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Harnessing Big Data and AI for Supply Chain Resilience in the Garments Industry: A Comparative Analysis of Bangladesh and China

Mushfiquddin Rafid, Tunazzina Binta Mostafa and Rejwanul Haque Wasi
Department of Mechanical and Production Engineering
Ahsanullah University of Science and Technology (AUST)
Dhaka, Bangladesh
rafid.khan10@gmail.com
tunazzina.mostafa001@gmail.com
rejwan.11wasi@gmail.com

Rupok Islam Avi
Department of Industrial & Production Engineering
Rajshahi University of Engineering & Technology
Rajshahi-6204, Bangladesh
rupokislamavi.ruet@gmail.com

Abstract

The Readymade Garments Industry of Bangladesh contributes about 80% of the export earnings and is currently positioned 2nd worldwide in exporting clothes and fabric industry. The competition within this industry is intensifying rapidly. In addition to fierce global competition labor union movements and higher-quality market demands are making it more challenging for brands to maintain their foothold. This study introduces strategies that may improve the resiliency of the supply chain in Bangladesh's Garments using AI and Big Data tools. About 3-4 case study designs are used in this study to compare the technological developments in Bangladesh's RMG industry with benchmark practices in China. Secondary sources such as case studies (HLA group, Alibaba, H&M, Zara), scholarly works, industry reports, and regulatory documents were used to gather data. The study shows China's adoption of advanced AI tools such as AI-based quality control cameras, Big Query to data analyze, blockchain platforms like Hyperledger Fabric, AI-generated digital patterns and Ethereum-based solutions, and physics-based simulators for garment modeling, which is contributing at an streamline operations, enhance transparency. On the other hand, Bangladesh has applied innovations like computer vision for quality inspections (Aamra vision by Amara technologies limited) and predictive analytics for supply chain planning and many . Development is still hampered by inadequate investment in digital technologies, a lack of qualified personnel, and inadequate infrastructure. Bangladesh's apparel and garments industry can improve supply chain resilience, lower costs, and improve compliance with international standards by giving targeted investments in AI and big data and making them a top priority. To ensure sustainability and long-term competitiveness, this study offers policymakers, governments and business executives practical suggestions for unlocking the full potential of AI and big data.

Keywords
Supply Chain, AI, Big Data, Global Competitiveness, Sustainability and Garments Industry

1. Introduction

In today's world and its globally integrated economy, supply chain resilience is important for companies trying to stay open and competitive in the face of numerous disruptions (Riad et al. 2024a). The garments industry is one of the corner stone of the global economy. It contributes significantly to trade, employment and GDP in many countries. Bangladesh is one of the largest exporters of ready-made garments (RMG) which heavily depends on its supply chain efficiency to maintain competitiveness in global markets. But, the industry faces numerous challenges, including rising labor costs, fluctuating demand , supply chain disruptions due to geopolitical tensions, climate change etc.

Big data and AI have emerged as transformative tools for modern supply chains. Capabilities such as predictive analytics, real-time tracking, and automation are contributing heavily to make a more resilient supply chain. By implementing these technologies, businesses can enhance operational efficiency , improve demand forecasting and proactively address disruptions automatically. China , a leader in garment manufacturing and export has successfully used big data and AI to manage its supply chain efficiency which gained them a competitive advantage. With advanced technological infrastructure and immense integration of AI-driven problem solutions, China show the potential of these technologies in enhancing resilience and agility across the supply chain.

The Bangladeshi Ready-Made Garments (RMG) industry requires a significant boost in technological adoption and development to address infrastructure challenges that hinder the large-scale implementation of big data and artificial intelligence. However, the Government along with the Bangladeshi Ready-Made Garments (RMG) industry now necessitates technological innovation and enhanced efficiency (Saha, n.d.2 024).

Table 1. Roles of big data and AI for supply chain resilience in garments industry

Framework Elements	**Contribution of AI and Big Data Analysis**	**Reference**
Machine Integrated Components	- Human error can be reduced with enhanced operational resilience, also efficiency can be increased in the inventory and logistics using AI driven automation	(Sanders 2014)
Enhancement in Supply Chain System	- To optimize routing, transportation, and logistics, thereby reducing costs and improving delivery times, AI can be applied	(Sanders 2014)
Personalizing Designs and Plannings	- AI tools use data analysis and pattern recognition to create customized designs that appeal to consumers. AI's ability to analyze large datasets and spot complex patterns lets it suggest design ideas that match each consumer's preferences and market trends. - AI and BDA can be used for predictive analytics and real-time decision-making. AI-driven predictive analytics can forecast demand with superior accuracy by analyzing vast amounts of datasets from various sources, such as market trends, historical sales data, and consumer behavior patterns	(Angela Omozele Abhulimen & Onyinye Gift Ejike, 2024; Emran & Ppm, n.d., 2024)
Risk Control and Remission	- The traditional risk management process depicts a continuous cycle of identification of hazards, valuation of risks, assessment of controls, selection of controls, implementing controls, and evaluate whole. In many implementations, risks can be quantified based on historical data, but evaluating risks requires assumptions based on subjective information.	(Pettit et al., 2010)
Sustainability and Eco-friendly Practices	- By using AI it can reduce waste, elevate processes, and regulate eco-friendly fashion decisions, making the sector more sustainable.	(Emran & Ppm, n.d., 2024)

1.1 Objectives
The research points to investigate and analyze the role of Big Data and AI in upgrading supply chain strength inside the articles, latest industry news from websites, and white papers of clothing industry, with a center on Bangladesh and China.

1. Exploring the Role of Big Data and AI in Strengthening garments Supply Chain process.
2. To find out the current state of Technological adoption in Bangladesh and China's RMG sector .
3. Comparative Assessment of the Garment Sectors in China and Bangladesh
4. Examine Opportunities and Challenges in both of the countries .
5. Uncovering Bangladesh's Potential and Provide Strategic Recommendations

2. Literature Review
The apparel sector is essential to international trade and propels economic expansion in many developing countries. China and Bangladesh have become industry leaders by taking advantage of their vast manufacturing networks and affordable labor. But the COVID-19 pandemic and geopolitical unrest have made global supply chain vulnerabilities worse, which has had significant impacts on garments exporters. Disruptions in integrated transport systems resulted in revenue loss and operational shutdowns for Bangladesh (Sabur 2023). In contrast, China has shown strategic vision through advanced technology adoption, sustainability initiatives, and proactive supplier engagement, offering a model for establishing a balance between environmental responsibility and efficiency (Tornikoski 2024). Ahmed and Islam analyzed the challenges faced by Bangladeshi and Chinese ready-made garment (RMG) exporters, emphasizing regulatory hurdles, labor issues, and global supply chain fragility. For Bangladesh, challenges include meeting international labor standards and coping with disruptions in transportation systems, while China faces rising production costs and competition from emerging markets (Tornikoski 2024). To solve these problems and improve supply chain resilience and operational effectiveness, technological integration, strategic policymaking, and teamwork are required.

Technological advancements, particularly in AI, IoT, and Big Data, are reshaping the RMG industry. In Bangladesh, AI-powered systems such as the Smart Worker Tracking and Monitoring System *(*SWTMS*)* are improving workplace safety, operational efficiency, and environmental performance (Saha 2024). Additionally, AI-based quality control systems like Aamra Vision use computer vision and machine learning to detect garment defects with greater accuracy, enhancing production quality (Sunayan, 2024). On the other hand, Chinese firms are at the forefront of supply chain digitization, utilizing IoT sensors, blockchain technology, and automated sewing systems to improve efficiency and transparency (Chen 2024),(Tornikoski 2024).Investments in AI infrastructure, targeted training programs, and policy interventions are critical to achieving widespread adoption and maximizing the benefits of these innovations in Bangladesh. (Emran & Ppm 2024).

AI and data analytics are transforming demand forecasting and inventory management, enabling firms to anticipate trends and reduce waste. AI technologies enhance supply chain resilience by addressing flexibility, redundancy, visibility, collaboration, and adaptability. Flexibility ensures the supply chain can respond to changes without significant delays or costs, while redundancy involves maintaining alternative suppliers or resources to mitigate disruptions(Riad et al. 2024b). Saha emphasizes how supply chain optimization, trend forecasting, and predictive analytics are made possible by AI-driven technologies, which reduce expenses and improve productivity(Saha 2024). Similar initiatives in China, such as Alibaba's AI-powered logistics platforms, assist SMEs in optimizing operations and remaining competitive (Chen 2024). But issues like data privacy, job displacement, and moral dilemmas with AI adoption are still common. Fostering innovation while maintaining workforce stability requires well-balanced approaches that combine human expertise with AI's computational power (Emran & Ppm 2024). Sustainability has emerged as a critical priority, driven by increasing consumer demand for eco-friendly products.

AI optimizes supply chains by minimizing waste and recommending sustainable materials, aligning production processes with global sustainability goals (Saha 2024) Chinese firms demonstrate a leading example by leveraging technology to implement sustainability initiatives across their supply chains, balancing economic and environmental priorities .Bangladesh can learn from these practices to enhance sustainability through AI integration, targeted investments, and policy support (Tornikoski 2024).

China’s integration of sustainability and advanced supply chain technologies serves as a blueprint for Bangladesh. While Bangladesh struggles with transportation inefficiencies and regulatory compliance, China's focus on AI-driven supply chain visibility and proactive sustainability measures provides a competitive edge. Ahmed and Islam emphasize that adopting similar strategies can help Bangladesh improve operational efficiency, enhance supply chain responsiveness, and achieve long-term competitiveness.

3. Methods

The application of Big Data and Artificial Intelligence (AI) in the Ready-Made Garments (RMG) sector is examined in this desk-based study using secondary data. This strategy was chosen in order to compile the most recent research and provide useful recommendations for improving Bangladesh's supply chain resilience

3.1 Research Design

This study is based on multiple case studies, comparing the technological practices of the readymade garment industry in Bangladesh with the standards of progress in China. This approach helps to identify strategies, challenges, and outcomes in different contexts, providing valuable insights for targeted recommendations.

3.2 Data Collection

Secondary data sources were used for the study
Published Case Studies: Offering insights into how Big Data and AI are applied to enhance supply chain resilience.

Academic Literature: Providing theoretical frameworks and in-depth analyses relevant to technological adoption.

Industry Reports: Highlighting the new market trends and technological advancements in the RMG sector.

Regulatory Documents: Giving contextual insights into the policy environment in Bangladesh and China.

3.3 Data Analysis

The analysis involved a comparative approach to highlight key differences and similarities in technology adoption between Bangladesh and China.
The methodology identified trends, enablers, and barriers to the use of AI and Big Data, facilitating evidence-based recommendations.

3.4 Rationale for Methodology

The literature-based approach ensured that the study synthesized existing knowledge comprehensively while focusing on practical implications. The comparative case study design enhanced the analysis by leveraging advanced technology practices in China as a reference. The methodology provided policymakers and industry stakeholders with actionable insights tailored to the specific challenges of the readymade garment industry in Bangladesh.

4. Findings and Analysis

The chapter shows the findings and analysis based on the objectives and methodology showed in chapter three. Using the research approach that was described earlier,a range of sources were examined to achieve the study objectives . The study identified major themes that provide valuable insights into the issue and contribute to a better understanding of the discipline.

4.1 Current State of Big Data and AI Adoption in Bangladesh’s Garments Industry

The garment industry in Bangladesh has seen remarkable growth, making it one of the key contributors to the country's economy. Technological advancements and innovations, such as Artificial Intelligence (AI), IoT, Big Data, and blockchain, are expected to further improve this sector's progress (Saha, 2024, Rahuman et al., 2022). While the rapid expansion of Bangladesh's (RMG) sector has increased economic growth, it has also increased challenges like worker safety, operational efficiency, and management. To address these concerns, the Smart Worker Tracking and Monitoring System (SWTMS) has been introduced. This system integrates advanced AI and Computer Vision technologies to enhance worker safety and streamline operations (Hasan, 2023).

AI-Based Quality Control: A practical example of AI implementation in Bangladesh's RMG sector is the implementation of AI-powered quality control systems. But in most of the RMG Small to large, manual inspection by workers is the method that's being implemented to identify defects such as stitching errors, fabric flaws, and color defects. This process can be time-consuming and also leads to inconsistencies in product quality.

To address these challenges, some garment factories in Bangladesh have started implementing AI-based quality control solutions. These systems utilize computer vision technology and machine learning algorithms to automatically inspect garments for defects with greater speed and accuracy than human inspectors. By analyzing images of garments captured by high-resolution cameras, AI algorithms can detect even subtle defects and anomalies in stitching, fabric texture, and color. One such example is the partnership between Aamra Technologies Limited, a leading IT solutions provider in Bangladesh, and several RMG factories. Aamra Technologies has developed an AI-powered quality control system called **"Aamra Vision"** specifically tailored for the garment industry. The system uses advanced image processing techniques and deep learning algorithms to identify defects in garments during the production process. (Sunayan 2024).

AI for Fashion trend : Global brands like H&M and Zara have set a model in using AI to predict fashion trends and consumer preferences. This practice is slowly being adopted in Bangladesh as a larger number of this company's factories are situated in Bangladesh (About 12) . Top brands of Bangladesh like Sailor, Arong are trying to implement this system into action.

IoT and Real-Time Tracking: Bangladesh`s textile industry has already taken a step towards Industry 4.0. Bangladesh has already implemented IoT with RFID based tracking system in the garment manufacturing process to increase efficiency and reduce production cost in the textile and garment industry

4.2 Insights into China's Technological Integration in Garments Supply Chains

Table 2. Technological advancements and supply chain resilience in China's garment industry

Key Area	**Description**	**Examples**	**Tools Used**	References
AI Applications	AI in the garment industry enables automation in design, production, and quality control, ensuring enhanced efficiency,better customer alignment,and improved product quality. AI tools can predict demand trends, optimize inventory, and personalize consumer experiences.	**HLA Group** uses AI to analyze consumer feedback and align designs with customer choices. - AI defect detection and quality improvement in garment manufacturing is on the process	- **AI Algorithms** for consumer feedback analysis - **AI-based QC Cameras** for inspection. - **Predictive Analytics** for production planning	N/A
Big Data Utilization	Big Data is one of the most important thing for decision-making and optimization in the garment supply chain. It facilitates forecasting demand, tracking market trends, predicting disruptions by analyzing large datasets from consumer behavior and production logistics.	- **Alibaba** uses Big Data to forecast demand - **Risk management** using Big Data models to predict and mitigate disruptions.	- **Hadoop Ecosystem** is used big data management. - **BigQuery** for real-time data analysis. and **Tableau** and **Power BI** for data visualization .	N/A

IoT Integration	IoT in garment manufacturing involves connecting sensors and devices to track the movement of raw materials, finished goods, and machine performance in real time, leading to enhanced transparency and process optimization. Additionally, IoT enables predictive maintenance to reduce downtime. (IoT) in garments	- **Smart sensors** monitor and tracks the product and the health.	- **IoT Sensors** like **RFID** and **BLE Tags** for real-time tracking. - **IoT Cloud Platforms** for centralized monitoring and data collection.	N/A
Blockchain Technology	Blockchain adoption can be an effective approach to improve the real-time transparency of supply chains with reliability and traceability	**Blockchain** tracks garment history from raw materials to delivery.Blockchain adoption can be one of the best approach to improve the real-time transparency of supply chains	- **Hyperledger Fabric** for enterprise-level blockchain integration. - **Ethereum-based platforms** to do transparency test - **IBM Blockchain** for product traceability.	(Saberi et al., 2019)
Pattern Initialization Technology	It's an automated approach to transform digital sewing patterns into well-fitted garments on human avatars. When given a sewing pattern with its associated sewing relationships, the primary challenge is to establish an initial arrangement of sewing pieces that is free from folding and intersections.	- **Virtual garment fitting** allows for design optimization before manufacturing. - **AI-generated digital patterns** to optimize garment construction. - **Pattern Initialization** and **Generative AI** used to create accurate digital garment pieces for physical production.	• **AI Classification** – Neural networks for identifying seed pieces in garment patterns. • **Heuristics** – Rule-based algorithms to guide initial pattern placements. • **Numerical Optimization** – Mathematical tools to refine positioning and shapes for seamless integration. • **Physics-Based Simulator** – Models garment behavior under realistic conditions to validate the final design.	. (Chen Liu, Weiwei Xu, Yin Yang, and Huamin Wang. 2024)
Workforce Development	To harbor technological advancements, China is focused on workforce upskilling through government initiatives,	- China's industrial masterplan **"Made in China 2025"** aims to turn the country into a	- **Online learning platforms** like **Coursera**, **Udemy**. - **In-house training**	(Wübbeke et al., 2016)

	industry partnerships, and online training programs to ensure that workers can effectively use new technologies like automation, AI, and robotics.	"manufacturing superpower" over the coming days.	**programs** on digital tools. - **Robotics programming courses** for hands-on learning.	
Case Studies	Many Chinese companies have implemented advanced technologies for improving supply chain efficiency , product quality, and customer satisfaction, showcasing the successful integration of IoT, Big Data and AI. HLA, is one of China's leading garments brands	- **HLA Group** uses Ai to tailor products to consumer preferences. - **Alibaba** offers Big Data tools to help SMEs optimize their operations.	**HLA Group**. use AI to analyze consumer feedback and design products aligned with customer preferences .. - **Alibaba**'s Big Data tools for supply chain optimization.	(Chen, 2024)

4.3 Challenges and opportunities

The apparel industries in China and Bangladesh must overcome particular obstacles and seize new opportunities presented by AI and big data to improve supply chain resilience. Bangladesh suffers from fragmented supply chains, growing compliance requirements, low investment in digital technologies, and a shortage of qualified professionals and infrastructure. However, the use of AI-based quality control tools like computer vision and predictive analytics, an engaged young workforce, and the global demand for affordable, environmentally friendly garments provide opportunities, though. There are also opportunities for growth through government programs and international alliances. In contrast, despite its technological advancements, China still faces issues like market saturation, rising labor costs, and pressure for sustainable production. Still, China is at the forefront of incorporating robotics, blockchain, and IoT into its supply chains, aided by initiatives like "Made in China 2025." These initiatives maintain its competitive edge globally by improving supply chain efficiency, automation, and transparency.

4.4 Comparative analysis: Bangladesh vs. China

Table 3. Comparative analysis of Bangladesh and China's garments industry

Aspect	Bangladesh	China
Technological Integration	Growing interest in programs such as SWTMS and Aamra Vision. Limited adoption as a result of inadequate infrastructure.	Advanced IoT, blockchain, and AI integration. Commonly utilized tools include digital garment initialization.
Cost Factors	Automation is discouraged by low labor costs. Advanced technology adoption is slowed by high upfront expenses	Investments in automation are driven by rising labor costs, which balance long-term expenses
Skill and Workforce	Massive skill gaps and few options for training in Big Data and AI.	Skilled staff with extensive training in cutting-edge technologies.
Global Market Position	Requires a lot of manual processes, which reduces efficiency and speed.	Leader of the world with high quality, timely delivery & efficient production systems.
Government Support	Early-stage policy assistance with few financial and legal rewards.	Strong government subsidies, motivations, and initiatives to promote innovation.
Sustainability	Blockchain and IoT are becoming more popular for transparency, but adoption is unrushed	Cutting-edge blockchain and IoT demands for transparent and sustainable supply chains.
Global Competition	Finds it difficult to match the speed and efficiency of world leaders	Keeps up a competitive edge through ongoing technological innovation and digitization

5. Discussion

5.1 Implications of Findings for Bangladesh

The result shows that integrating Big Data and AI in Bangladesh's apparel industry presents both significant challenges and great opportunities. Currently the country is at an early adoption of technology in this sector. The lack of infrastructure, insufficient expert people also lack of financial support has hindered the adoption of AI-powered solutions. Although the large factories of H&M or ZARA that are situated in Bangladesh are trying to cope up with the new technologies but medium and small factories are not able to cope up with the situation.
However, initiatives like AI-based quality control systems (e.g., Aamra Vision) and Smart Worker Tracking and Monitoring Systems (SWTMS) demonstrate that the foundation has been set. The technological solutions could significantly improve efficiency , reduce defects and enhance saftey keeping the budget in mind. .
Bangladesh's capacity to further imrpove in the global market will depend on its desire to welcome artificial intelligence and Big Data since efficiency, speed, and productivity become non-negotiable criteria for outside consumers.

The clothing sector might get a competitive edge in the worldwide supply chain by filling in skill shortages and making required infrastructural investments.

5.2 Lessons from China's Experience

China's garment industry has undergone a remarkable transformation, becoming a global leader through its adoption of advanced technologies and innovative practices. The following key lessons from China's journey can provide insights for other countries, including Bangladesh, aiming to strengthen their garment industries:

Technological Integration
China's extensive use of **AI, Big Data, IoT, and Blockchain** has streamlined its supply chain operations. Technologies like predictive analytics for demand forecasting, IoT sensors for real-time inventory tracking, and blockchain for transparency have enhanced efficiency and traceability across the supply chain.

Investments in Infrastructure and Technology
Government initiatives, such as *Made in China 2025*, focused on upgrading manufacturing capabilities by integrating automation, robotics, and smart systems, enabling industries to adapt to global trends quickly. Bangladesh should also try its way of Implementing "Bangladesh 2.0".

Focus on Workforce Development
The rapid technological shift was supported by significant investments in workforce upskilling programs, ensuring employees could operate advanced machinery and digital tools efficiently.
Sustainability Practices
With rising global concerns, China has embraced sustainable production methods like waterless dyeing and recycling initiatives, showcasing a commitment to reducing environmental impact while maintaining high production levels.

Adapting to Market Demands
Through Big Data and AI-driven consumer insights, Chinese manufacturers have quickly adapted to changing market trends, such as personalized fashion and fast delivery timelines.
Scale and Collaboration
Leveraging economies of scale and establishing strong global partnerships have helped China dominate export markets while innovating domestically to stay competitive.

By applying these lessons, Bangladesh can accelerate its garment sector's growth, particularly by adopting scalable technologies and aligning workforce capabilities with modern industrial demands

6. Recommendations

After analyzing scenarios, it is evident that China is current crown holder of the garments industry while facing significant challenges they demonstrate the true power of Ai and Big Data. Here are some recommendations for Bangladesh:

- Technologies like Aamra vison should be promoted widely and implemented in the industry.
- Government support: The Bangladeshi government should develop policies to facilitate the adoption and application of AI technology in the country. This may involve allocating funds for AI research and development, as well as granting tax benefits to corporations that make investments in AI.
- Encourage Public-Private Collaboration: Simplify partnerships between the government, private sector, and technology providers to accelerate AI and Big Data adoption. Provide financial incentives to encourage small and medium enterprises (SMEs) to invest in digital tools.
- Upskill the Workforce : Provide training programs for the workers and managers to help them gain the skills operate and maintain advanced technologies. Collaborate with local and international academic institutions to cultivate the uses of new innovation also notify them the value of this skills in the industry.
- Building a TechHub : A central TechHub should be made with the collaboration of government where an industry can take certain services for advanced technologies. It would beneficial for the SMEs who cant afford to have advanced system in their industry
- Investment in Skill Development and Training: The government and industry stakeholders should work together on comprehensive skill development and training programs. These programs should teach RMG designers and workers how to use AI tools. This investment in human capital will keep workers relevant and adaptive in an AI-driven industry.
- Benchmark Global Best Practices : Learn from China's success in integrating BIG data ,AI and automation into manufacturing to improve productivity, forecasting and efficiency
- Partnership with global leader : Try to build a partner ship with Chinese experts to help out industry further understand the best uses of Big Data and AI
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7. Conclusion

Implementation of Big data and AI in any industry has become a necessity for any country. As Bangladesh transitions into the "Bangladesh 4.0" era, driven by technological innovation, sustainable development, and inclusive growth , garments are poised to play a transformative role. In this context the garments industry is poised to play a transformative role. In the context integrating AI and Big Data in supply chain processes of Garments sector is not just and option but has become a necessity for enhancing operational efficiency , ensuring compliance and to meet global standards.

However successful adaptation of technologies is a real deal to break. Learning from China's experience Bangladesh can chart its own path toward technical excellence. If executed effectively these advancements will not only strengthen the RMG sector's global competitiveness but also contribute to the country's economic and social development.
There is a shortage of literature on the topic, which limits the scope of the current study. Open and focus group discussions can improve the survey’s structure.

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Biographies

Mushfiquddin Rafid is currently pursuing B.Sc degree in Industrial & Production Engineering at Ahsanullah University of Science and Technology. At Present, He is involved with multiple extracurricular activities, he is the Assistant Director of Branding & Promotion at IEOM Society AUST Student Chapter. His core interests include Supply Chain, Critical Thinking, Data science, Industrial Internet of Things, Automation, Production Planning, Project Management, Ergonomics and Human factor with high potentiality. He participated in multiple activities like Business Case competition, Project showcasing, Content writing. He is a pure illustration of prospects in mentioned fields like Data Analytics, Power BI data visualization, Quality management. He has excellent proficiency in Google Sheet, Graphic Design, MS office, Python, CAD simulation.

Tunazzina Binta Mostafa is an undergraduate student of Industrial and Production Engineering under the Department of Mechanical and Production Engineering at Ahsanullah University of Science and Technology. Her research interests include Supply Chain Management, Human Factors and Ergonomics, Blockchain Development, Industry 4.0 and Advanced Manufacturing Process. In addition to her research pursuits, she demonstrates a passion in her storytelling and has a zeal for learning new things to increase her adaptability. She has proficiency in Microsoft Word and Excel. She currently holds the position of Sub-Executive for AUST Innovation and Design club, supporting her core wing the Creative Content Writing Team.

Rupok Islam Avi is an undergraduate student in the Department of Industrial and Production Engineering at Rajshahi University of Engineering & Technology (RUET), Rajshahi, Bangladesh.

IoT in garment manufacturing connects devices and sensors to monitor materials, goods, and machine performance in real time, enhancing transparency, optimizing processes, and enabling predictive maintenance.

