chain technologies, successful implementation is hindered by a combination of technical, financial, infrastructural, and human factors. To overcome these barriers, a holistic approach involving government support, industry collaboration, capacity-building initiatives, and technological upgradation is essential for fostering a digitally resilient and competitive garment manufacturing sector.

Conclusion

The study concludes that while digital transformation presents immense opportunities for the garment manufacturing sector, its implementation remains complex and multifaceted. The Henry Garrett ranking analysis identified integration problems with existing ERP or legacy systems as the foremost challenge, reflecting the incompatibility between traditional operational frameworks and modern digital technologies. Furthermore, the lack of technical skills among employees, coupled with high implementation and maintenance costs, underscores the urgent need for workforce development and financial support mechanisms. Infrastructure gaps, particularly unreliable internet connectivity, and organizational resistance to change further exacerbate the digital divide between large and small enterprises. The findings also reveal that environmental sustainability and regulatory compliance, though gaining attention, still lag behind in technological readiness. To ensure a smooth digital transition, garment units must prioritize continuous training, strategic technology planning, and collaborative partnerships with digital solution providers. Policymakers should formulate supportive regulations, financial incentives, and infrastructure upgrades to promote technology diffusion among MSMEs. The success of digital supply chain transformation depends on a holistic ecosystem that integrates technology, people, and processes. By overcoming these challenges, the garment sector can strengthen its competitive edge, enhance operational efficiency, and align with global sustainability and transparency standards. Ultimately, this study provides valuable insights for industry practitioners, policymakers, and researchers aiming to foster a digitally empowered and future-ready garment manufacturing ecosystem.

References

1. Agrawal P, Narain R & Ullah I. Analysis of barriers in implementation of digital transformation of supply chain using interpretive structural modelling approach. *Journal of Modelling in Management.* 2020; 15(1):297–317. https://doi.org/10.1108/JM2-03-2019-0066
2. Chowdhury MMH, Rahman S, Quaddus MA & Shi Y. Strategies to mitigate barriers to supply chain sustainability: An apparel manufacturing case study. *Journal of Business & Industrial Marketing.* 2023; 38(4):869–885. https://doi.org/10.1108/JBIM-04-2021-0233
3. Heim H, Chrimes C & Green C. Digital hesitancy: Examining the organisational mindset required for the adoption of digitalised textile supply chain transparency. In S. S. Muthu (Ed.), *Blockchain technologies in the textile and fashion industry*, 2022, pp. 45–68. Springer. https://doi.org/10.1007/978-981-19-6569-2_3
4. Hui G, Rusli RD & Aris A bt. Remodeling the traditional fashion industry in the era of Industry 4.0. *International Journal of Global Optimization and Its Application.* 2023; 2(3):165–178. https://doi.org/10.56225/ijgoia.v2i3.259
5. Mahmood M, Habib MA, Ahmad M & Baig SA. Barriers to adoption of Industry 4.0 in textile sector: Analyzing challenges in transitioning to smart manufacturing with ISM and MICMAC. *IEEE Access.* 2025; 13:146722–146744. https://doi.org/10.1109/ACCESS.2025.3600580
6. Mohiuddin Babu M, Akter S, Rahman M, Billah MM & Hack-Polay D. The role of artificial intelligence in shaping the future of Agile fashion industry. *Production Planning & Control.* 2022; 35(15):2084–2098. https://doi.org/10.1080/09537287.2022.2060858
7. Pant K & Palanisamy P. Navigating the path to Industry 4.0: A study on key barriers in Indian textile supply chain. *Benchmarking: An International Journal.* Advance online publication, 2025. https://doi.org/10.1108/BIJ-11-2024-0970
8. Salman S, Hasanat S, Rahman R & Moon M. Analyzing the key barriers of adopting Industry 4.0 in Bangladesh's ready-made garment industry: An emerging economy example. *International Journal of Industrial Engineering and Operations Management.* 2024; 6(3):232–255. https://doi.org/10.1108/IJIEOM-04-2023-0034
9. Sankarprabhu M & Chandrasekaran DG. Challenges faced by garment exporters of Tirupur in the

digitalization of ICDs and CFS. *International Journal for Multidisciplinary Research.* 2025; 7(1):1–7. https://doi.org/10.36948/ijfmr.2025.v07i01.37440

10. Susitha E, Jayarathne A & Herath R. Integrating agility and digital capabilities: A new paradigm for competitive supply chain performance in the apparel sector. *Journal of Business and Technology.* 2024; 8(2):65–98. https://doi.org/10.4038/jbt.v8i2.124
11. Thadepalli S & Choudhary MU. Synergy of real and digital worlds – promising insights for the future generations of fashion. *International Journal of Recent Technology & Engineering.* 2024; 13(1):22–26. https://doi.org/10.35940/ijrte.a8054.13010524
12. Wu E. The impact and pathways of digitalization on the development of the fashion industry. *Highlights in Business, Economics and Management.* 2024; 46:220–225. https://doi.org/10.54097/8kwv5n85.