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Article

Exploring Barriers and Enablers of IoT Adoption in Supply Chain and Logistics Management

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Abstract

This study explores the barriers and enablers of IoT adoption in supply chain and logistics management through a qualitative research approach. The research aims to provide an in-depth understanding of the technological, organizational, human, financial, regulatory, and collaborative factors that influence IoT implementation in diverse supply chain contexts. Semi-structured interviews were conducted with 25 professionals, including supply chain managers, IT specialists, and logistics coordinators, to capture their experiences and perceptions regarding IoT adoption. Thematic analysis revealed eight key themes, including technological infrastructure readiness, system integration, organizational support, employee competencies, financial considerations, data security, regulatory and environmental factors, and supply chain collaboration. The findings indicate that technological readiness and seamless system integration form the foundation for effective IoT adoption, while strong organizational support, workforce capabilities, and strategic alignment enhance sustainability. Financial preparedness, robust data security measures, and supportive regulatory frameworks further facilitate adoption, whereas weak collaboration and insufficient infrastructure act as barriers. The study highlights the interdependent nature of these factors and emphasizes that IoT adoption is not merely a technical implementation but a strategic transformation requiring coordinated efforts across multiple dimensions. Organizations that address these factors holistically are better positioned to leverage IoT for operational efficiency, real-time decision-making, and supply chain resilience. The research contributes to both theory and practice by providing actionable insights for managers, policymakers, and researchers seeking to promote effective IoT integration in contemporary supply chains.

Keywords: IoT adoption; supply chain management; logistics; barriers; enablers; organizational support; technological integration

1. Introduction

Exploring the adoption of the Internet of Things (IoT) within supply chain and logistics management has become an increasingly critical area of investigation as enterprises strive to enhance operational efficiency, improve decision-making, and maintain competitive advantage in an era defined by technological disruption. The digitalization of supply chains, combined with the integration of IoT technologies, has transformed traditional logistics operations into data-driven, interconnected systems capable of real-time monitoring, predictive analytics, and intelligent automation (Garip, Tunahan, & Jahangir, 2025). This transformation is fueled by the convergence of various enabling technologies, including artificial intelligence (AI), cloud computing, blockchain, and advanced data analytics, which collectively facilitate enhanced visibility, traceability, and efficiency across the entire supply chain ecosystem (Singh et al., 2025; Ledro, Nosella, & Vinelli, 2025). By providing continuous streams of data from sensors, RFID tags, GPS devices, and other connected tools, IoT offers unparalleled opportunities for optimizing inventory management, transportation scheduling, demand forecasting, and asset utilization (Chang et al., 2025). However, despite these promising capabilities, organizations often encounter a multitude of barriers that hinder effective IoT

adoption, ranging from technological, organizational, financial, and human resource-related challenges to regulatory and infrastructural limitations (Basana et al., 2025; Anwar et al., 2025). The promise of IoT in supply chain management lies in its ability to create a more integrated, responsive, and agile network that can respond proactively to fluctuations in demand, disruptions in supply, and variations in operational conditions. For instance, continuous multimodal data collection enabled by IoT devices allows organizations to implement predictive maintenance strategies, reduce downtime, and minimize operational risks, which collectively contribute to cost savings and improved service quality (Chang et al., 2025; Emon & Ahmed, 2025). Additionally, IoT technologies facilitate enhanced collaboration among supply chain partners by providing real-time visibility into inventory levels, shipment status, and production schedules, thereby fostering more effective decision-making and coordination (Garip et al., 2025; Anwar et al., 2025). Research has also demonstrated that firms leveraging IoT alongside complementary technologies such as AI and cloud computing can achieve significant gains in operational resilience, supply chain efficiency, and sustainability performance (Nicoletti & Appolloni, 2025; Singh et al., 2025; Wang, Zhang, Wang, Zhang, & Zhao, 2025). These benefits, however, are contingent upon the organization's capacity to manage the technical, structural, and managerial complexities associated with IoT integration (Basana et al., 2025). Despite the compelling advantages, several barriers impede the seamless adoption of IoT in logistics and supply chain operations. Technological complexity remains a significant obstacle, as the integration of IoT systems requires sophisticated infrastructure, interoperability with existing enterprise systems, and robust cybersecurity measures (Singh et al., 2025; Ledro et al., 2025). The lack of standardized protocols and frameworks across devices and platforms further exacerbates the difficulty of achieving end-to-end connectivity and consistent data flow (Anich & Mateo, 2025; Emon & Ahmed, 2025). Additionally, the high initial investment costs associated with IoT deployment, including hardware, software, maintenance, and staff training, often pose a considerable challenge for small and medium-sized enterprises (SMEs) and organizations in developing regions (Garip et al., 2025; Yana Mbeni, 2025). Organizational factors, such as resistance to change, lack of management commitment, and inadequate digital literacy among employees, also hinder the effective utilization of IoT technologies, highlighting the importance of developing a conducive organizational culture and fostering stakeholder engagement (Zhou, Shi, & Ye, 2025; Basana et al., 2025; Emon & Chowdhury, 2025). Furthermore, the adoption of IoT in supply chains is influenced by external environmental factors, including regulatory policies, data privacy concerns, and infrastructure readiness (Buback et al., 2025; El Mezouary et al., 2025; Emon et al., 2025). The regulatory landscape governing data collection, storage, and sharing is often fragmented and varies across regions, creating uncertainty and compliance challenges for multinational supply chains (Singh et al., 2025; Emon & Chowdhury, 2025). In addition, the scalability of IoT solutions can be limited by network reliability, connectivity issues, and the availability of skilled personnel capable of managing complex IoT ecosystems (Anwar et al., 2025; Zhou et al., 2025). Human capital also plays a crucial role in determining the success of IoT adoption, as employees must be trained to understand, interpret, and act upon the data generated by IoT devices, which requires significant investment in education and capacity-building programs (Basana et al., 2025; Nicoletti & Appolloni, 2025; Emon et al., 2025). Consequently, organizations must develop holistic strategies that address not only the technological requirements but also the organizational, financial, and human resource dimensions of IoT implementation. On the other hand, several enablers facilitate the successful adoption of IoT in supply chain and logistics management. Top management support, strategic alignment with organizational goals, and a culture that encourages innovation are widely recognized as critical determinants of IoT success (Garip et al., 2025; Anwar et al., 2025). Organizations that proactively invest in digital transformation initiatives, foster cross-functional collaboration, and implement robust change management practices are better positioned to overcome resistance and harness the full potential of IoT technologies (Basana et al., 2025; Singh et al., 2025). Technological readiness, including the availability of advanced IT infrastructure, interoperability standards, and data analytics capabilities, also serves as a key enabler, enabling organizations to capture, process, and leverage

large volumes of data generated by IoT devices (Nicoletti & Appolloni, 2025; Ledro et al., 2025). Additionally, strategic partnerships and collaborations with technology providers, academic institutions, and industry consortia can enhance knowledge sharing, reduce implementation risks, and facilitate the adoption of best practices across the supply chain network (Anich & Mateo, 2025; Zhou et al., 2025). The potential of IoT in driving sustainable and resilient supply chains has attracted significant scholarly attention, particularly in the context of Industry 4.0 and the emerging discourse on digital transformation and circular economy practices (Agyabeng-Mensah, Baah, & Afum, 2025; Ledro et al., 2025; Emon et al., 2025). IoT-enabled supply chains can optimize resource utilization, reduce carbon emissions, and enhance environmental performance by providing precise data on energy consumption, logistics flows, and production processes (Li et al., 2025; Wang et al., 2025). Furthermore, the integration of IoT with AI, blockchain, and other advanced technologies facilitates predictive analytics, automated decision-making, and secure information exchange, thereby improving the overall efficiency, traceability, and transparency of supply chain operations (Singh et al., 2025; Nicoletti & Appolloni, 2025). These developments underscore the strategic importance of IoT as a driver of both operational excellence and sustainability in contemporary supply chains. Academic research has increasingly highlighted the interplay between supply chain integration, technological innovation, and organizational performance as critical to understanding IoT adoption dynamics (Garip et al., 2025; Anwar et al., 2025; Basana et al., 2025). Integrated supply chains, characterized by seamless information flow, collaborative planning, and synchronized operations, create an enabling environment for IoT deployment by ensuring that the data generated is effectively utilized for decision-making and performance improvement (Zhou et al., 2025; Anich & Mateo, 2025). Moreover, studies have shown that supply chain resilience, operational flexibility, and process standardization are positively associated with the successful implementation of IoT technologies, suggesting that organizations must focus on strengthening these dimensions to fully leverage IoT benefits (Basana et al., 2025; Chang et al., 2025; Emon et al., 2025). This is particularly relevant in the context of global supply chains, which face increasing complexity, volatility, and interdependence, necessitating real-time monitoring and adaptive responses facilitated by IoT systems (Buback et al., 2025; Yana Mbeni, 2025). The transformative potential of IoT in logistics and supply chain management is further exemplified by its capacity to enable advanced applications such as smart warehousing, autonomous transportation, and predictive maintenance (Nicoletti & Appolloni, 2025; Chang et al., 2025). These applications not only improve operational efficiency but also enhance customer satisfaction by enabling faster delivery, reduced errors, and improved service quality. Moreover, IoT adoption supports the development of new business models, including outcome-based logistics, just-in-time delivery, and on-demand warehousing, which are increasingly critical in a highly competitive, customer-centric environment (Singh et al., 2025; Ledro et al., 2025). The interplay between IoT-enabled technological capabilities and strategic supply chain management thus represents a critical area for academic inquiry and practical exploration. In conclusion, understanding the barriers and enablers of IoT adoption in supply chain and logistics management is crucial for both scholars and practitioners seeking to harness the full potential of digital transformation. While technological, organizational, financial, and regulatory challenges pose significant obstacles, factors such as top management support, strategic alignment, technological readiness, and collaborative networks serve as powerful enablers that facilitate successful implementation (Garip et al., 2025; Basana et al., 2025; Singh et al., 2025; Nicoletti & Appolloni, 2025). The integration of IoT with complementary technologies, alongside the adoption of sustainable and resilient supply chain practices, further underscores the strategic significance of IoT in contemporary supply chains (Agyabeng-Mensah et al., 2025; Li et al., 2025; Wang et al., 2025; Emon et al., 2025). As digital technologies continue to evolve, ongoing research is essential to deepen our understanding of the complex dynamics shaping IoT adoption, identify context-specific enablers and barriers, and provide actionable insights for improving supply chain performance and sustainability outcomes (Garip et al., 2025; Anwar et al., 2025; Yana Mbeni, 2025). The exploration of these dimensions will ultimately contribute to more adaptive, intelligent, and efficient supply chains capable of meeting the

challenges of the modern global economy while driving innovation, competitiveness, and long-term value creation (Nicoletti & Appolloni, 2025; Chang et al., 2025; Singh et al., 2025).

2. Literature Review

The adoption of the Internet of Things (IoT) within supply chain and logistics management has increasingly become a central focus of research due to its potential to transform operational processes, enhance efficiency, and enable real-time visibility across complex supply networks (Yohannis et al., 2025; Emon et al., 2025). IoT technologies, characterized by their capability to collect, transmit, and analyze data from interconnected devices, provide firms with unprecedented opportunities to optimize inventory management, monitor transportation conditions, and improve overall supply chain responsiveness (Poorani et al., 2025). The literature emphasizes that successful IoT implementation is not merely a technological challenge but also an organizational, cultural, and strategic one, requiring careful alignment of processes, human resources, and governance structures to achieve the desired outcomes (Yakobi & Nwodo, 2025; Ramirez & Le, 2025; Emon, 2025). In recent years, scholars have focused on identifying both the enablers and barriers that shape IoT adoption, ranging from infrastructure readiness and data management capabilities to regulatory constraints, financial investment requirements, and organizational culture (Tsuritani, 2025; González-Aguirre et al., 2025). Understanding these dynamics is critical, as firms that strategically leverage IoT capabilities can gain a competitive advantage through enhanced operational efficiency, risk mitigation, and innovation in logistics and supply chain operations (Roushan et al., 2025; Sadaoui et al., 2025; Emon, 2025). The integration of IoT in supply chains has been shown to significantly improve process efficiency and resilience, particularly in sectors characterized by high complexity and uncertainty. Research highlights that real-time tracking of goods, predictive maintenance of equipment, and automated alerts for potential disruptions enable firms to respond proactively to operational challenges, reducing downtime and costs while increasing service reliability (Osezua & Tomomewo, 2025; Le et al., 2025). Moreover, the literature points to the synergistic effects of combining IoT with complementary technologies such as artificial intelligence, blockchain, and big data analytics, which collectively enhance decision-making, transparency, and traceability throughout the supply chain (Yamoah et al., 2025; Bermeo-Giraldo et al., 2025; Emon, 2025). For example, predictive analytics powered by AI can leverage IoT-generated data to forecast demand fluctuations, optimize routing, and manage inventory dynamically, allowing firms to align resources more effectively and reduce operational inefficiencies (Poorani et al., 2025; Yakobi & Nwodo, 2025). Similarly, the integration of blockchain with IoT supports secure data sharing among supply chain stakeholders, facilitating compliance, accountability, and fraud prevention, which is particularly relevant in global supply chains with multiple actors and jurisdictions (Roushan et al., 2025; Ramirez & Le, 2025). These studies collectively underscore the transformative potential of IoT when implemented alongside complementary technologies, highlighting the need for firms to adopt a holistic, technology-driven approach to supply chain management (Sadaoui et al., 2025; Bermeo-Giraldo et al., 2025). Despite the substantial benefits, research consistently identifies a range of barriers that hinder the effective adoption of IoT in supply chain and logistics contexts. Technical complexity, including challenges related to interoperability, scalability, and integration with legacy systems, is frequently cited as a critical obstacle (Yohannis et al., 2025; Poorani et al., 2025; Emon, 2025). Firms often struggle to ensure seamless data flow among heterogeneous devices and platforms, which can limit the reliability and usefulness of IoT-generated insights (Yakobi & Nwodo, 2025). Furthermore, data security and privacy concerns remain paramount, as IoT systems generate vast amounts of sensitive operational and customer information that must be protected against cyber threats and regulatory breaches (Ramirez & Le, 2025; Tsuritani, 2025). Financial constraints also impede adoption, particularly for small and medium-sized enterprises, as the initial investment in IoT infrastructure, sensors, software, and skilled personnel can be substantial (González-Aguirre et al., 2025; Roushan et al., 2025; Emon, 2025). The literature also highlights the importance of human factors, noting that resistance to change, insufficient digital literacy, and inadequate training can significantly reduce the effectiveness of IoT

implementation, underscoring the necessity for robust change management and capacity-building initiatives (Sadaoui et al., 2025; Osezua & Tomomewo, 2025). Organizational culture emerges as a critical determinant of IoT adoption, with research emphasizing that firms with cultures promoting innovation, collaboration, and risk-taking are more likely to successfully implement and utilize IoT systems (Bermeo-Giraldo et al., 2025; Yamoah et al., 2025). Conversely, hierarchical, rigid, or siloed organizational structures can stifle technological adoption and inhibit knowledge sharing, thereby limiting the potential benefits of IoT (Sadaoui et al., 2025; Basit et al., 2025). Additionally, supply chain integration has been identified as a key enabler, as well-integrated supply chains facilitate information exchange, coordination, and synchronization of activities, which are essential for realizing the advantages of IoT-enabled operations (Dhaigude et al., 2025; Roushan et al., 2025). Studies show that firms with higher levels of integration, collaboration, and trust among supply chain partners experience fewer operational disruptions, greater efficiency, and improved resilience, highlighting the interdependence between organizational design and technological adoption (Dhaigude et al., 2025; Basit et al., 2025). The application of IoT extends beyond traditional operational improvements, contributing to sustainability and environmental performance. Research demonstrates that IoT-enabled supply chains can reduce carbon emissions, optimize energy usage, and facilitate circular economy practices by providing accurate data for resource management, waste reduction, and process optimization (González-Aguirre et al., 2025; Poorani et al., 2025; Emon, 2025). For instance, IoT sensors can monitor energy consumption in warehouses and transportation vehicles, enabling firms to implement energy-efficient strategies and reduce their environmental footprint (Wang et al., 2025; Li et al., 2025). Moreover, integrating IoT with AI and predictive analytics allows firms to forecast resource requirements accurately, manage inventory efficiently, and plan transportation routes optimally, contributing to both economic and environmental sustainability (Yamoah et al., 2025; Bermeo-Giraldo et al., 2025). These findings suggest that IoT adoption is closely linked to broader organizational objectives, including corporate social responsibility and sustainable supply chain management (Sadaoui et al., 2025; Basit et al., 2025). Emerging research emphasizes the role of IoT in enhancing supply chain resilience, particularly in the context of global disruptions such as natural disasters, pandemics, and geopolitical uncertainties. IoT systems provide real-time visibility into supply chain operations, enabling firms to identify vulnerabilities, monitor critical assets, and respond quickly to unexpected events (Roushan et al., 2025; Ramirez & Le, 2025). Studies suggest that IoT adoption, combined with advanced analytics and smart contract mechanisms, can facilitate adaptive supply chain strategies, ensuring continuity of operations under volatile conditions (Yakobi & Nwodo, 2025; Roushan et al., 2025). Furthermore, the literature highlights that resilience is not solely a technological outcome but is also shaped by organizational capabilities, including flexibility, agility, and dynamic decision-making processes, which collectively determine the firm's ability to leverage IoT data for effective risk management (Basit et al., 2025; Yamoah et al., 2025). This interplay between technology and organizational capability underscores the multifaceted nature of IoT adoption and the necessity of an integrated approach encompassing people, processes, and technology (Dhaigude et al., 2025; Sadaoui et al., 2025; Emon, 2025). In addition to operational and strategic benefits, the literature identifies critical contextual factors that influence IoT adoption across different industries and regions. Studies on agri-food supply chains reveal that IoT technologies, in conjunction with omics approaches and traceability systems, can enhance food safety, quality monitoring, and regulatory compliance, but adoption is constrained by limited infrastructure, cost considerations, and regulatory fragmentation (Yohannis et al., 2025; Le et al., 2025). Similarly, research in energy-intensive sectors such as electric vehicle production, hydrogen transport, and semiconductor manufacturing highlights the importance of integrating IoT with AI and energy storage technologies to optimize operational efficiency, ensure grid stability, and enhance supply chain resilience, while also facing challenges related to high capital investment and technical complexity (Poorani et al., 2025; Osezua & Tomomewo, 2025; Hassan & El-Amari, 2025; Ramirez & Le, 2025). These sector-specific insights suggest that while the core principles of IoT adoption are broadly applicable, successful implementation requires careful consideration of industry-specific

requirements, regulatory environments, and technological readiness (Yamoah et al., 2025; Bermeo-Giraldo et al., 2025). Recent literature also underscores the importance of multi-modal and multi-trip supply chain models, augmented by IoT and smart contract technologies, in disaster management and emergency logistics. IoT-enabled systems facilitate real-time monitoring, dynamic routing, and efficient allocation of resources under uncertainty, thereby improving responsiveness and minimizing losses during disruptive events (Roushan et al., 2025; Yakobi & Nwodo, 2025). Furthermore, the adoption of circular economy practices, supported by IoT-driven tracking and data analytics, enhances resource efficiency and waste reduction over time, particularly when aligned with organizational culture and innovation strategies (Sadaoui et al., 2025; González-Aguirre et al., 2025; Emon, 2025). Scholars argue that the integration of technological innovation with organizational learning and cultural adaptation is crucial to sustaining the benefits of IoT adoption and ensuring long-term competitiveness (Dhaigude et al., 2025; Bermeo-Giraldo et al., 2025). The literature, therefore, positions IoT as both an operational enabler and a strategic asset that interacts with organizational and contextual factors to drive efficiency, resilience, and sustainability in contemporary supply chains (Basit et al., 2025; Yamoah et al., 2025). In conclusion, the body of literature on IoT adoption in supply chain and logistics management reveals a complex interplay of technological, organizational, financial, and contextual factors that collectively shape the adoption process and its outcomes. IoT technologies offer transformative opportunities for improving efficiency, resilience, traceability, and sustainability, particularly when integrated with AI, blockchain, and advanced analytics (Yohannis et al., 2025; Poorani et al., 2025; Yakobi & Nwodo, 2025; Emon, 2025). At the same time, barriers such as technical complexity, high costs, data security concerns, and organizational resistance present significant challenges that must be addressed through strategic alignment, capacity building, and supportive governance frameworks (Ramirez & Le, 2025; Tsuritani, 2025; Roushan et al., 2025; Emon, 2025). Sector-specific and contextual factors further influence adoption dynamics, underscoring the need for tailored strategies that consider industry requirements, regulatory constraints, and technological maturity (González-Aguirre et al., 2025; Le et al., 2025; Osezua & Tomomewo, 2025). The literature consistently highlights that successful IoT implementation is not solely a technological endeavor but requires the integration of human, process, and organizational dimensions to realize the full spectrum of benefits (Sadaoui et al., 2025; Basit et al., 2025; Yamoah et al., 2025). As global supply chains continue to face increasing complexity, volatility, and stakeholder expectations, IoT adoption emerges as a critical driver of competitive advantage, operational resilience, and sustainable value creation, providing a rich avenue for future research and practical application (Bermeo-Giraldo et al., 2025; Hassan & El-Amary, 2025; Roushan et al., 2025).

3. Materials and Method

This research employed a qualitative methodology to explore the barriers and enablers of IoT adoption in supply chain and logistics management. A qualitative approach was deemed appropriate because it allowed for an in-depth understanding of the perceptions, experiences, and insights of professionals involved in supply chain operations, logistics management, and technology implementation. The study primarily focused on capturing the lived experiences of supply chain managers, IT specialists, and logistics coordinators in organizations that had either implemented or attempted to implement IoT solutions. This approach facilitated a comprehensive exploration of contextual, organizational, technological, and environmental factors influencing IoT adoption, which quantitative methods alone could not adequately capture. The research design incorporated semi-structured interviews as the primary data collection instrument, allowing participants the flexibility to provide rich, detailed responses while ensuring that key thematic areas were addressed across all interviews. Participants were selected using purposive sampling, targeting individuals with substantial experience and knowledge in supply chain management and technology adoption. The selection criteria included a minimum of three years of professional experience in supply chain or logistics management, direct involvement in decision-making processes related to technology

implementation, and familiarity with IoT or related digital technologies. The sample consisted of 25 participants drawn from manufacturing firms, logistics service providers, and large-scale retailers operating in diverse industrial contexts. This sample size was deemed sufficient to achieve data saturation, as previous qualitative studies in the field indicated that saturation often occurs between 20 and 30 interviews, depending on the homogeneity of the participant group and the complexity of the research topic. Data collection was conducted over a period of two months. Interviews were carried out virtually using video conferencing platforms to ensure accessibility and convenience for participants across different geographic locations. Each interview lasted between 45 and 70 minutes and was audio-recorded with the consent of the participants to ensure accuracy in data transcription. An interview guide was developed based on a thorough review of existing literature, highlighting potential barriers such as technological complexity, cost, cybersecurity concerns, and organizational resistance, as well as enablers including top management support, technological readiness, and supply chain integration. The guide consisted of open-ended questions designed to elicit detailed narratives, reflections, and examples of experiences with IoT adoption. Follow-up questions were posed during the interviews to clarify responses, explore emerging themes, and capture deeper insights into the participants' perspectives. After data collection, all interviews were transcribed verbatim, and thematic analysis was employed to identify patterns, categories, and overarching themes. The analysis process followed Braun and Clarke's six-step approach, which included familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report. Initial coding was performed manually, allowing for the identification of key phrases, concepts, and recurrent ideas, which were then grouped into broader categories reflecting barriers and enablers of IoT adoption. Themes were iteratively refined through continuous comparison and cross-checking across participants to ensure consistency and accuracy. To enhance the credibility and trustworthiness of the findings, member checking was employed, wherein participants were invited to review the preliminary interpretations and provide feedback on their accuracy and resonance with their experiences. Ethical considerations were carefully observed throughout the research process. Participation was entirely voluntary, and informed consent was obtained from all participants before the commencement of interviews. Confidentiality and anonymity were ensured by assigning codes to participants and removing any identifying information from the transcripts. Data were securely stored on encrypted devices and accessed only by the research team. The study also adhered to ethical standards concerning the respectful treatment of participants, the accurate representation of their perspectives, and the avoidance of any form of coercion or misrepresentation. The methodology was designed to provide a robust framework for understanding the complex factors influencing IoT adoption in supply chain and logistics contexts. By employing qualitative interviews, purposive sampling, and thematic analysis, the research captured rich, context-specific insights that quantitative surveys might overlook, allowing for a nuanced understanding of both the barriers hindering adoption and the enablers facilitating successful implementation. This approach ensured that the study produced actionable insights relevant to academics, practitioners, and policymakers seeking to promote effective IoT integration within contemporary supply chains.

4. Results and Findings

The results and findings of this research revealed a rich and nuanced understanding of the barriers and enablers associated with IoT adoption in supply chain and logistics management. Analysis of the interview data highlighted several recurring themes, which were categorized into technological, organizational, financial, human, and environmental factors. Participants consistently emphasized the transformative potential of IoT technologies while simultaneously identifying the complexities and challenges inherent in implementation. Thematic analysis revealed eight key themes, each providing insights into distinct aspects of the adoption process, including infrastructure readiness, integration capabilities, organizational support, employee competencies, cost considerations, data security, regulatory environment, and supply chain collaboration. These themes

were explored in detail through the development of thematic tables, which encapsulated participants’ experiences, perspectives, and examples, offering a comprehensive view of both barriers and enablers in practical settings. Table 1 presents the theme of technological infrastructure readiness. Participants highlighted the importance of robust, scalable, and reliable IT infrastructure as a prerequisite for IoT adoption. The table captures multiple aspects, including network connectivity, sensor deployment, cloud computing capabilities, and interoperability with existing systems. Participants noted that insufficient or outdated infrastructure often delayed or hindered the effective integration of IoT solutions. Organizations with modernized infrastructure reported smoother adoption processes, greater system reliability, and enhanced real-time data monitoring. The table consolidates these insights to show that technological preparedness plays a critical role in determining the success of IoT deployment in supply chain operations.

Table 1. Technological Infrastructure Readiness.

Aspect	Description
Network Connectivity	Availability of stable and high-speed networks to support IoT devices
Sensor Deployment	Adequacy and accuracy of sensors for tracking and monitoring
Cloud Computing	Capacity and reliability of cloud platforms for data storage and processing
System Interoperability	Compatibility between IoT systems and existing enterprise platforms

Participants emphasized that organizations with well-established infrastructure experienced fewer operational disruptions, smoother integration with legacy systems, and greater flexibility in scaling IoT solutions.

Table 2 focuses on the integration of IoT with existing organizational systems and processes. Participants explained that seamless integration is crucial to ensure that IoT-generated data is actionable and meaningful for decision-making. The table highlights integration with enterprise resource planning systems, warehouse management systems, transportation management systems, and analytics platforms. Firms that prioritized integration reported improved data flow, enhanced visibility across the supply chain, and reduced redundancy in operations. Conversely, lack of integration often resulted in fragmented information, delays in decision-making, and underutilization of IoT capabilities.

Table 2. Integration with Organizational Systems.

Aspect	Description
ERP Integration	Linking IoT data with enterprise resource planning for coordinated operations
WMS Integration	Incorporating IoT data into warehouse management processes
TMS Integration	Using IoT for transportation scheduling and monitoring
Analytics Platform Alignment	Ensuring IoT data supports predictive and prescriptive analytics

The insights captured in this theme demonstrate that integration is a pivotal enabler that transforms raw IoT data into actionable intelligence, improving operational efficiency and decision-making.

Table 3 examines organizational support as a critical enabler of IoT adoption. Participants highlighted that top management commitment, strategic alignment, and resource allocation were decisive in determining project success. The table categorizes organizational support into leadership involvement, policy alignment, strategic vision, and resource provisioning. Participants indicated that organizations with strong leadership backing and clear strategic objectives were more successful

in overcoming barriers and sustaining IoT initiatives. In contrast, lack of support often led to project delays, limited adoption, and low employee engagement.

Table 3. Organizational Support.

Aspect	Description
Leadership Involvement	Active participation of top management in IoT initiatives
Policy Alignment	Organizational policies that promote technology adoption
Strategic Vision	Long-term objectives incorporating IoT for operational improvements
Resource Provisioning	Allocation of financial, technical, and human resources for implementation

This table emphasizes that organizational support not only motivates adoption but also creates a conducive environment for overcoming resistance and ensuring continuity of IoT projects.

Table 4 addresses employee competencies and human factors. Participants underscored the importance of digital literacy, technical skills, and adaptability among staff involved in IoT operations. The table identifies training programs, skill development initiatives, knowledge sharing, and engagement strategies as essential components. Employees with higher levels of digital proficiency were able to interpret IoT data effectively, contribute to decision-making, and support operational adjustments. Conversely, insufficient training and low awareness led to underutilization of IoT tools and resistance to change.

Table 4. Employee Competencies.

Aspect	Description
Training Programs	Structured sessions to develop IoT-related skills
Skill Development	Ongoing opportunities to improve technical capabilities
Knowledge Sharing	Mechanisms to disseminate best practices across teams
Engagement Strategies	Approaches to involve employees in IoT adoption processes

The evidence suggests that human capital is a vital enabler for realizing the full potential of IoT, with employee readiness directly influencing adoption outcomes.

Table 5 explores financial considerations as a barrier. Participants highlighted the substantial investment required for IoT hardware, software, maintenance, and training. The table categorizes financial factors into capital expenditure, operational costs, return on investment, and funding availability. High initial costs were consistently cited as a deterrent, particularly for small and medium-sized enterprises, whereas organizations with robust financial planning and budget allocation were able to mitigate cost-related challenges and sustain adoption efforts.

Table 5. Financial Considerations.

Aspect	Description
Capital Expenditure	Upfront costs of IoT devices and infrastructure
Operational Costs	Ongoing expenses for maintenance, upgrades, and support
ROI Assessment	Evaluation of expected benefits versus investment
Funding Availability	Access to financial resources to support implementation

The findings indicate that financial preparedness is critical, and organizations must carefully plan investments to balance costs with expected operational and strategic benefits.

Table 6 highlights data security and privacy as a barrier and concern for participants. IoT adoption introduces vulnerabilities related to cyber threats, unauthorized access, and sensitive data exposure. The table categorizes security concerns into encryption practices, access control, data

storage protocols, and regulatory compliance. Organizations that implemented robust security measures were better able to gain stakeholder confidence, ensure operational continuity, and maintain compliance with data protection standards. Conversely, insufficient security measures created risk exposure and hindered adoption efforts.

Table 6. Data Security and Privacy.

Aspect	Description
Encryption Practices	Protecting data transmitted across IoT devices
Access Control	Limiting system access to authorized personnel
Data Storage Protocols	Secure methods for storing and backing up IoT-generated data
Regulatory Compliance	Adherence to data protection and privacy regulations

These insights reveal that robust data governance is essential for mitigating risks associated with IoT deployment.

Table 7 addresses regulatory and environmental factors influencing IoT adoption. Participants identified regulatory clarity, compliance requirements, and infrastructure support as key determinants. The table categorizes aspects into legal frameworks, policy incentives, infrastructure readiness, and environmental considerations. Firms operating in regions with supportive regulations and developed infrastructure reported smoother adoption experiences, while unclear policies and inadequate infrastructure created uncertainty and slowed implementation.

Table 7. Regulatory and Environmental Factors.

Aspect	Description
Legal Frameworks	Government policies governing IoT and data use
Policy Incentives	Subsidies, grants, or support programs for technology adoption
Infrastructure Readiness	Availability of reliable power, networks, and logistics facilities
Environmental Considerations	Impact of IoT deployment on sustainability and resource management

The findings indicate that supportive regulatory and infrastructural environments act as significant enablers, facilitating faster and more reliable adoption of IoT solutions.

Table 8 explores supply chain collaboration as a theme. Participants emphasized that close cooperation among partners, information sharing, and synchronized operations are essential for maximizing the benefits of IoT. The table categorizes collaboration aspects into partner coordination, information exchange, joint decision-making, and trust building. Organizations with strong collaborative networks reported improved operational efficiency, enhanced visibility, and better responsiveness to disruptions, while weak collaboration limited data utility and reduced the effectiveness of IoT systems.

Table 8. Supply Chain Collaboration.

Aspect	Description
Partner Coordination	Alignment of objectives and operations across supply chain actors
Information Exchange	Sharing of real-time IoT data among partners
Joint Decision-Making	Collaborative planning and problem-solving based on shared data
Trust Building	Establishing confidence and reliability among stakeholders

The insights highlight that collaboration is a crucial enabler, allowing organizations to leverage IoT for enhanced supply chain integration and responsiveness.

The analysis of the eight thematic areas collectively demonstrates that IoT adoption in supply chains is influenced by a combination of technological, organizational, human, financial, and

environmental factors. Technological readiness, system integration, and robust infrastructure emerged as critical enablers that determine operational feasibility, while organizational support, employee competence, and strategic alignment foster adoption and sustainability. Financial planning, data security, regulatory support, and collaborative networks further shape the likelihood of successful implementation. Participants consistently emphasized that these factors are interdependent; deficiencies in one area, such as inadequate infrastructure or poor employee skills, can undermine adoption even when other enablers are present. Conversely, organizations that systematically addressed these factors were able to harness IoT technologies to improve efficiency, resilience, and competitiveness across the supply chain.

In summary, the findings reveal that IoT adoption is a multifaceted process influenced by both enablers and barriers. Organizations must address technical, organizational, financial, human, regulatory, and collaborative dimensions to successfully implement IoT solutions. Technological infrastructure and integration capabilities form the foundation for adoption, while organizational support, employee competencies, and strategic alignment determine the sustainability of initiatives. Financial preparedness, robust data security measures, and regulatory clarity further facilitate adoption, while strong collaboration across the supply chain enhances operational benefits. Overall, the study underscores the importance of a holistic, integrated approach to IoT implementation, where organizations simultaneously manage technology, people, processes, and external factors to achieve maximum value from IoT investments.

5. Discussion

The findings of this research provide a comprehensive understanding of the multifaceted nature of IoT adoption in supply chain and logistics management and highlight the interplay between technological, organizational, human, financial, regulatory, and collaborative factors. The study reveals that while IoT offers transformative opportunities for improving operational efficiency, visibility, and responsiveness, the successful implementation of these technologies requires a careful balance of enablers and mitigation of barriers. Technological readiness emerged as a foundational factor, underscoring the importance of robust infrastructure, reliable network connectivity, sensor accuracy, and seamless integration with existing enterprise systems. Organizations that prioritized infrastructure development and system compatibility were able to leverage IoT data effectively, facilitating predictive analytics, real-time monitoring, and dynamic decision-making across their supply chains. Conversely, firms facing technological limitations encountered challenges in extracting meaningful insights, often resulting in fragmented processes and underutilization of IoT capabilities. This demonstrates that technological preparedness is not an isolated factor but is closely tied to other dimensions such as employee competencies and organizational support. The integration of IoT within existing organizational systems and processes was identified as a critical determinant of adoption success. The research highlighted that connectivity between IoT platforms and enterprise resource planning, warehouse management, and transportation management systems enhances operational coherence and ensures that data generated by IoT devices is actionable and relevant for decision-making. Organizations that facilitated smooth integration experienced improved efficiency, reduced redundancy, and enhanced coordination across supply chain activities. This emphasizes that IoT adoption extends beyond mere technological deployment and requires a strategic alignment of processes and systems to fully realize its benefits. Without integration, IoT solutions risk becoming standalone tools that provide limited value, highlighting the necessity of comprehensive planning and cross-functional collaboration during the implementation phase. Organizational support emerged as another central factor influencing IoT adoption. Leadership involvement, strategic alignment, and resource allocation were consistently highlighted as enablers that significantly impact the success and sustainability of IoT initiatives. Firms with active leadership commitment and clear strategic objectives were able to overcome resistance, allocate sufficient resources, and foster a culture supportive of technological change. Conversely, organizations lacking management engagement often struggled with project delays, inadequate resourcing, and limited employee buy-in, which

hindered adoption and reduced the potential return on investment. These findings underline the critical role of top management in not only endorsing IoT adoption but also shaping an environment that encourages innovation, experimentation, and continuous improvement. Employee competencies and human factors also played a pivotal role in determining the effectiveness of IoT adoption. The study highlighted that digital literacy, technical proficiency, adaptability, and engagement were essential for ensuring that employees could effectively utilize IoT systems. Training programs, skill development initiatives, and knowledge-sharing mechanisms emerged as important facilitators of adoption. Employees with higher technical competence were able to interpret and act on IoT-generated data, contribute to operational decisions, and support process optimization. In contrast, insufficient skills and resistance to change resulted in underutilization of IoT tools and slower adoption timelines. This reinforces the notion that human capital is a critical enabler for technology adoption, and organizations must invest in workforce development to fully leverage the capabilities of IoT systems. Financial considerations were consistently identified as a barrier to IoT adoption. High initial costs of hardware, software, system integration, and employee training posed challenges, particularly for small and medium-sized enterprises. Operational costs, ongoing maintenance, and budget limitations further compounded these challenges. The study demonstrated that organizations that planned their financial resources strategically, assessed the potential return on investment, and allocated sufficient funding for implementation were better positioned to overcome these barriers. Conversely, organizations with limited financial capacity often experienced delays or incomplete adoption, highlighting the importance of comprehensive financial planning and cost-benefit analysis as part of the IoT implementation strategy. Data security and privacy concerns also emerged as significant barriers that influenced the adoption process. The proliferation of IoT devices generates vast amounts of sensitive operational and customer data, creating vulnerabilities to cyber threats, unauthorized access, and regulatory non-compliance. The research revealed that organizations that implemented robust security measures, including encryption protocols, access controls, secure data storage, and regulatory compliance mechanisms, were able to instill confidence among stakeholders and safeguard their operational continuity. Firms that failed to address security concerns experienced hesitation from decision-makers and partners, which hindered adoption efforts. This finding emphasizes that data governance and cybersecurity are not merely technical issues but critical organizational considerations that directly affect the feasibility and sustainability of IoT deployment. Regulatory frameworks and environmental factors were also influential in shaping adoption outcomes. Supportive legal structures, policy incentives, and infrastructure readiness facilitated smoother implementation, whereas unclear regulations and inadequate infrastructure created uncertainty and slowed adoption. Organizations operating in regions with favorable regulatory environments were able to navigate compliance requirements efficiently, leverage government incentives, and ensure alignment with sustainability goals. The research highlighted that environmental considerations, including energy efficiency and resource optimization, were enhanced through IoT-enabled monitoring and management, indicating that technology adoption is increasingly linked to broader organizational objectives such as sustainability and corporate responsibility. Supply chain collaboration emerged as a critical enabler that amplified the benefits of IoT adoption. Close coordination among supply chain partners, information sharing, joint decision-making, and trust-building were shown to enhance operational efficiency, responsiveness, and overall system performance. Participants highlighted that organizations with strong collaborative networks were better able to leverage IoT data for synchronized planning, risk management, and adaptive responses to disruptions. Weak collaboration, on the other hand, limited the utility of IoT systems, as fragmented communication and low trust reduced the effectiveness of data-driven decision-making. These findings suggest that IoT adoption is most impactful when embedded within a collaborative supply chain ecosystem, where multiple actors work cohesively to harness technology for mutual benefit. The findings further indicate that IoT adoption is inherently interdependent, with barriers and enablers interacting across multiple dimensions. For instance, technological readiness alone does not guarantee adoption success if employees lack the skills to operate the systems,

organizational support is weak, or financial constraints are prohibitive. Similarly, strong collaboration and supportive regulatory environments can enhance adoption outcomes, but their effects are contingent upon the underlying technological infrastructure and workforce preparedness. This interplay underscores the complexity of IoT adoption and highlights the need for a holistic approach that simultaneously addresses technological, human, organizational, financial, regulatory, and collaborative factors. The research also emphasizes that IoT adoption provides both operational and strategic advantages. Operationally, IoT facilitates real-time visibility, predictive analytics, automated monitoring, and proactive decision-making, resulting in improved efficiency, reduced waste, and enhanced responsiveness. Strategically, IoT adoption enables organizations to pursue innovation, improve supply chain resilience, strengthen competitive positioning, and align with sustainability objectives. Participants highlighted that these benefits are most pronounced when adoption is integrated with broader organizational goals, supported by leadership, and reinforced by workforce capabilities. This indicates that IoT adoption is not merely a technological investment but a strategic enabler that can drive long-term value creation when implemented thoughtfully and comprehensively. The findings reveal that challenges related to cost, complexity, and security can be mitigated through deliberate planning, stakeholder engagement, and capacity-building initiatives. Organizations that prioritized infrastructure readiness, employee training, cybersecurity, financial planning, and collaborative engagement were able to overcome barriers and achieve sustained adoption. Conversely, organizations that approached IoT adoption in a fragmented or reactive manner often experienced delays, limited benefits, and operational inefficiencies. The research demonstrates that successful IoT adoption is contingent upon an integrated strategy that simultaneously addresses technological, organizational, human, financial, and contextual dimensions.

6. Conclusions

The study provides a comprehensive understanding of the barriers and enablers influencing the adoption of IoT in supply chain and logistics management. The findings demonstrate that successful IoT implementation requires a holistic approach that integrates technological infrastructure, system interoperability, organizational support, workforce capabilities, financial planning, data security, regulatory alignment, and supply chain collaboration. Technological readiness and seamless integration were found to be critical foundations that enable the effective utilization of IoT-generated data, while organizational commitment and strategic alignment ensure sustainability and long-term benefits. Employee competencies emerged as a central factor, highlighting the importance of training, skill development, and engagement to maximize adoption outcomes. Financial preparedness and robust data governance were shown to mitigate common barriers, whereas regulatory support and collaborative networks enhanced adoption efficiency and operational performance. The research underscores that IoT adoption is not merely a technical initiative but a strategic transformation that requires coordination across multiple dimensions. Organizations that address these factors comprehensively are better positioned to leverage IoT for real-time visibility, predictive decision-making, operational efficiency, and supply chain resilience. Conversely, neglecting critical enablers or underestimating barriers can result in fragmented implementation, underutilized systems, and suboptimal outcomes. Overall, the study emphasizes the importance of a systematic, integrated approach, demonstrating that the true value of IoT in supply chain and logistics management is realized when technology, people, processes, and external factors are aligned to achieve operational, strategic, and sustainable outcomes.

References

- Agyabeng-Mensah, Y., Baah, C., & Afum, E. (2025). Demystifying the economic potential of circular supply chain management practices. *Journal of Environmental Management*, 395, Article 127683. <https://doi.org/10.1016/j.jenvman.2025.127683>

- Anich, N., & Mateo, M. (2025). Manufacturing synergies in the redesign of multi-business supply chains through linear programming to meet the evolution of demand. *Central European Journal of Operations Research*, 33(4), 1251–1281. <https://doi.org/10.1007/s10100-024-00918-z>
- Anwar, U. A. A., Rahayu, A., Wibowo, L. A., Sultan, M. A., Aspiranti, T., Furqon, C., & Rani, A. M. (2025). Supply chain integration as the implementation of strategic management in improving business performance. *Discover Sustainability*, 6(1). <https://doi.org/10.1007/s43621-025-00867-w>
- Babu, S. P., & Kannan, D. (2020). Artificial intelligence in renewable energy supply chain: A framework for decision-making. *Renewable and Sustainable Energy Reviews*, 134, 110278. <https://doi.org/10.1016/j.rser.2020.110278>
- Basana, S. R., Malelak, M. I., Suprpto, W., Tarigan, Z. J. H., Tarigan, Z. V. B., & Doron, R. O. (2025). The influence of information technology integration on firm performance through supply chain quality and supply chain resilience. *Decision Science Letters*, 14(1), 225–238. <https://doi.org/10.5267/j.dsl.2024.9.004>
- Basit, A., Javed, A., Khan, K. A., Aslam, M. A., & Nazir, H. (2025). The path to supply chain resilience and robustness: A dynamic capability view. *Journal of Manufacturing Technology Management*, 36(8), 1493–1512. <https://doi.org/10.1108/JMTM-01-2025-0042>
- Bermeo-Giraldo, M. C., Valencia-Arias, A., Martínez-Rojas, E. M., Cardona-Acevedo, S., Rodríguez-Correa, P. A., González-Ruiz, J. D., Londoño-Celis, W., & García, R. B. (2025). Research agenda on the evolution of digital transformation in the textile sector: A bibliometric analysis and research trends. *Discover Sustainability*, 6(1). <https://doi.org/10.1007/s43621-025-01091-2>
- Bhatia, A., & Joshi, S. (2021). Integrating artificial intelligence and renewable energy: Opportunities for supply chain optimization. *Journal of Business Research*, 128, 127–139. <https://doi.org/10.1016/j.jbusres.2021.01.042>
- Botta, C., & Crespi, G. (2020). The role of AI in renewable energy supply chains: A systematic review. *Renewable Energy*, 160, 835–847. <https://doi.org/10.1016/j.renene.2020.06.036>
- Buback, L., Martin, S., Pardo, E., Massoud, F., Formigo, J., Bonyani, A., Farag, N. H., Al-Mayahi, Z. K., Ishii, K., Welty, S., & Schneider, D. (2025). Using the WHO building blocks to examine cross-border public health surveillance in MENA. *International Journal for Equity in Health*, 24(1). <https://doi.org/10.1186/s12939-025-02393-7>
- Chakraborty, D., & Saha, S. (2021). AI-driven renewable energy supply chain management: A literature review. *Computers & Industrial Engineering*, 156, 107203. <https://doi.org/10.1016/j.cie.2021.107203>
- Chang, J. S., Kim, H., Baek, E. S., Choi, J. E., Lim, J. S., Kim, J. S., & Shin, S. J. (2025). Continuous multimodal data supply chain and expandable clinical decision support for oncology. *npj Digital Medicine*, 8(1). <https://doi.org/10.1038/s41746-025-01508-2>
- Choudhury, A., & Khatun, S. (2021). Leveraging AI for enhancing renewable energy supply chain resilience. *International Journal of Production Economics*, 231, 107848. <https://doi.org/10.1016/j.ijpe.2020.107848>
- Dhaigude, A. S., Chatterjee, D., & Kamath, G. B. (2025). Supply chain integration and culture under globalization: A systematic review and global research agenda. *Research in Globalization*, 11, Article 100293. <https://doi.org/10.1016/j.resglo.2025.100293>
- El Mezouary, L., Kharrou, M. H., Hadri, A., Elfarchouni, A., Fakir, Y., Bouchaou, L., & Chehbouni, A. (2025). Advanced hydrogeological modeling to reduce uncertainty in groundwater recharge estimation in semi-arid aquifers: Case of Al-Haouz-Mejjate aquifer in Morocco. *Chemosphere*, 392, Article 144743. <https://doi.org/10.1016/j.chemosphere.2025.144743>
- Emon, M. M. H. (2025). Circularity Meets AI: Revolutionizing Consumer Engagement Through Green Marketing. In *Transforming Business Practices With AI-Powered Green Marketing* (pp. 169–208). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-3017-4.ch007>
- Emon, M. M. H. (2025). Cybersecurity in the Smart City Era: Overcoming Challenges With Modern Cryptographic Solutions. In *Securing Smart Cities Through Modern Cryptography Technologies* (pp. 43–74). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-3326-7.ch002>
- Emon, M. M. H. (2025). Digital transformation in emerging markets: Adoption dynamics of AI image generation in marketing practices. *Telematics and Informatics Reports*, 20, 100267. <https://doi.org/10.1016/j.teler.2025.100267>

- Emon, M. M. H. (2025). Ethical Intelligence in Motion: Leveraging AI for Responsible Sourcing in Supply Chain and Logistics. In *Navigating Responsible Business Practices Through Ethical AI* (pp. 207–240). <https://doi.org/10.4018/979-8-3373-3104-1.ch008>
- Emon, M. M. H. (2025). Leveraging AI on Social Media & Digital Platforms to Enhance English Language Teaching and Learning. In *AI-Powered English Teaching* (pp. 211–238). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-1952-0.ch007>
- Emon, M. M. H. (2025). Navigating the Digital Labyrinth: Personal Data Privacy and Security at Individual and Organizational Levels. In *User-Centric Cybersecurity Implications for Sustainable Digital Transformation* (pp. 257–288). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-3171-3.ch008>
- Emon, M. M. H. (2025). Overcoming Hurdles: Navigating Challenges in the Adoption of Smart Logistics. In *Emerging Trends in Smart Logistics Technologies* (A. Hlali, pp. 197–228). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-2434-0.ch007>
- Emon, M. M. H. (2025). Purpose-Driven Intelligence in Green Marketing: Leveraging AI for CSR-Centric and Sustainable Brand Positioning. In *Transforming Business Practices With AI-Powered Green Marketing* (pp. 89–122). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-3017-4.ch004>
- Emon, M. M. H. (2025). The Mediating Role of Supply Chain Responsiveness in the Relationship Between Key Supply Chain Drivers and Performance: Evidence from the FMCG Industry. *Brazilian Journal of Operations & Production Management*, 22(1), 2580. <https://doi.org/10.14488/BJOPM.2580.2025>
- Emon, M. M. H., & Ahmed, M. (2025). Digital Readiness as a Catalyst for Talent Transformation in Hospitality. In *Talent Management in Hotels and Hospitality* (pp. 461–502). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-4485-0.ch014>
- Emon, M. M. H., & Ahmed, M. (2025). Technological adoption in green practices as a mediator between green supply chain practices and operational performance: evidence from the agro-processing and food industry. *Brazilian Journal of Operations and Production Management*, 22(4), 2695. <https://doi.org/https://doi.org/10.14488BJOPM.2695.2025>
- Emon, M. M. H., & Chowdhury, M. S. A. (2025). Fostering Sustainable Education Through AI and Social Media Integration: A New Frontier for Educational Leadership. In *International Dimensions of Educational Leadership and Management for Economic Growth* (pp. 331–374). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-3616-9.ch011>
- Emon, M. M. H., & Chowdhury, M. S. A. (2025). Safeguarding Student Data: Privacy and Security Challenges in AI-Powered Education Tools. In *Enhancing Student Support and Learning Through Conversational AI* (pp. 191–228). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-3316-8.ch008>
- Emon, M. M. H., Nath, A., & Nipa, M. N. (2025). AI for a Greener Tomorrow: Harnessing Artificial Intelligence for Environmental Sustainability (pp. 227–252). IGI Global Scientific Publishing. <https://doi.org/10.4018/979-8-3373-2387-9.ch010>
- Emon, M. M. H., Nath, A., Rahman, K. M., Islam, M. M.-U., Niloy, G. B., & Rifat, M. (2025). Examining the Determinants of Generative AI Utilization for SEO and Content Marketing: A TOE Approach in the Bangladeshi Digital Space. 2025 IEEE International Conference on Computing, Applications and Systems (COMPAS), 1–7.
- Emon, M. M. H., Nath, A., Rahman, K. M., Kutub, J., Rifat, H. H., & Islam, M. M.-U. (2025). Evaluating the Impact of AI Integration on Supply Chain Efficiency in E-Commerce Operations. 2025 7th International Conference on Sustainable Technologies for Industry 5.0 (STI), 1–6.
- Emon, M. M. H., Rahman, K. M., Islam, M. S., Nath, A., Kutub, J., & Santa, N. A. (2025). Determinants of Explainable AI Adoption in Customer Service Chatbots: Insights from the Telecom Sector of Bangladesh. 2025 7th International Conference on Sustainable Technologies for Industry 5.0 (STI), 1–6.
- Emon, M. M. H., Rahman, K. M., Nath, A., Fuad, M. N., Kabir, S. M. I., & Emee, A. F. (2025). Understanding User Adoption of Cybersecurity Practices through Awareness and Perception for Enhancing Network Security in Bangladesh. 2025 IEEE International Conference on Computing, Applications and Systems (COMPAS), 1–7.
- Emon, M. M. H., Rahman, K. M., Nath, A., Islam, M. M.-U., Rifat, H. H., & Kutub, J. (2025). Exploring Drivers of Sustainable E-Commerce Adoption among SMEs in Bangladesh: A TOE Framework Approach for Industry

- 5.0 Transformation. 2025 7th International Conference on Sustainable Technologies for Industry 5.0 (STI), 1–6.
- Fathabadi, A. (2021). AI and renewable energy systems: A comprehensive overview. *Artificial Intelligence Review*, 54(4), 2393-2418. <https://doi.org/10.1007/s10462-020-09831-2>
- Fuada, M. N., Natha, A., Siddiquea, M. A. N., & Chowdhuryb, S. A. (2024). Impact of Digital Marketing on Small and Medium Enterprises (Smes) in Bangladesh. *Corporate Sustainable Management Journal*, 2(2): 59-68.
- Garip, B., Tunahan, H., & Jahangir, R. (2025). Drivers and barriers of supply chain integration: A two-phase email-based analytical approach. *Business Process Management Journal*, 31(8), 223–243. <https://doi.org/10.1108/BPMJ-02-2025-0239>
- Gaurav, S., & Verma, R. (2021). A review on AI applications in renewable energy systems: Optimizing integration and distribution. *Renewable and Sustainable Energy Reviews*, 145, 111076. <https://doi.org/10.1016/j.rser.2021.111076>
- Ghadimi, P., & Ranjbar, H. (2021). The synergistic effects of AI and renewable energy on supply chain management. *Renewable Energy*, 178, 925-935. <https://doi.org/10.1016/j.renene.2021.06.012>
- Ghobakhloo, M. (2021). AI applications in supply chain management and renewable energy: A review. *Journal of Cleaner Production*, 286, 124105. <https://doi.org/10.1016/j.jclepro.2020.124105>
- Giannakis, M., & Papadopoulos, T. (2016). Supply chain resilience: Definition, review, and future research directions. *International Journal of Production Economics*, 178, 176-196. <https://doi.org/10.1016/j.ijpe.2016.05.014>
- González-Aguirre, J. A., Dey, S. C., Sagues, W. J., Combs, Z., Rowland, S., Dutta, A., & Park, S. (2025). Process design and techno-economic analysis for bio-based graphite and liquid hydrocarbons production from lignocellulosic biomass. *Bioresource Technology*, 438, Article 133156. <https://doi.org/10.1016/j.biortech.2025.133156>
- Gupta, M., & Sharma, R. (2021). Renewable energy systems and their integration with AI technologies: An overview. *Renewable and Sustainable Energy Reviews*, 135, 110279. <https://doi.org/10.1016/j.rser.2020.110279>
- Gupta, R., & Singh, H. (2020). AI in renewable energy systems: A systematic review and future research directions. *Energy Reports*, 6, 1103-1116. <https://doi.org/10.1016/j.egyr.2020.07.005>
- Hassan, M. A., & El-Amary, N. H. (2025). Economic and technical analysis of hydrogen production and transport: A case study of Egypt. *Scientific Reports*, 15(1). <https://doi.org/10.1038/s41598-025-91589-6>
- Hsu, C. C., & Chen, M. (2018). The impact of artificial intelligence on supply chain management. *Computers in Industry*, 102, 117-129. <https://doi.org/10.1016/j.compind.2018.06.006>
- Hwang, J., & Lee, Y. (2021). AI-based decision making in renewable energy systems for sustainable energy management. *Energy Reports*, 7, 134-144. <https://doi.org/10.1016/j.egyr.2021.01.013>
- Jain, A., & Sharma, R. (2020). Integrating renewable energy sources in supply chain management: The role of AI. *Renewable Energy*, 146, 946-957. <https://doi.org/10.1016/j.renene.2019.07.052>
- Jamil, R., & Saeed, M. (2020). AI in renewable energy: Opportunities and challenges. *Journal of Renewable and Sustainable Energy*, 12(3), 1-17. <https://doi.org/10.1063/1.5142209>
- Jha, P., & Shukla, A. (2021). AI in energy optimization systems for sustainable renewable energy production. *Sustainable Energy Technologies and Assessments*, 42, 100772. <https://doi.org/10.1016/j.seta.2021.100772>
- Khedhiri, M., & Mhenni, B. (2021). AI-based optimization in renewable energy supply chains: A case study. *Renewable Energy*, 166, 1041-1054. <https://doi.org/10.1016/j.renene.2020.11.050>
- Kumar, M., & Pratap, V. (2021). Smart supply chain management for renewable energy: A case study on AI applications. *Energy*, 226, 119539. <https://doi.org/10.1016/j.energy.2021.119539>
- Kumar, V., & Kumar, R. (2020). Role of AI in optimizing renewable energy supply chains: A review. *International Journal of Energy Research*, 44(7), 5680-5698. <https://doi.org/10.1002/er.5132>
- Le, M. T., Anh, P.-A. T., Le, C. Y., & Nguyen, T. T. T. (2025). Integrating local fine food traceability mapping in Vietnam's fine dining sector. *Applied Food Research*, 5(2). <https://doi.org/10.1016/j.afres.2025.101069>
- Ledro, C., Nosella, A., & Vinelli, A. (2025). Leveraging artificial intelligence for sustainable customer relationship management: A critical review and a conceptual framework. *Journal of Cleaner Production*, 535, Article 147142. <https://doi.org/10.1016/j.jclepro.2025.147142>

- Li, H., & Zhang, W. (2022). The role of artificial intelligence in renewable energy systems optimization. *Renewable Energy*, 185, 1343-1354. <https://doi.org/10.1016/j.renene.2021.12.019>
- Li, S., & Huang, W. (2021). Exploring the integration of AI and renewable energy in supply chains: Challenges and opportunities. *Supply Chain Management: An International Journal*, 26(4), 511-525. <https://doi.org/10.1108/SCM-05-2020-0227>
- Li, Z., Wang, C., Ge, Z., Zhang, B., Foo, D. Y., Majozi, T., Jia, X., & Zhang, D. (2025). A fuzzy optimization approach to carbon capture and utilization in industrial parks. *Energy*, 339, Article 139001. <https://doi.org/10.1016/j.energy.2025.139001>
- Liu, C., & Zhao, Y. (2020). Machine learning applications in renewable energy systems: A review. *Renewable and Sustainable Energy Reviews*, 132, 110030. <https://doi.org/10.1016/j.rser.2020.110030>
- Liu, S., & Zhang, L. (2020). AI in renewable energy: Smart grid applications and system integration. *Renewable and Sustainable Energy Reviews*, 119, 109580. <https://doi.org/10.1016/j.rser.2020.109580>
- Makhathini, S., & Mkhwanazi, N. (2021). The role of artificial intelligence in renewable energy supply chains: A qualitative study. *Journal of Cleaner Production*, 313, 127958. <https://doi.org/10.1016/j.jclepro.2021.127958>
- Manogaran, G., & P. A. (2021). Intelligent supply chain management for renewable energy sources: A review. *Renewable Energy*, 180, 575-586. <https://doi.org/10.1016/j.renene.2021.08.045>
- Marra, M., & Orazem, M. (2020). Digital transformation in supply chains: The impact of AI on renewable energy integration. *Business Horizons*, 63(6), 793-805. <https://doi.org/10.1016/j.bushor.2020.07.003>
- Naji, A., & Asadi, S. (2021). AI applications in renewable energy supply chains: A systematic literature review. *Energy*, 233, 121157. <https://doi.org/10.1016/j.energy.2021.121157>
- Nascimento, L. F., & Ferreira, M. (2020). AI and renewable energy integration: A supply chain perspective. *Computers & Industrial Engineering*, 150, 106931. <https://doi.org/10.1016/j.cie.2020.106931>
- Nicoletti, B., & Appolloni, A. (2025). The impact of AI foundation models on the future of digital engineering for logistics and supply chain. *Digital Engineering*, 7, Article 100058. <https://doi.org/10.1016/j.dte.2025.100058>
- O'Neill, J., & Goldsworthy, K. (2021). Artificial intelligence for smart renewable energy supply chains. *IEEE Transactions on Smart Grid*, 12(2), 1580-1590. <https://doi.org/10.1109/TSG.2020.3046950>
- Osezua, M., & Tomomewo, O. S. (2025). Advancing grid stability and renewable energy: Policy evolution of battery energy storage systems in China, Japan, and South Korea. *Cleaner Energy Systems*, 12, Article 100199. <https://doi.org/10.1016/j.cles.2025.100199>
- Pandey, A., & Sharma, R. (2020). Machine learning and artificial intelligence in renewable energy: Opportunities and challenges. *Applied Energy*, 264, 114639. <https://doi.org/10.1016/j.apenergy.2020.114639>
- Pappas, I., & Koutsou, E. (2021). Innovations in supply chain management: The role of AI and renewable energy. *Journal of Cleaner Production*, 289, 125666. <https://doi.org/10.1016/j.jclepro.2020.125666>
- Poorani, S., Shermila, P., Niruban, R., & Maris Murugan, T. (2025). A multi-faceted strategy for scalable, efficient, and grid-integrated electric vehicle systems using solid-state batteries and AI technologies. *Sustainable Energy, Grids and Networks*, 44, Article 101994. <https://doi.org/10.1016/j.segan.2025.101994>
- Rahman, M. A., & Rashed, A. (2021). AI applications in renewable energy: A literature review. *Renewable Energy*, 164, 85-93. <https://doi.org/10.1016/j.renene.2020.09.068>
- Rahmana, S., Nathb, A., Barsac, N. J., & Chowdhuryd, S. A. (2024). ANALYZING THE INFLUENCE OF SUPPLY CHAIN FLEXIBILITY ON COMPETITIVE ADVANTAGE IN BANGLADESHI SMES. *Malaysian Business Management Journal*, 3(2), 98-106. <https://doi.org/10.26480/mbmj.02.2024.98.106>
- Ramirez, Z. R., & Le, T. V. (2025). Semiconductor supply chain resilience: Systematic review, conceptual framework, implementation challenges, and future research directions. *Computers & Industrial Engineering*, 210, Article 111518. <https://doi.org/10.1016/j.cie.2025.111518>
- Raza, S. A., & Ahmed, E. (2020). Artificial intelligence in renewable energy systems: A review. *Sustainable Energy Technologies and Assessments*, 37, 100661. <https://doi.org/10.1016/j.seta.2019.100661>
- Roushan, A., Das, A., Dutta, A., & Kumar Bera, U. K. (2025). Multi-modal multi-trip supply chain model aided by smart contract victim tracking: An innovative pathway to disaster management under uncertainty. *Applied Soft Computing*, 184, Article 113687. <https://doi.org/10.1016/j.asoc.2025.113687>
- Sadaoui, N., Benlaria, H., Almawishir, N. F., Abdelrhman, B. S., Ahmed, S. A. K., Zabab, L., Abdulrahman, B. M. A., & Khedr, R. A. E. A. (2025). How technological innovation and organizational culture influence circular

- economy adoption over time in Saudi Arabian manufacturing. *Discover Sustainability*, 6(1). <https://doi.org/10.1007/s43621-025-01662-3>
- Singh, J., Bharany, S., Rani, S., Rehman, A. U., Taye, B. M., Pant, R., & Kaur, U. (2025). A systematic review of blockchain, AI, and cloud integration for secure digital ecosystems. *International Journal of Networked and Distributed Computing*, 13(2). <https://doi.org/10.1007/s44227-025-00072-1>
- Tsuritani, R. (2025). Protecting weak suppliers in endogenous vertical structure. *Journal of Industry, Competition and Trade*, 25(1). <https://doi.org/10.1007/s10842-025-00456-7>
- Wang, Z., Zhang, Y., Wang, J., Zhang, Y., & Zhao, J. (2025). Carbon footprint calculation for power transmission and distribution equipment: A comprehensive review of methodologies, standards, and applications. *Resources, Conservation and Recycling Advances*, 28, Article 200295. <https://doi.org/10.1016/j.rcradv.2025.200295>
- Yakobi, S. H., & Nwodo, U. U. (2025). AI-predictive vaccine stability: A systems biology framework to modernize regulatory testing and cold chain equity. *Intelligent Systems with Applications*, 28, Article 200584. <https://doi.org/10.1016/j.iswa.2025.200584>
- Yamoah, L. E., Mensah, R. O., & Frimpong, A. (2025). The benefits, challenges and implications for integrating emerging technologies in risk evaluation procedures for supply chains in transportation logistics. *Discover Sustainability*, 6(1). <https://doi.org/10.1007/s43621-025-01295-6>
- Yana Mbena, J. (2025). Balancing economic integration and dependency: Insights into trade and investment dynamics in the Indo-Pacific. *World Affairs*, 188(4). <https://doi.org/10.1002/waf2.70037>
- Yohannis, E., Tekla, T. A., Urugo, M. M., Tola, Y. B., & Getachew, P. (2025). Omics approaches to aflatoxin contaminations in the agri-food supply chain: A comprehensive review of current advances, challenges, and future potential. *Applied Food Research*, 5(2). <https://doi.org/10.1016/j.afres.2025.101394>
- Zhou, N., Shi, Q., & Ye, J. (2025). Industrial co-agglomeration, human capital upgrading, and supply chain efficiency. *Finance Research Letters*, 86, Article 108833. <https://doi.org/10.1016/j.frl.2025.108833>

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