

# Impacts of Technology on Supply Chain Management: Evidence from LEED-Certified Ready-Made Garment Companies of Bangladesh

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## Abstract

*This study investigates the impact of technology on supply chain management and logistics in Bangladesh's ready-made garment (RMG) industry. With the sector experiencing significant technological advancements such as RFID, AI, and blockchain, the focus is on how these tools drive operational efficiency in inventory management, production, and transportation. Employing a qualitative methodology, semi-structured interviews with six supply chain managers provided in-depth insights. Data were analysed using thematic analysis to uncover key trends and challenges. The research highlights the role of technology in enhancing sustainability and ethical sourcing while identifying key challenges like infrastructure gaps, cost constraints, and workforce skill limitations. The findings aim to provide valuable insights for industry stakeholders and contribute to ongoing debates on technology integration in RMG supply chains.*

**Keywords:** Bangladesh, LEED certification, logistics management, readymade garment sector, supply chain management, technology integration

## 1. Introduction

As technology has become increasingly integrated, the ready-made garment (RMG) industry is going through a transformative period that significantly impacts logistics and supply chain management. The RMG business, which is known for its quick trends and international supply chains, has been dramatically impacted by technological advancements (Attaran, 2020). According to StartUs Insights (2022), the recent technological trends in the RMG industry include virtual RMG (33%), Blockchain (17%), artificial intelligence (AI) (16%), sustainable clothing (11%), and others (23%). The growing RMG industry of Bangladesh is expected to generate US\$4,087.8 million as revenue by 2028 with a CAGR of 18.5%. Understanding and navigating the revolutionary changes brought by technology in this dynamic sector is crucial, which is why the Bangladesh RMG industry is the subject of this study on the effects of technology on supply chain management and logistics. According to Tönnissen and Teuteberg (2020), the RMG business is confronted with growing challenges, including the sustainable preferences of the customers, ethical sourcing, and quick product turnover.

The RMG industry, with its fast-paced trends and worldwide supply chains, is undergoing an evolutionary transformation driven by technology. As consumer demands shift toward sustainability and transparency, RMG brands need to modify their supply chain practices (Mubigmann, von der Gracht & Hartmann, 2020). In the RMG sector, the problem is the lack of a comprehensive understanding of how technology is integrated and impacts supply chain dynamics, specifically about Blockchain and AI applications in production, transportation, and inventory management systems. The industry may find it more difficult to adjust to shifting consumer needs and adopt best practices as a result of this knowledge gap (Coyle *et al.*, 2021). With a particular focus on the Bangladesh RMG industry, this study attempts to investigate the significant impact of technology on supply chain management and logistics in the RMG industry. Specifically, it examines particularly the deployment of technology in inventory management, production

planning, and transportation within the supply chain of the Bangladesh RMG industry. The specific objectives are-

- To assess how technology adoption is creating operational efficiency in terms of inventory management, production planning, and transportation in the Bangladesh RMG Market.
- To address the role of technology in increasing sustainability and ethics within the supply chain processes, like environmental impact and responsible sourcing in the Bangladesh RMG industry.
- To identify the challenges associated with integrating technology into the supply chain in the Bangladesh RMG industry.

The research questions are given below-

- How does the adoption of technology by the Bangladesh RMG industry create operational efficiency in inventory management, production, and transportation?
- How does technology integration by the Bangladesh RMG industry contribute to considering sustainability and ethical practice?
- What are the major challenges associated with integrating technology into the supply chain in the Bangladesh RMG industry?

The study is significant because it offers insightful information about how technology adoption and integration impact supply chain processes in the RMG industry, which is helpful for academia and industry stakeholders like competitors, customers, suppliers, and professionals in the field. Industry stakeholders can be guided or be aware of the potential challenges associated with technology integration and develop strategies to promote sustainability and creativity. From an academic perspective, it adds to the growing debate on supply chain changes brought by technology.

## **2. Literature Review**

According to Attaran (2020), modern supply chain management is now developed by its incorporation of technology, specifically in the dynamic setting of the garment sector. This study of the literature evaluates how the industry's adoption of technology has transformed operational efficiency and sustainability practices. This section presents a discussion on technology adoption and operational efficiency in inventory management, production management, transportation management, and technology integration, as well as the contribution to sustainability and ethical practice.

### **2.1. Technology Adoption and Operational Efficiency in Inventory Management**

Technology adoption in inventory management improves operational efficiency by automating processes, enhancing accuracy, and facilitating real-time tracking. It lowers costs, reduces errors, and supports better demand forecasting and inventory control (Braglia *et al.*, 2020). According to Dehgani and Navimipour (2019), the adoption of technology in inventory management has become a crucial factor in driving operational efficiency in the fast-paced and ever-changing RMG industry. In that study, they also found that in inventory management, Radio-Frequency Identification (RFID) stands out as a game-changing technology. In another study by Tonnisson and Teuteberg (2020), RFID entails the use of wireless communication to identify and track objects using unique tags, giving companies real-time supply chain visibility into product supply and modern technology connected with sophisticated inventory management systems processes huge volumes of data on inventory units, order fulfillment, and customer demand by using data analytics. In addition, Fatorachian and Kazemi (2021) posit that technology-enabled inventory management makes order fulfillment processes more effective. According to their study, technology-enabled order processing automation guarantees concise and real-time order fulfilment, increasing customer satisfaction. Meanwhile, Blichfeldt and Faullant (2021) showed in their study that E-commerce platforms

and modern inventory systems work together smoothly, giving companies the ability to manage shipments and online orders, and give customers real-time updates on the process of their buying processes. To find bottlenecks, smooth procedures, and maximize the effectiveness of the entire supply chain, visibility is essential.

## **2.2. Technology Adoption and Operational Efficiency in Production Management**

Production management is the process of planning, organizing, and controlling manufacturing processes to ensure that items are produced efficiently (Newman and Gough, 2020). According to Govindaraj *et al.* (2024), production management, which was formerly considered by manual procedures and stand-alone systems, has experienced a significant change as a result of the introduction of cutting-edge technology, improving accuracy, adaptability, and response to market changes. On the other hand, Huang, Fang and Lin (2020) stated that production process optimization now depends heavily on Automated Production Planning Systems. These systems estimate demand, allocate resources effectively, and create production plans that are optimized by using complex accounting and data analytics. Javaid *et al.* (2022) added that the design, manufacturing, and distribution teams can collaborate and communicate with each other more easily because of digital tools. Kurdi *et al.* (2022), in their analysis, showed that real-time information may be acquired and shared by stakeholders through cloud-based systems, which promotes collaboration and guarantees that all production-related aspects are consistent with broad corporate objectives. Then, Lagorio *et al.* (2022) stated that applications for the Internet of Things (IoT) that are integrated into machinery and equipment collect data in real time about performance, requirements, and productivity. Also, Lee *et al.* (2022) stated that businesses may apply predictive maintenance techniques with this data-driven strategy, which limits downtime and maximizes overall equipment effectiveness (OEE). Moreover, according to Mangla *et al.* (2020), lean manufacturing concepts are consistent with the use of technology in production management. Efficiency outputs and cost reduction are achieved by technology-driven processes through waste reduction, setup time reduction, and production flow optimization. In addition, Neumeyer, Santos and Morris (2020) stated that modern technology, such as robotics and computer numerical control (CNC) equipment, automates repetitive jobs to guarantee accuracy and productivity in manufacturing.

## **2.3. Technology Adoption and Operational Efficiency in Transportation Management**

Transportation management refers to the strategic planning, implementation, and optimization of the flow of goods from the point of origin to the point of destination. It entails choosing carriers, controlling freight, guaranteeing adherence, and enhancing supply chain delivery effectiveness (Periyasami & Periyasamy, 2022). According to Saurabh and Dey (2021), technology use in transportation management has been essential in the RMG sector for reforming logistics processes, improving operational efficiency, and guaranteeing smooth and economical delivery of goods. Similarly, Sihombing (2024) stated that the incorporation of modern technology that enhances supply chain visibility facilitates real-time tracking, optimizes route planning, and characterizes the changing properties of transportation management. Unhelkar *et al.* (2022) showed in their study that a key element of the technology revolution in transportation management is the use of GPS tracking systems. GPS trackers use satellite technology to give running vehicles real-time location information. Again, Dehgani and Navimipour (2019) posit that proactive decision-making is made easier by real-time tracking, which helps companies react quickly to delays, disruptions, or adjustments to the supply time frame. In addition, according to Tönnissen and Teuteberg (2020), route optimization software has become a key component of equipment for transportation management. These systems use statistical equations to determine the best fuel-efficient routes for transportation based on several variables, including traffic, delivery schedules, and fuel economy. Then, Ivanov, Dolgui and Sokolov (2019) elaborated that real-time visibility tools increase the operational effectiveness of transportation management even further. According to Coyle *et al.* (2021), technology integration in transportation management reflects cloud-based platforms and Electronic Data Interchange (EDI).

## **2.4. Technology Integration and Its Contribution to Sustainability and Ethical Practice**

According to Huang *et al.* (2020), in reaction to international demands for ethical and ecological standards, the RMG industry has been using technology as a strong weapon to change its supply chain. Javaid *et al.* (2022) stated that a ground-breaking method for increasing supply chain traceability and transparency is blockchain technology. Blockchain offers an unchangeable and transparent record in the context of the RMG industry, where raw materials like textiles and clothing go through a complicated international supply network. Krishnan *et al.* (2024) added that technology adoption also makes it easier to track and lessen the effects on the environment. Businesses can monitor and assess environmental elements through sophisticated systems and sensors that are frequently included in IoT applications. According to Fatorachian and Kazemi (2021), technology is crucial for maintaining ethical supply chain activities in the field of responsible sourcing. Businesses can precisely screen suppliers using digital tools and platforms to ensure social responsibility and ethical standards are being followed. Unhelkar *et al.* (2022) stated that predictive analytics utilizes machine learning and AI to predict demand, prepare optimum production schedules, and minimize the risk of overproduction and surplus inventory. Lagorio *et al.* (2022) stated that technology integration also assists in adopting ethical RMG initiatives by enabling companies to make customers aware of their dedication to ethical business practices.

## **2.5. Challenges Associated with Integrated Technology in the Supply Chain**

Huang *et al.* (2020) stated that there are many challenges in the way of the RMG industry's efforts to incorporate technology into its supply chain, from infrastructure constraints to resistance to change. According to Javaid *et al.* (2022), the current infrastructure obstacles are one of the main challenges to technology integration in the supply chain of the RMG industry. According to Unhelkar *et al.* (2022), the lack of technical skills and digital literacy in the workforce is a major problem. A workforce qualified to operate, maintain, and utilize these technologies is necessary for the effective integration and use of technology. According to Mangla *et al.* (2020), one of the biggest barriers facing companies willing to incorporate technology into their supply chain management is cost. According to Neumeyer *et al.* (2020), the adoption of technology is hindered by human factors as well, such as resistance to change. Because they are habituated to traditional means, employees, management, and other stakeholders may resist the adoption of new technologies in fear of losing their jobs, ignorance of the new systems, or inability to maintain workflows. According to Unhelkar *et al.* (2022), as supply chain operations increasingly adopt technology, privacy and data security issues are becoming more emerging. Robust cybersecurity protections are important for the collection, storage, and transportation of sensitive data, including customer and confidential business data.

## **2.6. Gap Analysis**

One significant gap in the research is the limited attention paid to the context-specific barriers the RMG industry in Bangladesh has when aiming to integrate technology into its supply chain. Previous research offers broad perspectives, but is limited to tackling the complex problems particular to this situation. It would be beneficial to conduct more studies to gain a more comprehensive understanding of the trends, cultural influences, and regulatory factors that specifically impact technology integration in Bangladesh's RMG supply chain. This would enable potential solutions for sustainable and effective integration.

## 2.7. Theoretical Framework

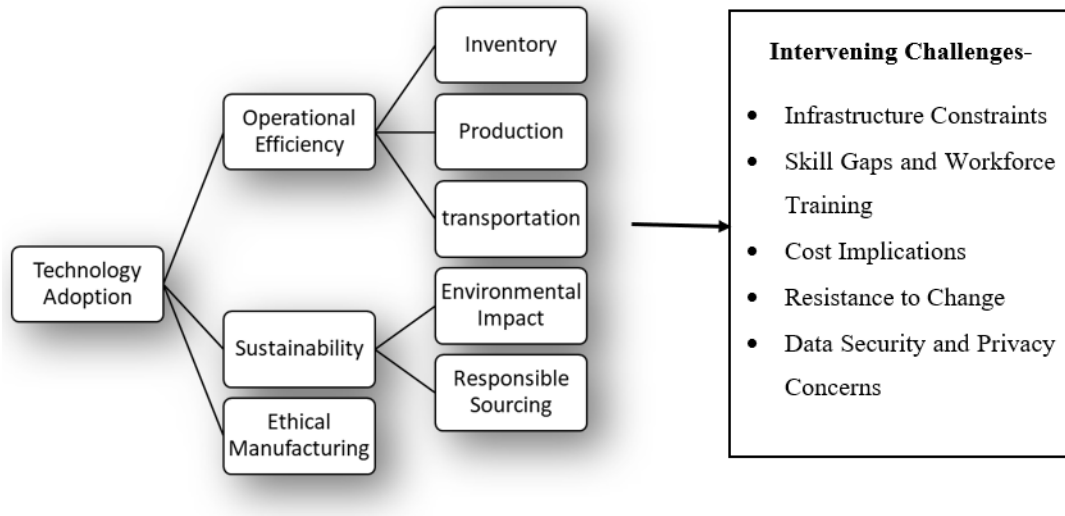


Figure 1: Theoretical Framework

The framework illustrates how the RMG business in Bangladesh is driven by Sustainability and Ethical Practices, and how Operational Efficiency is greatly impacted by technology adoption. Issues with infrastructure, skill gaps, cost implications, resistance to change, and other issues are highlighted, indicating possible roadblocks in the supply chain integration process. To successfully and significantly transform the sector through technology, these difficulties must be addressed.

## 3. Methodology

Pragmatism was selected since it permits an adaptable and comprehensive methodology that ensures positivist and interpretive components (Saunders, Lewis & Thornhill, 2016). The use of a pragmatic approach ensures that the research can proficiently tackle the complexities of the subject matter and produce practical insights. For this study, a qualitative research design was employed since it provided a comprehensive examination of the viewpoints and experiences of the research subjects consistent with the integration of technology into the supply chain and logistics of the Bangladeshi RMG industry.

### 3.1. Sampling and Participants

Primary data was collected for this study with a focus on obtaining deep, insightful information on the perceptions of stakeholders about the adoption and practice of technology in the supply chain and logistics of the Bangladeshi RMG sector (Haydam & Steenkamp, 2020). Representatives from RMG labels, producers, suppliers, logistics companies, and industry experts were among them. Purposive sampling was used, which reflected the selection of participants based on their knowledge of the adoption of technology within the sector and their relevance to the objectives of the study (Keleman & Rumens, 2008). For that reason, six supply chain managers (aged between 35 years and 55 years) who worked in the RMG industry of Bangladesh have been chosen for the study, ensuring a wide representation of opinions guided by knowledge and experiences (Table 1). Six supply chain managers from the RMG sector participated in the study, which was appropriate considering its exploratory, qualitative design. Rather than statistical generalization, the goal was to obtain profound insights. In order to prevent non-response bias, experienced participants were chosen through deliberate sampling, rapport was established in advance, and flexible scheduling for follow-up reminders was offered (Thomas, 2021). Participants were selected from a variety

of companies to capture a range of viewpoints, and data saturation was achieved, guaranteeing adequacy. Although the sample size was limited, it was well-chosen, rich, and relevant. For this study on technology adoption, Saunders *et al.* (2019) suggest a sample size of 5 to 30 participants for semi-structured interviews. This range ensures that it achieves data saturation while obtaining in-depth insights relevant to the research focus.

**Table 1. Profile of the Participants**

| No. | Name               | Company                 | Position                                         |
|-----|--------------------|-------------------------|--------------------------------------------------|
| 01. | Md. Rasheduzzaman  | Snowtex Sportswear Ltd. | Production Manager                               |
| 02. | Mahadi Tushar      | Sepal Garments Ltd.     | Production Director                              |
| 03. | Monirujjaman Monir | Vertex Sweaters Ltd.    | Senior Manager (Production Planning and Control) |
| 04. | Md. Zahidul Islam  | Anowara RMGs Ltd.       | Production Manager                               |
| 05. | Rakib Hossain      | Amir Shirt's Limited    | Senior Executive                                 |
| 06. | Md. Sifat Zaman    | Cotton Field BD Ltd.    | Senior Production Manager                        |

### 3.2. Data Collection

To collect qualitative data, semi-structured interviews were held with the selected participants. Open-ended questions intended to gather information about participants' perspectives, experiences, and difficulties with the use of technology in the supply chain have guided the interview. There were 12 open-ended questions in the interview under the 3 research objectives, respectively. Every question during the interview was asked in English. Moreover, it is anticipated that all of the interviewees, being high-level staff, would readily respond to every question. To save time and ensure convenience, the interview was held over the telephone, and it took almost 20 minutes per interviewee. The responses were recorded with the consent of the participants.

### 3.3. Data Analysis

The recorded interviews were transcribed word-for-word and analyzed using thematic analysis, a systematic method for identifying, analyzing, and reporting patterns (themes) within qualitative data (Braun & Clarke, 2006). Thematic analysis involved an iterative coding process to classify data into meaningful themes aligned with the research objectives. This process included:

**Familiarization with the Data:** The interview data were thoroughly reviewed multiple times to understand the key patterns and trends related to the impact of technology on logistics and supply chain management in the Bangladeshi RMG sector.

**Generating Initial Codes:** Systematic coding was applied to identify significant features within the data. Initial codes were generated for key technologies, contributions to operational efficiency, sustainability practices, and challenges in technology integration.

Theme Development: The codes were grouped into overarching themes to provide a deeper understanding of the research topic. The main themes that emerged included:

- *Operational Efficiency:* Technologies like barcoding, RFID, IoT-enabled machinery, and AI were identified as driving factors in improving inventory, production, and transportation management.
- *Sustainability and Ethics:* Key themes included the use of eco-friendly materials, real-time tracking, and blockchain for ethical sourcing, promoting a more sustainable and transparent supply chain.
- *Challenges in Technology Integration:* Common barriers identified were infrastructural constraints (e.g., poor connectivity, outdated systems), skill gaps (inefficiency, lack of productivity), cost constraints (limited investment), and resistance to change among stakeholders.

Reviewing and Refining Themes: The themes were refined iteratively to ensure they accurately captured the participants' views and aligned with the study's research objectives. This process involved verifying the relevance and coherence of each theme.

Defining and Naming Themes: Each theme was clearly defined and named to ensure clarity and consistency in understanding the impacts of technology adoption. These themes highlighted both the positive contributions of technology to operational efficiency and sustainability, as well as the challenges faced in its integration within the RMG sector.

### 3.4. Ethical Considerations

Ethical approval was obtained, and all participants were informed about the study's purpose, their rights, and data confidentiality. Consent was secured before recording interviews, ensuring transparency and compliance with ethical research practices.

## 4. Data Analysis and Findings

The results of the data study are shown in this part, with an emphasis on how technology adoption has impacted logistics and supply chain management in the Bangladeshi RMG sector. It emphasizes operational efficiency improvements, sustainability, ethical practice promotion, challenges regarding technology integration, and suggestions for improved technology adoption using thematic analysis of interview data.

|                      |                  | Key Themes         | Frequency of Mentioning | Representative Quote                                                                                                                                                                   |
|----------------------|------------------|--------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inventory Management | Key Technologies | Barcoding          | 6                       | 'For example, Barcoding, RFID, and advanced IMS (Inventory Management System) improve accuracy and streamline processes for increased control and efficiency of inventory management.' |
|                      |                  | RFID               | 5                       |                                                                                                                                                                                        |
|                      |                  | Advanced MIS       | 4                       |                                                                                                                                                                                        |
|                      | Contributions    | Real-time Tracking | 5                       | 'Through real-time tracking, automation, and data analytics, technology integration in inventory management improves operations,                                                       |
|                      |                  | Automation         | 5                       |                                                                                                                                                                                        |

|                           |                  |                              |   |                                                                                                                                                                                                                                                                                     |
|---------------------------|------------------|------------------------------|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |                  | Data Analytics               | 4 | reduces errors, and provides instant data for the Bangladeshi RMG sector’                                                                                                                                                                                                           |
| Production Management     | Key Technologies | Automation                   | 4 | ‘As an industry insider, I found that Bangladeshi RMG's production management is influenced by technology. A few notable examples of technology that improve operational efficiency and accuracy are automation, AI, and IoT-enabled machinery.’                                    |
|                           |                  | AI (Artificial Intelligence) | 4 |                                                                                                                                                                                                                                                                                     |
|                           |                  | IoT-enabled Machinery        | 6 |                                                                                                                                                                                                                                                                                     |
|                           | Contributions    | Reduced Lead Times           | 6 | ‘Technology integration in production planning reduces lead times, maximizes resource allocation, and enables real-time communication. This helps enhance schedules, decrease, and heighten flexibility toward fluctuating market requirements to achieve a competitive advantage.’ |
|                           |                  | Resource Allocation          | 6 |                                                                                                                                                                                                                                                                                     |
|                           |                  | Real-time Communication      | 6 |                                                                                                                                                                                                                                                                                     |
|                           |                  | Proper Scheduling            | 4 |                                                                                                                                                                                                                                                                                     |
|                           |                  | Flexibility                  | 4 |                                                                                                                                                                                                                                                                                     |
|                           |                  |                              |   |                                                                                                                                                                                                                                                                                     |
| Transportation Management | Key Technologies | GPS Monitoring               | 6 | ‘As a professional in this field, I have found how technology is revolutionizing transportation in Bangladesh's RMG industry. GPS monitoring, real-time visibility tools, and route optimization software enhance productivity and logistics management.’                           |
|                           |                  | Real-time Visibility Tools   | 6 |                                                                                                                                                                                                                                                                                     |
|                           |                  | Route Optimization Software  | 4 |                                                                                                                                                                                                                                                                                     |
|                           |                  |                              |   |                                                                                                                                                                                                                                                                                     |

|  |               |                                   |   |                                                                                                                                                                                              |
|--|---------------|-----------------------------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Contributions | Use of eco-friendly materials     | 6 | 'By lowering costs, enhancing visibility, and ensuring on-time delivery, technology integration in the transportation system of the Bangladeshi RMG sector increases operational efficiency' |
|  |               | Real-time Tracking                | 4 |                                                                                                                                                                                              |
|  |               | Adoption of sustainable practices | 6 |                                                                                                                                                                                              |

Table 1. Assessing how technology adoption is creating operational efficiency; source: original research

After conducting a thematic analysis of the participants' opinions, several important themes emerged about the level of technology utilization in operational efficiency in three areas, including inventory management, production management, and transportation management in the Bangladeshi RMG industry. The three key technologies used in inventory management that were found to be the most effective were barcoding, RFID, and improved IMS. These technologies enhance the operational efficiency of inventory management in the Bangladeshi RMG sector, were real-time tracking, automation, and data analytics. Again, currently the most used technologies in production management are IoT-enabled machinery, automation and AI. These technologies increase operational efficiency in inventory management primarily by reducing lead times, optimizing resource allocation, and ensuring real-time communication, as well as by advancing production schedules and maintaining flexibility. Also, some key technologies for operational efficiency were route optimization software, real-time visibility tools, and GPS tracking. These technologies enhance operational efficiency by ensuring on-time delivery, improving visibility, and reducing cost.

|                        | Key Themes                        | Frequency of Mentioning | Representative Quote                                                                                                                                                                                                                              |
|------------------------|-----------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sustainability         | Use of eco-friendly materials     | 6                       | 'Technology in the Bangladesh RMG industry minimizes environmental impact by using eco-friendly materials, real-time tracking of production processes, and adopting sustainable practices, fostering a greener and more responsible supply chain' |
|                        | Real-time Tracking                | 4                       |                                                                                                                                                                                                                                                   |
|                        | Adoption of sustainable practices | 6                       |                                                                                                                                                                                                                                                   |
| Ethical Implementation | Traceability via Blockchain       | 6                       | 'Technology assists the Bangladeshi RMG industry with ethical sourcing by providing traceability via blockchain, guaranteeing transparency, and using                                                                                             |
|                        | Transparency                      | 6                       |                                                                                                                                                                                                                                                   |

|  |                |   |                                                                                                   |
|--|----------------|---|---------------------------------------------------------------------------------------------------|
|  | Data Analytics | 4 | data analytics to screen suppliers and ensure materials that are ethically and socially supplied' |
|--|----------------|---|---------------------------------------------------------------------------------------------------|

Table 2: Addressing the role of technology in increasing sustainability and ethics; source: original research

Several major themes were found from a thematic analysis of participant responses about how technology has been used to increase sustainability and ethical practice in the supply chain operations of the Bangladeshi RMG industry. The use of environmentally friendly materials, real-time manufacturing process tracking, and the adoption of sustainable practices were the key themes mentioned the most. Also, the three themes that were mentioned most frequently were data analytics, transparency, and blockchain-based traceability for ethical implementation.

|                             | Key Themes                       | Frequency of Mentioning | Representative Quote                                                                                                                                                                                                                                  |
|-----------------------------|----------------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Infrastructural Constraints | Slow connectivity                | 4                       | 'Infrastructure constraints, such as slow connectivity or obsolete systems, hinder the effective integration of technology by causing delays, data inaccuracies, and disruptions in communication within the Bangladesh RMG industry's supply chain.' |
|                             | Obsolete systems                 | 5                       |                                                                                                                                                                                                                                                       |
|                             | Delays                           | 6                       |                                                                                                                                                                                                                                                       |
|                             | Data inaccuracy                  | 5                       |                                                                                                                                                                                                                                                       |
|                             | Disruptions in communication     | 4                       |                                                                                                                                                                                                                                                       |
| Skill Gaps                  | Inefficiency                     | 6                       | 'The current team of employees is evident with lower productivity and efficiency'                                                                                                                                                                     |
|                             | Lack of productivity             | 6                       |                                                                                                                                                                                                                                                       |
| Cost Constraints            | Limited investment in technology | 6                       | 'Limited budget and cost constraints are creating several obstacles like limited investment in technology, limited innovation, and slow adoption rate'                                                                                                |
|                             | Limited innovation               | 5                       |                                                                                                                                                                                                                                                       |
|                             | Slow adoption rate               | 4                       |                                                                                                                                                                                                                                                       |
| Resistance to Change        | Reluctance                       | 6                       | 'Resistance to change among stakeholders, including employees and management, can hinder the successful integration of technology in the Bangladesh RMG industry's supply chain by                                                                    |
|                             | Lack of Collaboration            | 5                       |                                                                                                                                                                                                                                                       |

|  |                       |   |                                                                                     |
|--|-----------------------|---|-------------------------------------------------------------------------------------|
|  | Slowing down Adoption | 3 | raising reluctance, hindering collaboration, and slowing down the adoption process' |
|--|-----------------------|---|-------------------------------------------------------------------------------------|

Table 3: Identifying the challenges associated with integrating technology into the supply chain; source: original research

Several key themes were found from a thematic analysis of participant comments on how challenging it is to integrate technology into the supply chain of the Bangladeshi RMG sector. The themes that were mentioned the most as infrastructural constraints were poor connectivity, out-of-date systems, delays, inaccurate data, and communication disruptions. Two major themes found from a thematic analysis of participant responses about how labour skill gaps make it challenging to adopt technology into the supply chain of Bangladesh RMG industry are lack of efficiency and productivity. The fact that the theme of limited investment frequently reflects the difficulties caused by limited financial resources, which can hinder innovation efforts and hamper the acceptance of new technologies. Three main themes found from a thematic analysis of participant responses on how stakeholders' resistance to change makes it challenging to adopt technology into the supply chain of the Bangladeshi RMG industry are reluctance, impeding collaboration, and slowing down the adoption process.

## 5. Discussion on Findings

Thematic analysis of participant responses directs findings about technology adoption and its effect on operational efficiency in the supply chain of the Bangladeshi RMG industry, which is generally consistent with existing research on the topic (Table 1). According to the literature, using technology may greatly increase operational efficiency by enhancing visibility across the supply chain, improving accuracy, and simplifying tasks (Irfan, Wang and Akhtar, 2020). Barcoding, RFID, real-time tracking, automation, and data analytics are themes in inventory management that are consistent with literature that emphasizes the advantages of these technologies in terms of increasing inventory accuracy, decreasing mistakes, and providing greater control over stock quantities (Pal, 2020). These results are consistent with existing research that emphasizes how crucial technology-enabled inventory management systems are to enhancing operational effectiveness and customer service.

Similarly, themes found in production management literature reflect the significance of technology in reducing production processes, cutting lead times, and optimizing resource allocation. These themes include automation, AI, IoT-enabled machinery, and real-time communication (Lee, 2021). The results of this study are consistent with the literature, which indicates that technology integration can improve production scheduling, flexibility, and overall operational effectiveness and efficiency. In terms of transportation systems, the themes that have been found, like GPS tracking, real-time visibility tools, and route optimization software, are consistent with existing literature that reflects how technology can improve logistics management, enhance efficiency, and ensure real-time delivery (Hader *et al.*, 2022). The results of this study are supported by other research, which suggests that technology-enabled transportation systems can result in lower costs, better delivery outcomes, and more customer responsiveness.

The results of the thematic analysis about how technology can enhance sustainability and ethics (Table 2) in the supply chain of the Bangladeshi RMG industry both support earlier research and offer insightful new knowledge that enhances the understanding of these areas. It shows that technology plays an important role in increasing sustainability in the RMG supply chain. Examples of this include real-time tracking and practicing sustainable activities (Caldarelli, Zardini & Rossignoli, 2021). This result is consistent with other studies that emphasize how technology may increase sustainability through waste reduction, improved resource management, and the encouragement of eco-friendly behaviour (Wang *et al.*, 2020). The focus on environmentally friendly products and real-time monitoring tools is consistent with existing research that reflects how technology is enabling sustainable sourcing and production systems.

It also reflects how important technology is for ensuring traceability and transparency procedures in ethical sourcing practices. This result is consistent with existing research that emphasizes the contribution of technology, such as blockchain and data analytics, to improve supply chain reliability and transparency. The focus on blockchain-based traceability is consistent with research indicating that the technology might update supply chain transparency by offering transparent and unchangeable records of product sourcing (Akram *et al.*, 2022). It further finds the contribution that digital tools and platforms have to traceability and transparency in sustainable purchasing. This result is consistent with research that highlights how crucial digital technologies are to providing customers with the information they need to buy sustainable products (Kalyar, Shafique & Ahmad, 2020). Research indicates that digital platforms may empower customers by providing them with access to detailed product information, including environmental and ethical concerns. This is supported by the emphasis on real-time data and product information.

The theme analysis conducted on the challenges in adopting technology into the supply chain of the Bangladeshi RMG industry offers insights into the issues that stakeholders face (Table 3). By placing these findings in the context of the body of knowledge already available on supply chain technology adoption, it may better highlight the difficulties and consequences involved.

Infrastructure-related limitations to technology integration, such as slow connectivity and outdated systems, are found. This is consistent with other studies that emphasize the need for a strong infrastructure for effective technology integration. Inadequate connections and outdated technologies may cause disruptions in communication, delays, and inaccurate data, which can hinder the smooth integration of technology across the supply chain (Agrawal *et al.*, 2021). The results reflect how important it is to overcome infrastructure limitations to enhance technology adoption and improve supply chain efficiency. In addition, it indicates that a major challenge to the integration of technology is skill gaps in the workforce. This result is consistent with previous research prioritizing the value of trained human capital in utilizing technology properly. Reduced efficiency and productivity can result from an ineffective and unproductive workforce caused by a lack of skills, which can hinder dedication to accept new technologies (Camargo, Pereira & Scarpin, 2020). The results indicate the necessity of funding training and upskilling programs to minimize skill gaps and provide the workforce with the confidence to adopt new technology.

Cost constraints are found as a hindrance to technology integration in the RMG supply chain. This result is consistent with earlier studies that found limited funding might reduce efforts to invest in technology and innovate. Cost constraints preventing large investments in technology might lead to low innovation and poor adoption rates, which would affect the competitiveness of the sector negatively. The results demonstrate how important it is to remove financial challenges by carefully allocating resources and designing investments to enhance technological innovation and adoption (Fung *et al.*, 2021). Finally, it identifies the issue of stakeholders' reluctance to adapt when it comes to the adoption of new technologies. This result is consistent with research that shows how organizational culture and change management may help enhance the adoption of new technologies. The adoption process can be slowed down, and collaboration is hindered by management and staff resistance to change, which can neglect the potential advantages of technological integration (Alves *et al.*, 2022). The results demonstrate how complex it is to develop an innovative culture and offer sufficient assistance and training to tackle reluctance and enhance the adoption of new technologies.

## **6. Conclusion**

The research infers that technology plays a transformative role in the supply chain management of the Bangladeshi RMG industry, enhancing operational efficiency and promoting sustainability. Tools such as RFID, AI, and blockchain have streamlined processes and increased transparency, supporting ethical sourcing and eco-friendly practices. However, the industry faces notable challenges, including infrastructure limitations, skill shortages, and resistance to adopting new systems. These issues underline

the need for targeted investment and training. Overall, while technology integration has shown positive outcomes, addressing these challenges will be crucial to fully leveraging technological advancements for long-term industry growth and resilience.

### **6.1. Limitations of the Research**

The qualitative insights of this study cannot be statistically generalized; the transferability of the findings is limited by their reliance on a small purposive sample of six managers. Although data saturation was attained, the variety of viewpoints might have been limited by the homogeneity of the participants. Despite their convenience, telephone interviews limit the ability to observe nonverbal clues, which can sometimes enhance qualitative interpretation. Furthermore, contextual specificity may limit the applicability of the study to other businesses or national settings because it is based in the Bangladeshi RMG sector.

### **6.2. Further Research**

Subsequent evaluations were directed to further explore the perceptions of various participants in the Bangladeshi RMG sector, such as producers, vendors, merchants, and customers. Studies that follow the enhancement of technology adoption over time may offer a more thorough analysis of the effects that technology has on industrial ethics, sustainability, and operational effectiveness. Future studies could examine how advanced technologies like AI, machine learning, and the IoT could enhance supply chain operations in the Bangladeshi RMG sector, focusing on how quickly technology is developing. Studies that compare the supply chain practices and technological adoption of the Bangladeshi RMG industry to those of other countries may provide insightful comparisons and benchmarks for improvement.

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