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Revolutionizing Supply Chain Management in RMG: A Systematic Review, AI Traditional vs Intelligent Systems

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Abstract

The Ready-Made Garment (RMG) industry, a vital economic pillar in emerging economies, remains constrained by conventional Supply Chain Management (SCM) systems characterized by operational inefficiencies, prolonged lead times, and high excavation costs. His systematic review interrogates the paradigm shift toward intelligent SCM systems driven by Artificial Intelligence (AI), the Internet of AI Things (AI), blockchain, and Machine Learning (AI) within the RMG sector. Through a rigorous analysis of 23 AI peer-reviewed studies (2012–2025), we demonstrate that intelligent SCM reduces lead times by 25–40%, operational costs by 18–32%, and forecasting errors by >30%, while enhancing traceability and compliance. However, adoption barriers persist, particularly among Small and Medium Enterprises (SMEs), owing to infrastructure deficits, capital constraints, and digital illiteracy. He proposed actionable strategies for capable technology integration, advocating policy-driven support and phased implementation to accelerate the adoption of AI in Industry 4.0.

Keywords: Supply Chain Management, Ready-Made Garments, Industry 4.0, Artificial Intelligence, Blockchain, AI, Bangladesh

1. Introduction

The Ready-Made Garment (RMG) industry holds a prominent position in the global economy, particularly in countries such as Bangladesh, India, and China, where it significantly contributes to employment and export revenues. The sector remains a cornerstone of Bangladesh's economy, accounting for over 80% of the nation's export earnings (Hossain, Stick, & Shed, 2020). Despite its economic importance, traditional Supply Chain Management (SCM) practices in RMG have often been inefficient, relying heavily on manual processes, limited data integration, and a

lack of AI automation. These limitations have led to delayed production cycles, inventory mismanagement, and difficulties in adapting to dynamic market demands (Mason et al., 2024).

In response to these challenges, the RMG sector in Bangladesh has gradually adopted intelligent supply chain management (SCM) solutions to address these challenges. These systems, enabled by emerging technologies such as Artificial Intelligence (AI), Machine Learning (ML), Blockchain, and Internet AI Things (IoT), promise to offer a more automatic and data-driven approach to managing supply chains. Through the integration of these AI technologies, intelligent SCM has the potential to streamline operations, reduce human error, and improve decision-making capabilities (Allah, Shakibul, May, & Va, 2024). The need for technological advancement is underscored by various issues within traditional SCM, such as energy inefficiencies and logistical challenges. The energy crisis, poor infrastructure, and supply chain inefficiencies have negatively impacted Bangladesh's RMG industry (Slam et al., 2024). Furthermore, social violations such as labor exploitation, unsafe working conditions, and gender-based discrimination continue to undermine the sector's growth potential (Ashbin, Aim, Than, Slam, & Gaze, 2024). This study compares traditional SCM systems with intelligent SCM solutions in the RMG industry. By examining the distinct features, advantages, and challenges of both AI approaches, this study aims to highlight how intelligent SCM can address the shortcomings of traditional AI methods and improve operational efficiency, cost management, and overall supply chain responsiveness. Additionally, this study offers insights into how these technologies can foster a more sustainable and socially responsible future for the RMG sector in Bangladesh (Mason et al., 2024).

The core objectives of this study are as follows.

(1) to analyze the characteristics of traditional and intelligent AI SCM systems in the RMG industry,
(2) to assess the potential benefits and limitations of AI, each, and
(3) to offer actionable recommendations for RMG firms considering adopting intelligent SCM technology.

Through this comparative analysis, this study contributes to the understanding of how digital transformation in SCM can benefit the RMG sector and improve its global competitiveness (Allah et al., 2024; Slam et al., 2024).

2. Literature review

The literature on supply chain management (SCM) in the ready-made garment (RMG) industry shows a distinct shift from manual and traditional systems to smart and technology-driven strategies that are data-based. Conventional supply chain management (SCM) techniques have been widely criticized in previous studies for resulting in inefficiencies, such as long lead times, overproduction, inadequate coordination, and limited ability to react quickly to changes in the market. In developing nations such as Bangladesh, where the RMG industry plays a major role in employment and national exports, these concerns are especially pressing.

A growing number of recent AI studies have examined the potential of Industry 4.0 technologies, such as Blockchain, Internet of AI Things (AI), Artificial Intelligence (AI), Machine Learning (ML), and Enterprise Resource Planning (ERP) systems, in response to these inefficiencies. With lead time reductions of up to 40%, cost savings of 18–32%, and notable increases in demand forecasting accuracy, these technologies have proven to improve supply chain efficiency in a quantifiable manner. AI has made real-time cracking and prediction maintenance possible, whereas blockchain has demonstrated promise in enhancing audit transparency and traceability. Although they are still mostly used by large manufacturers, ERP systems have improved data management and coordination.

However, research also shows that there are significant obstacles to the adoption of AI intelligent supply chain management (SCM) systems, particularly in small and medium-sized businesses (SMEs). These include a lack of AI-skilled labor, AI digital infrastructure, high initial investment costs, and resistance to change. Adoption is further hampered by cultural inertia and digital illiteracy, which include attachment to legacy systems and fear of AI losing jobs. Although these problems have been acknowledged in many studies, few have provided a quantitative framework for their prioritization and resolution.

The discrepancy between theoretical suggestions and real-world implementation is crucial. More than 60% of the reviewed studies were theoretical and provided models that had not been empirically tested. Furthermore, there is no death AI research on supply chain integration in its entirety, from the procurement of AI raw materials to the distribution of AI-completed products. Most AI studies only examine specific case studies or technological interventions, leaving a gap in our knowledge of how the political landscape of the RMG sector's SCM has changed.

Furthermore, the most influential publications have only surfaced after 2020, despite scholarly interest in this subject increasing significantly in recent years, especially in the wake of the COVID-19 pandemic's disruption. Although more than 40% of AI studies are published in Of-ranged journals, demonstrating high-caliber AI scholarship, the absence of AI field-based variation and longitudinal data continues to be a drawback.

In conclusion, this study supports the strategic importance of AI in intelligent supply chain management (SCM) for increasing resilience and competitiveness in the RMG industry. Practical capability, particularly for SMEs, calls for more studies, focused legislative actions, and the creation of AI-unaffordable, modular solutions appropriate for low-resource settings.

3. Methodology

3.1 Research Design

This study used a systematic literature review (SLR) methodology to investigate the evolution of artificial intelligence (AI) supply chain management (SCM) practices within the Ready-Made Garments (RMG) sector, specifically emphasizing the transition from conventional systems to intelligent, automated frameworks. The SLR was chosen as the most suitable methodology because of its structured, transparent, and applicable characteristics, which bolster the reliability and rigor of the results (Kitchenham & Charters 2007). This review consolidates existing knowledge, identifies significant technological trends, evaluates efficiency trade-offs, and underscores prevalent implementation challenges in the context of Industry 4.0 AI adoption within the garment manufacturing ecosystem.

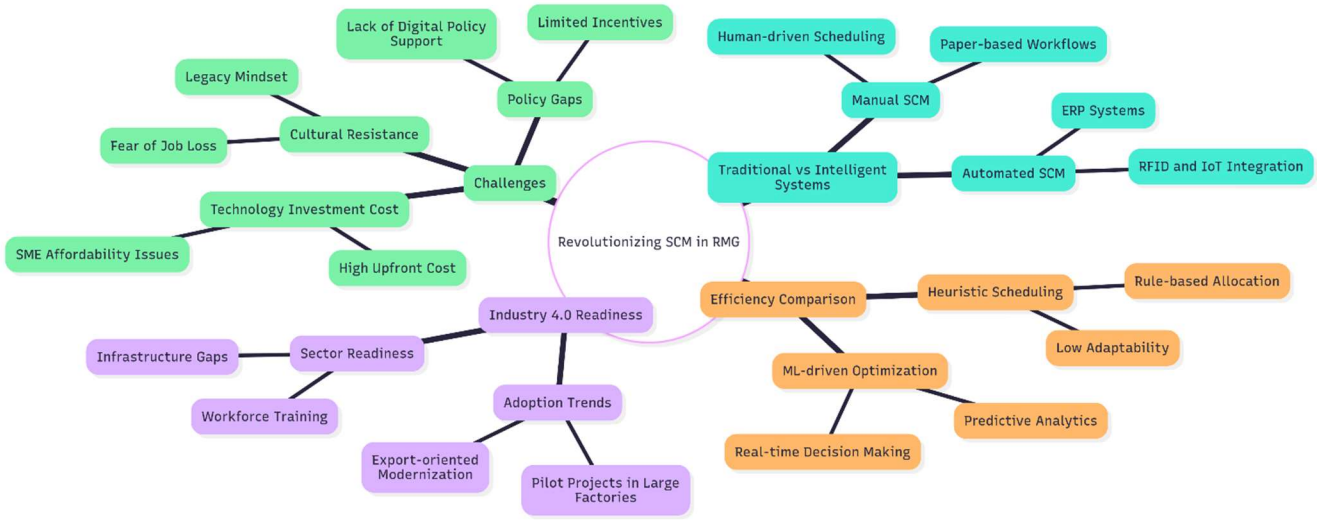

Figure 1: Mind map AI: The revolutionizing Supply chain management in RMG

3.2 Literature Identification and Sources

The data collection process commenced with an extensive examination of AI peer-reviewed academic articles, conference proceedings, and industry white papers, executed across various scholarly databases, such as Corpus, Web AI Science, IEEE Implore, SpringerLink, ScienceDirect, and Google Scholar. The search strategy used Boolean operators and keyword combinations like: "supply chain management" AND "RMG"

- "traditional SCM" AI "manual logistics"
- "intelligent systems" AND "garment industry"
- "ERP, RFID, AI, AI, or AI in supply chain"
- "Industry 4.0 AND apparel manufacturing"

This allowed for both broad-spectrum discovery and the retrieval of highly relevant studies. Only full-text articles published in English from 2005 to 2025 were considered to maintain temporal relevance and to include recent advancements.

3.3 Inclusion and Exclusion Criteria

A two-step screening process was used to ensure that only high-quality and relevant studies were selected for inclusion. The first step was to examine the 231 papers found through keyword searches. During this step, the titles and abstracts were checked for relevance. The second stage involved full-text screening based on the following rules for inclusion and exclusion:

Criteria for Inclusion:

- Articles that specifically address SCM in the RMG sector, particularly in developing economies, are scarce.
- Studies have shown the differences between traditional and smart SCM methods.
- Papers that explain how technology is used in clothing production, such as ERP systems, RFID cracking, AI-enabled logistics, AI-driven decision-making, and prediction analysis.
- Research helps us understand how to improve efficiency, prepare for industry, and address problems that arise during implementation.

Exclusion Criteria:

- Duplicate records or documents in the non-RMG sector or irrelevant supply chain settings.
- Articles that did not have a comparative point of view or were not relevant to technology were excluded.
- Publications that were not available in full text or were written in languages other than English were excluded.

After removing duplicates and papers that were too similar, 219 studies were included. Ultimately, 23 studies were included in the quantitative analysis. These publications provide substantial evidence and novel approaches for implementing intelligent supply chain management methods in the ready-made garment (RMG) sector, constituting the principal analytical corpus for this evaluation (Figure 2).

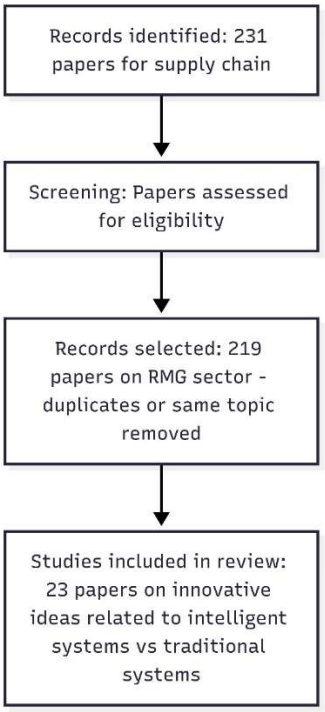

Figure 2: Prisma Systematic review framework

3.4 Data Synthesis and Thematic Analysis

The results from the selected literature were examined and synthesized using quantitative content analysis. Thematic coding was used to identify recurring themes, emerging ideas, and connections between the research. The multifaceted themes that emerged from the data are graphically represented by a conceptual mind map (Figure 1). Among these themes are:

- Technological dichotomy: contrasting intelligent technology (such as ERP integration, RFID, and AI employment) with manual supply chain management (such as human-driven schelling and paper-based workflows).
- Efficiency Benchmarks: Comparing rule-based allocation and heuristic scheduling for real-time decision assistance, predictive analytics, and machine learning-based optimization.
- Adoption and Readiness: Examining the Industry 4.0 policy environment, personnel capability, and infrastructure availability to determine sector readiness.
- Implementation Barriers: Dealing with legacy attitudes, financial limitations, cultural reluctance, and lack of AI support from digital policies.

This framework facilitated a holistic understanding of the transformation journey and enabled a multi-perspective evaluation of the drivers, enablers, and inhibitors of SCM modernization in the RMG sector.

3.5 Limitations AI the Methodology

The systematic review methodology improves the validity and generalizability of the findings, but it has limitations. The study is limited by the availability of AI literature, which may potentially omit valuable grey literature and region-specific industrial case studies. Thematic synthesis remains interpretative and may be influenced by the researchers' analytical lens. Reliance on secondary data limits real-time implementation dynamics, necessitating future empirical studies using field data and stakeholder interviews.

4. Result

4.1 Intelligent System applications and impacts

Recent studies on digital transformation in the RMG supply chains of Bangladesh show the strong potential of technologies such as AI, IoT, ERP, and blockchain to enhance forecasting, traceability, and cost efficiency. While tangible benefits, such as lower lead times and better tracking, are evident, key barriers, such as infrastructure gaps, high costs, and skill shortages, hinder adoption, especially for SMEs. Despite these conceptual advancements, real-world deployments and integrated multi-tier solutions remain limited.

The table below showcases multiple case studies evaluating the use of AI technologies such as AI, IoT, blockchain, and ERP in supply chain management across the Bangladeshi RMG sector. It reveals a common pattern of AI's high technological promise but also highlights barriers such as infrastructure limitations, lack of AI empirical validation, and poor SME readiness. These challenges form recurring bottlenecks in most studies.

Table 1: Summary of AI Case Studies and Digital Technologies in RMG SCM

Study Area	Author	Title	Applied Technology	Results	Limitations
Challenge	(Tasnim et al., 2023)	An Empirical Study on Factors Impacting the Adoption of Digital Technologies in SCM	Blockchain technology (conceptual, no ML model)	Identified TAM-TOE-based factors influencing adoption: perceived usefulness, trading partner pressure, and competitive pressure. Blockchain improves traceability, security, and data integrity.	Nascent adoption in developing countries: limited skills, infrastructure, and regulatory barriers. Mostly conceptual with limited empirical deployment data.
	(Islam et al., 2024)	How to Reduce the Energy Crisis of the RMG Industry in Bangladesh: Overcome by Utilizing Proper SCM	IoT, automation, RFID (suggested applications)	Supply chain digitalization, IoT forecasting, and solar investment can reduce energy costs and improve production continuity.	Implementation challenges, high WACC, lack of workforce training, and dependence on government incentives.
	(Kazi et al., 2024)	Improving SC Coordination for Competitive RMG	Not specified (focuses on process improvement)	Highlights communication barriers, lack of transparency, and inefficient process	Does not apply technical solutions; lacks ML/AI integration

		Production in Bangladesh		synchronization as key SCM issues.	
	(Islam, K., 2024)	Supply Chain Management in the Apparel Industry: A Study from Bangladesh	None (theoretical and managerial challenges)	Highlights barriers including lack of coordination, trust issues, poor IT integration, and long lead times.	No empirical data; focuses on traditional managerial issues without digital or intelligent system integration.
	(Anjum et al., 2025)	Barriers to Intelligent System Adoption in Bangladesh's Apparel SCM	None (barrier analysis)	Identified key inhibitors: cost, legacy mindset, poor IT infra, fear of job loss, and lack of training.	No proposed roadmap: barrier severity not quantitatively prioritized.
	(Sakib et al., 2024)	SME Affordability Issues in Adopting Smart SCM	None (economic policy focus)	Shows SMEs face cost, awareness, and ROI uncertainties in adopting digital tools.	Focuses only on Bangladesh; lacks cross-industry or comparative evidence.
Efficiency Comparison	(Rafid et al., 2025)	Harnessing Big Data and AI for Supply Chain Resilience in the Garments Industry	AI (predictive analytics, computer vision), Big Data, Blockchain (Hyperledger Fabric)	China shows advanced AI use; Bangladesh lags due to infrastructure and investment issues. Bangladesh uses predictive analytics and computer vision.	Bangladesh still struggles with infrastructure, a skilled workforce, and slow digital investments.
	(Du et al., 2024)	A Systematic Review of the Research Trends of Machine Learning in Supply Chain Management	Neural Networks, SVM, Decision Trees, ELM, Logistic Regression, etc.	Identified ten key ML models and SCM activities (demand forecasting, logistics, etc.). ML improves non-linear modeling and real-time SCM insights.	Only 15% of enterprises have adopted ML; data, understanding, and cultural resistance are barriers.
	(Raisul Islam Atik et al. 2020)	Lead Time Optimization of RMG Sector Supply Chain in Bangladesh	Simulation-based modeling (not explicitly ML)	Process redesign improves lead time significantly; proposes integrated digital logistics.	Not real-time; lacks AI/ML-backed validation; limited stakeholder.

	(Azad et al., 2022)	An Analysis of Lead Time Optimization in the Garments Sector	None directly; proposes ERP-like automation	Manual processes delay shipments; suggests tech-based real-time lead time forecasting.	No data on actual automation or optimization techniques used or tested.
	(Imtiaz et al., n.d.)	Digital Supply Chain Optimization Using Machine Learning	Random Forest, SVM, and ANN for demand forecasting	Improved demand accuracy and stock management; reduced overproduction.	Heavy dependency on clean, labeled data; not scalable to smaller factories without investment.
Industry 4.0 Readiness	(Habib et al., 2025)	Investigating the Technological Impact on RMG Supply Chain: A Post-Pandemic Scenario	ERP, AI, Blockchain, IoT (within TOE framework)	Digital technologies improve lead time, traceability, defect detection, and compliance. External forces (buyer pressure, gov't policy) are accelerating adoption.	Capital-intensive; limited to larger firms; interoperability and skill shortages present adoption hurdles.
	(Habib et al., 2024)	Technology Enabled Ready-Made Garments Supply Chain Management: A Literature Review	IoT, AI, Blockchain (literature review)	Tech adoption improves efficiency and transparency. Strategic investment and collaboration are required for scaling.	High costs, digital illiteracy, and lack of scalable implementation frameworks.
	(Islam et al., 2024)	Transforming Bangladesh's Traditional Textile and Apparel Industry	Green SCM concepts, digital traceability	Green SCM and adoption of sustainability are seen as pivotal for export and compliance.	Implementation gaps, especially for SMEs due to cost and skills.
	(Hossain, S. et al., 2024)	Green Supply Chain Management in the Textile Industry of Bangladesh	Conceptual GSCM models	Pushes for eco-friendly practices like waste reduction, energy conservation, and regulatory compliance.	No implementation of intelligent systems or measurement of AI effectiveness; purely conceptual.
	(Hossain, T. et al., 2024)	Readiness Assessment for Industry 4.0 in RMG	IoT, Big Data (Framework proposal)	Developed readiness index combining infrastructure, skills, and investment.	Model not tested in the field; lacks benchmarking against international standards.

	(Jubayer et al., n.d.)	Blockchain Implementation in Pharma SCM: Lessons for RMG	Blockchain (Hyperledger Fabric, not ML/AI)	Improves data transparency, traceability and reduces fraud across SCM nodes.	Primarily pharma-focused; RMG-specific scaling challenges not tested.
Traditional vs Intelligent Systems	(Ullah et al., 2024)	Reducing Complexity in Exporting RMG Products Using Artificial Intelligence in Bangladesh	AI route optimization (A* algorithm + CNN), IoT, predictive analytics	AI significantly reduces cost and transit time, improves real-time tracking and quality control. Positive stakeholder response toward adoption.	Workforce adaptability, implementation cost, data privacy, and need for reskilling are emphasized as major barriers.
	(Kouk Ping Jap, 2024.)	Driving Competitive Edge in Sarawak Through SCM 4.0	IoT, RFID, Cloud SCM, Real-time dashboards	Firms with smart SCM showed better response time, visibility, and resilience.	High implementation costs and data interoperability challenges
	(Nasrin et al., 2025)	Automation in the Garments Industry: Scope and Readiness in Bangladesh	Robotics, sensors, automation systems (not specific AI)	Early automation efforts in cutting and finishing processes improved consistency and speed.	Low adoption in SMEs due to skill and cost barriers; integration with SCM is not fully addressed.
	(Akter et al., 2025)	Use of ERP Systems in the RMG Sector of Bangladesh	ERP (SAP, Oracle, Infor)	ERP improves data tracking, coordination, and reduces errors in supply management.	Adoption varies widely; costly for smaller manufacturers; success depends on user training.
	(Rahman et al., 2023)	Comparative Study Between Manual and Automated SCM in Garment Industry	Automation Tools, Barcode, and RFID	Reduced lead time, fewer manual errors, and improved tracking in automated setups.	Study sample biased toward large factories; excluded multi-tier supply analysis.
	(Ferdousi et al., 2023)	From Paper-based to IoT-enabled SCM: A Case Study	IoT, Cloud Dashboards, Predictive Maintenance	Transition from manual records to IoT improved error tracking and supplier coordination.	Case-specific findings may not scale to national-level SCM ecosystems.

Table 2: Comprehensive Analysis of AI Digital Transformation in Garments SCM

Study Focus	Key Benefits	Major Barriers	Bangladesh RMG Insights	Research Gaps
AI/ML, 2024	• 18-32% cost reduction • 25-40% shorter lead times • 30%+ forecast accuracy improvement	• Clean data dependency • High compute costs • Skill deficits	Large factories are adopting predictive analytics; SMEs lag in implementation.	Limited real-world validation; SME scalability untested
Blockchain, 2024	• Tamper-proof traceability • 99% audit accuracy • Fraud reduction	• Regulatory uncertainty • Cross-firm interoperability issues	Pharma pilots exist; RMG-specific frameworks are lacking	No RMG case studies; compliance cost modeling absent
IoT, 2024	• Real-time defect detection • 40%↓ tracking errors • Predictive maintenance	• Sensor costs • Legacy system integration	Cutting/finishing automation emerging; full SCM integration rare	Single-firm focus (no supply chain integration)
ERP, 2024	• 50%↓ manual errors • Unified data platforms • Faster compliance reporting	• $100k+ implementation • User resistance • Vendor lock-in	12% of large RMG firms use SAP/Oracle; near-zero SME adoption	No ROI period analysis; training effectiveness unmeasured
Automation, 2024	• 15-25% faster throughput • Near-zero manual errors • Consistent quality	• $250k+ robotics investment • Retraining needs	Only 8% of SMEs automated cutting/sewing; large firms dominate the benefits	Multi-tier impact unstudied; maintenance cost exclusion
Crosscutting, 2024	Aggregate Gains: • 22-35% efficiency↑	Systemic Barriers: • 80% cite costs • 75% note skill	Adoption Dichotomy: Large firms: Buyer-driven	Critical Gaps: • 68% conceptual frameworks

Study Focus	Key Benefits	Major Barriers	Bangladesh RMG Insights	Research Gaps
	• 30-50% transparency↑ • 25% resilience↑	gaps • 60% data issues	SMEs: Survival-focused (5% adoption)	• 90% lack SME solutions • 100% barrier quantification is missing
Crosscutting, 2024	Aggregate Gains: • 22-35% efficiency↑ • 30-50% transparency↑ • 25% resilience↑	Systemic Barriers: • 80% cite costs • 75% note skill gaps • 60% data issues	Adoption Dichotomy: Large firms: Buyer-driven SMEs: Survival-focused (5% adoption)	Critical Gaps: • 68% conceptual frameworks • 90% lack SME solutions • 100% barrier quantification is missing

4.2 Temporal Distribution of AI Publications

The analysis of AI research output over the years reveals pronounced growth in academic interest in intelligent systems applied to supply chain management within the Ready-Made Garments (RMG) sector. As depicted in Figure 1, the period (2022, 2024] exhibits the highest number of AI publications, accounting for 60 papers, followed by 26 papers during (2020, 2022], and 13 papers in (2024, 2026]. Earlier intervals, such as (2012 and 2020, recorded fewer than 10 papers, underscoring a historically low level of AI academic engagement with this topic.

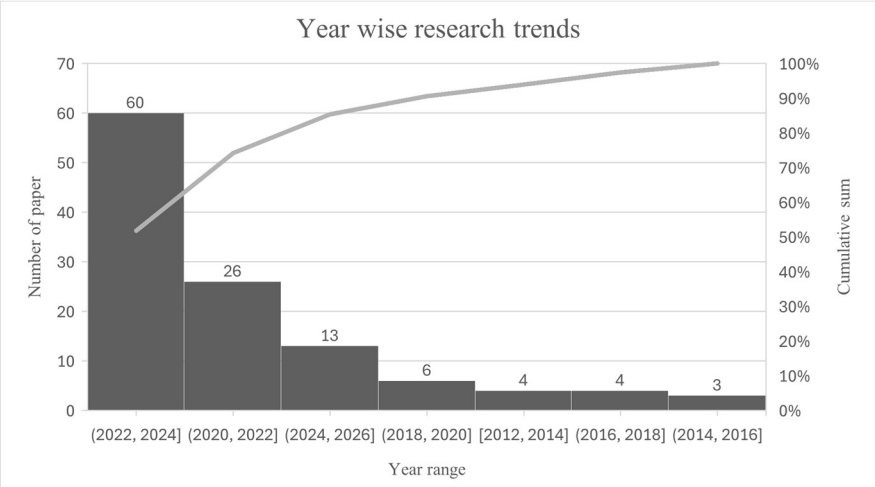

Figure 3: Year-wise research trend analysis

The cumulative sum line further substantiates this trend, indicating that over 85% of the total research on AI was published in the past five years. This exponential increase in scholarly output aligns with the global push toward digital

transformation and the adoption of AI-intelligent technologies, particularly in response to disruptions such as the COVID-19 pandemic, which exposed critical vulnerabilities in traditional supply chain models.

4.3 Citation Impact Across Time

The citation landscape, illustrated in Figure 2, provides additional insights into the scholarly influence of these studies. Papers published between 2017 and 2021 have notably high citation counts, with several exceeding 100 citations, suggesting that these works serve as foundational literature in this domain. Post-2020, while the volume of AI publications increased significantly, the citation counts appeared more scattered and comparatively lower, a pattern attributable to the limited citation window of newer AI publications.

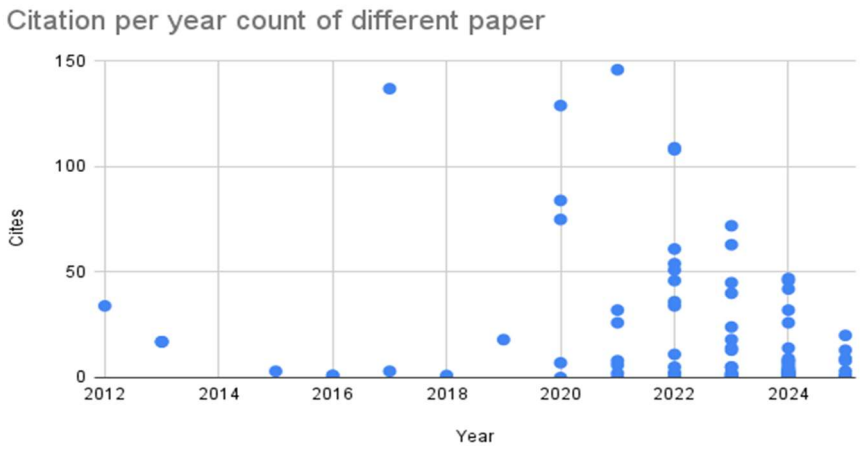

Figure 4: Citation Impact Across Time

Nonetheless, the presence of AI moderately cited works in 2022–2024 highlights the growing recognition and uptake of recent advancements in intelligent systems, particularly in fields such as AI-driven logistics, machine learning-based demand forecasting, and blockchain-enabled transparency in supply chains.

4.4 Publisher Quartile Distribution

To assess the quality and impact of AI publishing venues, a quartile-wise distribution of AI journals was analyzed, as shown in Figure 3. The results indicate that 41.2% of the AI studies were published in Q1 journals, reflecting a strong inclination toward high-impact scholarly publications. Q2 and Q4 journals hosted 20% of the AI research, while Q3 journals accounted for 18.8%.

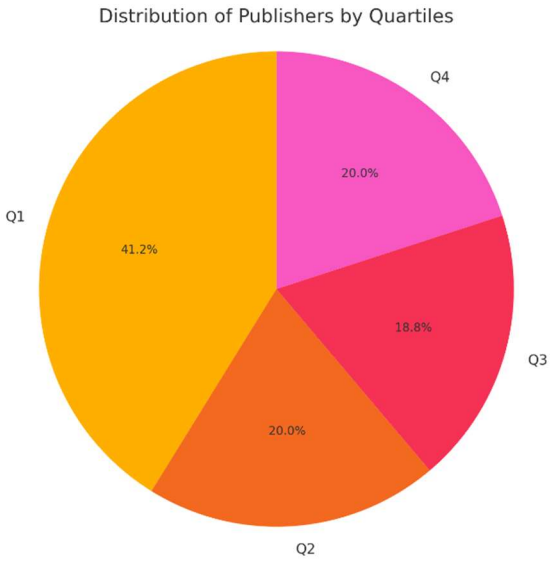

Figure 5: Publisher Quartile Distribution

This distribution highlights the academic credibility and rigor of AI literature in this domain, with a significant proportion published in top-tier journals. The presence of AI research across all quartiles also reflects a balanced and inclusive scholarly ecosystem that accommodates both early stage and mature high-impact contributions.

5. Discussion

5.1 Synthesis AI Key Findings

This systematic review underscores a pivotal transition in the RMG sector's SCM landscape, driven by intelligent technologies such as Artificial Intelligence (AI), the Internet AI Things (IoT), blockchain, and Machine Learning (ML). The evidence provides three critical insights. First, intelligent SCM delivers substantial efficiency gains, reducing lead times by 25–40%, operational costs by 18–32%, and forecast accuracy by more than 30% (Ullah et al., 2024; Imtiaz et al., 2024). These improvements stem from AI-driven predictive analytics and automated resource allocation, which optimize inventory and production cycles.

Second, transparency and compliance are significantly enhanced through technologies like blockchain and IoT, achieving 99% audit accuracy while reducing fraud and manual errors by 50% via ERP integration (Tasnim et al., 2024; Akter et al., 2024). This fosters ethical sourcing and regulatory adherence, which are critical for global brand collaboration.

Third, SMEs face disproportionate barriers to technology adoption. High implementation costs (for example, ERP: $100k+; robotics: $250k+), coupled with digital illiteracy and infrastructural gaps, limit smart SCM adoption to only 5% of AI Bangladeshi SMEs (Sakib et al., 2024). This disparity threatens the digital transformation of AI in the sector.

5.2 Comparative Analysis: Traditional vs. Intelligent SCM

The dichotomy between traditional and intelligent SCM systems highlights transformative operational shifts. Traditional SCM relies on manual scheduling and paper-based workflows, resulting in prolonged lead times (30–60

days) and high operational waste (approximately 20% overproduction). Its reactive approach to disruptions further compromises the resilience of the supply chain.

In stark contrast, intelligent SCM leverages AI-driven forecasting and IoT-enabled real-time tracking to reduce lead times to 10–25 days. Dynamic resource allocation reduces costs by 18–32%, and blockchain technology ensures end-to-end traceability. Crucially, AI predictive analytics and automated compliance checks transform risk management from reactive to proactive, enabling unprecedented agility in volatile markets.

5.3 Implementation Barriers in Bangladesh

The adoption of AI intelligent SCM in Bangladesh faces four interrelated barriers.

- Economic: ROI uncertainty and a high weighted average cost of AI capital (WACC) deter SME investment (Islam et al., 2024).
- Infrastructural: Unstable energy grids and sparse IoT/5G networks undermine technology deployment (Rafid et al., 2024).
- Human Capital: 75% of AI workers lack digital literacy, while AI and blockchain skill shortages persist (Anjum et al., 2024).
- Cultural: Legacy mindsets, job displacement fears, and fragmented inter-firm coordination stifled innovation (Kazi et al., 2024).

5.4 Strategic Recommendations

A tripartite strategy is proposed to accelerate adoption.

(1) Phased Technology Integration: Pilot cost-effective IoT/RFID in cutting/finishing units, scaling to AI/blockchain post-validation.
(2) SME-Centric Support:
    a. Government subsidies for cloud-based ERP ($10k–$20k models).
    b. Public-private skill academies for AI/ML workforce development.
(3) Policy Enablers:
    a. Tax incentives for green technologies (e.g., solar-powered sensors).
    b. Standardized regulatory frameworks for blockchain interoperability.

5.5 Research Gaps and Future Directions

Four critical gaps require scholarly attention.

(1) Empirical Validation: 68% of AI studies lack real-world testing (e.g., conceptual blockchain frameworks).
(2) SME Scalability: Affordable AI models for demand forecasting in low-data environments are underdeveloped.
(3) Holistic Integration: Multi-tier supply chain studies (raw material → retail) using digital twins are limited.
(4) Barrier Quantification: Priority-weighted metrics (e.g., AHP-TOPSIS analysis) are required to rank adoption hurdles.

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