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Data-Driven Sustainability: How Predictive Analytics ShapeSupply Chain Performance

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Abstract

Purpose: The integration of predictive analytics into supply chains has emerged as a critical driver of sustainability in the manufacturing sector. This study explores the role of predictive analytics in enhancing sustainable supply chain performance, with a particular focus on manufacturing firms in Dhaka, Bangladesh.

Research Methodology: This study adopts a positivist paradigm with a hypothetical deductive approach and employs a cross-sectional design. Data were collected from 211 manufacturing firms using stratified random sampling and structured questionnaire surveys.

Results: The findings revealed that supply chain transparency, predictive analytics accuracy, data integration, and organizational sustainability goals positively and significantly influenced sustainable supply chain performance. However, no significant relationship was found between technology readiness and sustainable supply chain performance, indicating the need for further investigation into factors beyond technological capabilities.

Conclusions: This study concludes that while predictive analytics and aligned organizational practices are key drivers of sustainable supply chain performance, technology readiness alone is insufficient, highlighting the importance of integrated strategies beyond infrastructure capability.

Limitations: This study is limited to manufacturing firms in Dhaka and adopts a cross-sectional design, which restricts the generalizability of the findings. Future research should explore longitudinal studies and incorporate other industries to provide a broader perspective on sustainable supply chain performance.

Contribution: These results highlight the importance of fostering transparent practices, enhancing predictive analytics capabilities and aligning organizational goals with sustainability objectives. The practical implications include strategies for improved data integration and analytics adoption to drive sustainable outcomes.

Keywords: *Data Integration*, *Manufacturing Industry, Predictive Analytics, Supply Chain Transparency, Sustainable Supply Chain*

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1. Introduction

Global supply chains are undergoing profound transformations as industries strive to reconcile their operational efficiency with environmental sustainability. Predictive analytics, which leverages sophisticated data processing and machine learning algorithms, has become indispensable in this endeavor (Abareshi, 2025; Afrin, Sehreen, Polas, & Sharin, 2020).In particular, manufacturing industries in developing economies are increasingly deploying predictive analytics to optimize resource allocation, refine demand forecasting and minimize waste. In Dhaka, Bangladesh, a major hub for manufacturing industries, supply chain sustainability is of paramount importance due to rising environmental concerns and international pressure for greener practices (Bag, Dhamija, Gupta, & Sivarajah, 2021). Despite the proliferation of data-driven strategies, the effectiveness of predictive analytics in achieving sustainable supply chain performance remains underexplored. Addressing this gap is crucial as industries grapple with inefficiencies, data fragmentation, and inconsistent technological adoption (Al-Khatib, 2022).

Sustainability in supply chainsdemands a multidimensional approach, encompassing economic, environmental, and social performance (Varsei, Soosay, Fahimnia, & Sarkis, 2014). Within Dhaka's manufacturing sector, key determinants such as supply chain transparency, data integration, and organizational sustainability goals directly influence the sustainability outcomes. Predictive analytics is a key enabler that provides actionable insights that help mitigate risks and align operations with sustainability objectives (Mishra, Choudhury, & Rao, 2019). Key stakeholders include manufacturing firms, policymakers, and logistics providers, while indirect stakeholders comprise consumers demanding eco-friendly products and regulatory bodies that promote sustainable practices (Albertoni, Elia, Massini, & Piscitello, 2017). This interconnected network underscores the need for robust predictive analytics frameworks to foster collaboration and enhance transparency in the supply chain.

Despite the growing adoption of predictive analytics in global supply chains, its application in the manufacturing sector of developing economies remains insufficiently studied. Existing research often overlooks contextual factors such as limited technological infrastructure, fragmented data systems, and varying levels of organizational commitment to sustainability (Muchenje, Ruzive, Mugoni, Katsvairo, & Tapera, 2023). In Dhaka's manufacturing industry, these challenges are further exacerbated by the inconsistent adoption of predictive tools, resulting in suboptimal supply chain performance and environmental degradation. Although some studies have explored isolated factors such as transparency and data integration, a comprehensive analysis linking these elements to sustainable supply chain performance is still lacking. Furthermore, the role of technology readiness remains contentious, necessitating a deeper investigation.

This study contributes to the growing body of knowledge on sustainable supply chain management by elucidating the role of predictive analytics in the context of a developing economy. This study provides actionable insights for manufacturing firms to enhance their supply chain practices and ensure alignment with global sustainability goals. The findings offer a roadmap for policymakers and industry leaders to prioritize investments in data integration, predictive tools, and organizational sustainability initiatives. For academics, this study addresses critical gaps in the literature, paving the way for future research on the role of predictive analytics in supply chain sustainability.

The overarching research question and objective of this study is to investigate the impact of predictive analytics on sustainable supply chain performance in the manufacturing sector in Dhaka, Bangladesh. Specifically, it aims to:

RQ: *How do predictive analytics tools and associated factors such as supply chain transparency, predictive analytics accuracy, data integration, organizational sustainability goals, and technology readiness impact sustainable supply chain performance in the manufacturing sector?*
RO: *To investigate the impact of predictive analytics tools and key factors, including supply chain transparency, predictive analytics accuracy, data integration, organizational sustainability goals, and technology readiness, on enhancing sustainable supply chain performance in the manufacturing industry.*

The remainder of this paper is organized as follows: Section 2 reviews the relevant literature on predictive analytics and sustainable supply chains. Section 3 outlines the research methodology, including the positivist paradigm, hypothetical deductive approach, and data collection techniques used. Section 4 presents the findings and their implications of this study. Finally, Section 5 concludes with recommendations, limitations, and future research directions.

2. Literature review

2.1 Theoretical Foundations

This study integrates two foundational theories: the Resource-Based View (RBV) and Dynamic Capabilities Theory. The RBV posits that a firm's internal resources, those that are valuable, rare, inimitable, and non-substitutable (VRIN), serve as the foundation for achieving sustainable competitive advantage (Mailani, Hulu, Simamora, & Kesuma, 2024). In the context of supply chain sustainability, resources such as predictive analytics tools, data integration, and organizational sustainability goals are critical enablers of improved performance (Bai & Sarkis, 2020). These resources empower firms to optimize operations, enhance transparency, and meet environmental and social sustainability requirements. Dynamic Capabilities Theory complements the RBV by emphasizing how firms adapt to rapidly changing environments through the continuous development, integration, and reconfiguration of resources (AI Humdan, Shi, Behina, & Chowdhury, 2024). Predictive analytics, as a dynamic capability, enables firms to anticipate supply chain disruptions, align operations with sustainability goals, and foster innovation(Madhani, 2022). Moreover, integrating transparency and analytics ensures supply chain responsiveness and resilience. Together, these theories provide a robust framework for examining how manufacturing firms in Dhaka leverage predictive analytics and related factors to achieve sustainable supply chain performance while addressing the complexities of technological readiness and organizational adaptation (Polas et al., 2025).

2.2 Supply Chain Transparency and Sustainable Supply Chain Performance

Supply chain transparency has gained significant attention as a critical driver of sustainable performance. Transparency refers to the visibility and accessibility of supply chain activities and data to stakeholders, enabling informed decision-making and accountability (Bag et al. 2021). High transparency levels are associated with enhanced trust among supply chain partners, which is essential for fostering collaborative efforts toward sustainability. Research indicates that when firms share information about their supply chain practices, such as sourcing and production processes, they enhance their ability to meet environmental and social compliance standards (Bahrami, Shokouhyar, & Seifian, 2022).

Moreover, transparency improves risk management by providing real-time insights into disruptions or inefficiencies, allowing firms to proactively address potential challenges (Liu et al., 2024). Studies in the manufacturing sector have shown that transparency reduces supply chain opacity, enabling firms to identify opportunities for resource optimization and waste reduction. However, implementing transparency practices requires significant investment in technologies such as blockchain and the IoT, which may limit their adoption in resource-constrained settings. Thus, the following hypothesis was proposed:

H1: There is a positive and significant relationship between supply chain transparency and sustainable supply chain performance.

2.3 Predictive Analytics Accuracy and Sustainable Supply Chain Performance

Predictive analytics plays a crucial role in driving supply chain sustainability by enabling data-driven decision making. Predictive analytics accuracy refers to the ability of analytical models to forecast supply chain trends, demand patterns, and potential disruptions (Feng, Wang, & Zhao, 2025). Accurate predictions allow firms to optimize their inventory, reduce waste, and minimize carbon emissions, all of which contribute to sustainability (Al-Khatib, 2022).

Empirical studies have demonstrated that firms leveraging advanced analytics tools achieve higher supply chain efficiency and sustainability (Feng et al., 2025). For instance, by accurately predicting demand fluctuations, companies can avoid overproduction, thereby reducing waste and conserving resources (Feizabadi, 2022). Predictive analytics also enables firms to identify and address bottlenecks in their supply chains, promoting continuous improvement and resilience (Guandalini, 2022). However, the effectiveness of predictive analytics depends on the quality and quantity of the available data and the technical expertise of the supply chain personnel. Thus, the following hypothesis was proposed:

H2: There is a positive and significant relationship between the accuracy of predictive analytics and sustainable supply chain performance.

2.4 Physical Work Environment Factors on Employee Performance

Data integration refers to the seamless sharing and harmonization of data across different functions and stakeholders in the supply chain. Integrated data systems facilitate the real-time exchange of information, empowering firms to make informed decisions and coordinate their sustainability efforts (Apolaagoa, Muhammed, Zuzie, & Owusu, 2023). Extant research highlights that robust data integration is indispensable for monitoring and measuring key performance indicators (KPIs) related to sustainability, such as energy consumption, emission, and resource usage.

Furthermore, integrated data architectures enhance collaboration among supply chain partners, fostering trust and joint problem-solving (Han & Huo, 2020). For example, manufacturers and suppliers with integrated data systems can synchronize their sustainability objectives, leading to the adoption of greener practices. However, achieving data integration often requires substantial investment in IT infrastructure and overcoming challenges related to data security and privacy issues. Recent advancements in cloud computing and big data analytics have significantly improved the feasibility of data integration, making it a key enabler of sustainable supply chain management. Thus, the following hypothesis was proposed:

H3: There is a positive and significant relationship between data integration and sustainable supply chain performance.

2.5 Organizational Sustainability Goals and Sustainable Supply Chain Performance

Organizational sustainability goals represent the strategic objectives that firms establish to balance their economic, environmental, and social outcomes. These goals serve as a foundational framework for implementing sustainable supply chain practices (Hussain and Malik, 2020; Porter and Kramer, 2018). Empirical evidence suggests that firms with clearly defined sustainability goals are more inclined to adopt eco-friendly technologies, minimze waste, and engage in ethical sourcing practices (Fu, Abdul Rahman, Jiang, Abbas, & Comite, 2022).

A strong alignment between sustainability goals and supply chain performance metrics ensures that all stakeholders are unified in pursuing common objectives (Das & Hassan, 2022). For instance, organizations with explicit sustainability targets are better equipped to monitor progress, identify performance gaps, and uphold accountability throughout the supply chain (Bansal & DesJardine, 2014; Belhadi, Kamble, Gunasekaran, & Mani, 2022). Nevertheless, achieving these goals often entails overcoming internal resistance to change and fostering commitment among employees and external partners. Case studies within the manufacturing sector demonstrate that integrating sustainability goals into supply chain strategies significantly enhances performance and contributes to long-term competitive advantages. Thus, the following hypothesis was proposed:

H4: There is a positive and significant relationship between organizational sustainability goals and sustainable supply chain performance.

2.6 Technology Readiness and Sustainable Supply Chain Performance

Technology readiness refers to an organization's capacity and willingness to adopt and effectively utilize emerging technology. Within the context of sustainable supply chains, it serves as a pivotal determinant in the adoption of advanced tools such as predictive analytics, The Internet of Things (IoT), and blockchain technologies (Shahzad, Liu, & Zahid, 2025). Extant Literature suggests that firms with high levels of technology readiness are more likely to implement sophisticated systems that enhance visibility, traceability, and efficiency, thereby improving sustainability outcomes (Behl, Jayawardena, Pereira, & Sampat, 2024; W. Wang et al., 2023).

However, empirical evidence on the relationship between technology readiness and sustainable supply chain performance is inconclusive. While some studies highlight a significant positive relationship, others identify minimal or no impact, particularly in resource-constrained environments (Karmaker, Al Aziz, Ahmed, Misbauddin, & Moktadir, 2023; S. Wang & Yang, 2022). Barriers such as a lack of technical expertise, high implementation costs, and organizational resistance to change often impede technology adoption, thereby limiting its potential to drive sustainability (Ullah, Kukreti, Sami, & Shaukat, 2025). This highlights the need for tailored strategies to enhance technology readiness, including capacity-building initiatives, policy-driven incentives, and strategic collaborations with technology providers (Rehman Khan, Ahmad, Sheikh, & Yu, 2022). Thus, the following hypothesis was proposed:

H5: There is a positive and significant relationship between technology readiness and sustainable supply chain performance.

Based on the literature review, the proposed conceptual framework incorporates five independent variables–supply chain transparency, predictive analytics accuracy, data integration, organizational sustainability goals, and technology readiness–as predictors of sustainable supply chain performance in the manufacturing industry. This framework provides a structured approach to examine the factors influencing sustainable supply chain performance in the context of Dhaka's manufacturing sector.

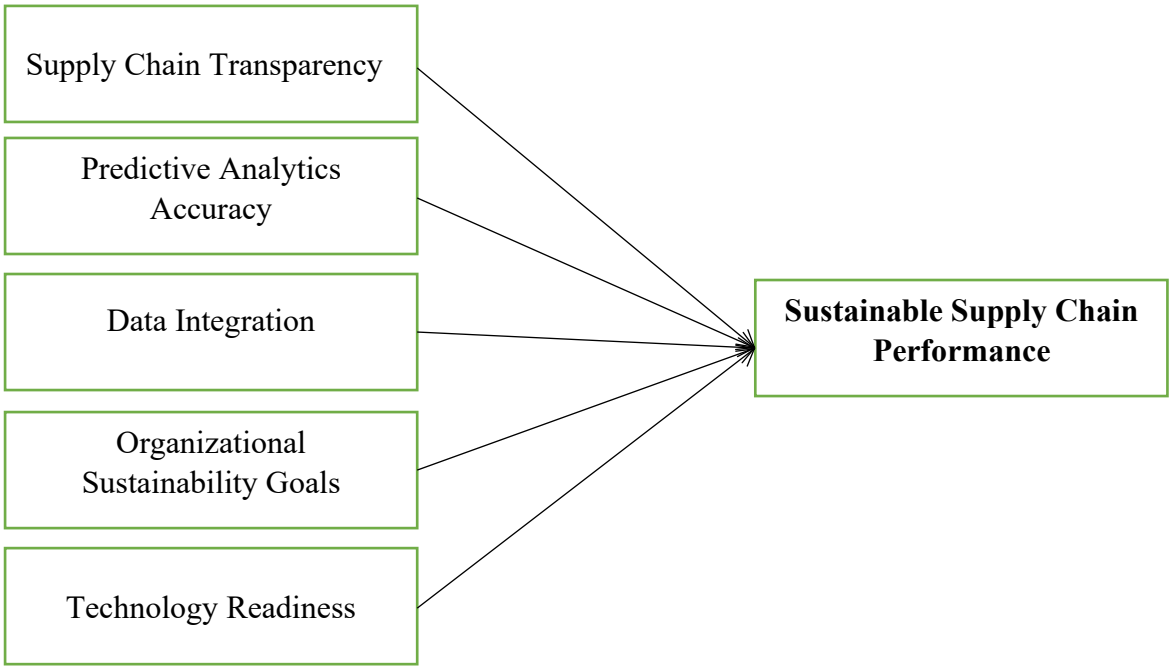

Figure 1. The Framework of the study

3. Methodology

3.1 Research Design

This study adopts a quantitative research design grounded in the positivist paradigm and employs a hypothetical-deductive approach to investigate the role of predictive analytics in enhancing

sustainable supply chain performance. This study aims to empirically examine the relationships between supply chain transparency, predictive analysis, data integration, organizational sustainability goals, technology readiness, and sustainable supply chain performance. The cross-sectional design enabled data collection at a single point in time, facilitating a systematic and objective analysis of these variables within the manufacturing industry in Dhaka, Bangladesh. This approach ensures precision in hypothesis testing and contributes to a broader understanding of sustainability practices in supply chain management.

3.2 Sampling Technique

A stratified random sampling technique was employed to ensure a representative sample of 211 manufacturing firms operating in Dhaka from October to November 2024. Stratification was based on firm size and type, capturing diverse perspectives in the manufacturing sector. This method ensures that the sample accurately reflects the population, providing robust insights into the adoption and impact of predictive analytics on the sustainable supply chain performance. By focusing on manufacturing firms, this study aligns its sampling strategy with the sector's critical role in Bangladesh's economy and its potential for driving sustainability transformations.

3.3 Data Collection

Structured questionnaires were administered to top-level managers and supply chain professionals in the sampled manufacturing firms for data collection. The questionnaire captured respondents' perceptions of supply chain transparency, predictive analytics accuracy, data integration, organizational sustainability goals, technology readiness, and their impact on sustainable supply chain performance. The instrument employed a five-point Likert scale (ranging from 1 = Strongly Disagree to 5 = Strongly Agree) to measure the constructs. Small incentives were offered to respondents to encourage participation and ensure data reliability. Additionally, the study conducted a time-trend extrapolation analysis to detect and mitigate non-response bias (Rahman, Saha, Belal, Hasan Ratul, & Graham, 2024).

3.4 Demographic Overview

The respondents' demographic profiles provide insights into their professional backgrounds and firm characteristics. Most participants represented mid-to large-sized manufacturing firms with operations centered in Dhaka. Male respondents constituted 66.8% of the sample, reflecting the gender distribution of managerial roles within the industry. Approximately 48.7% of respondents reported prior experience with predictive analytics, and 62.5% demonstrated advanced technological proficiency, highlighting the sector's growing inclination toward data-driven decision making.

3.5 Questionnaire Design

The survey instrument consisted of 30 items: 25 addressing the core constructs, and five demographic questions. The constructs were measured using validated scales adapted from previous studies. Supply chain transparency and data integration were assessed using four items adapted from Carter and Rogers (2008). The predictive analytics accuracy was measured using four items adapted from Waller and Fawcett (2013). Organizational sustainability goals were measured using scales from Epstein (2018), and technology readiness was assessed using items from Parasuraman (2000). Sustainable supply chain performance was measured using a five-item scale adapted from Green, Zelbst, Meacham, and Bhadauria (2012). The rigorous development and adaptation of these scales ensured high reliability and validity, aligning the questionnaire with the established methodological standards.

3.6 Data Analysis

The collected data were analyzed using SPSS Version 25. Descriptive statistics provided an overview of the sample characteristics, while correlation analysis identified the strength and direction of the relationships between the variables. SPSS was used to test the hypothesized relationships and assess the direct effects of the independent variables on sustainable supply chain performance. This approach enabled a robust analysis of the measurement model, offering deeper insights into the predictive power of supply chain transparency, predictive analytics accuracy, data integration, organizational sustainability goals, and technology readiness.

3.7 Ethical Considerations

This study adhered to ethical guidelines to ensure the confidentiality and rights of the participants. The respondents were informed about the purpose of the study and voluntarily provided consent before participating. The anonymity of the responses was maintained throughout the research process. Additionally, ethical approval was obtained from the relevant institutional review board, underscoring the study's commitment to responsible research.

3.8 Summary of Hypotheses

Table 1. Summary of Hypotheses

Hypothesis	Statement
H1	There is a positive and significant relationship between supply chain transparency and sustainable supply chain performance.
H2	There is a positive and significant relationship between predictive analytics accuracy and sustainable supply chain performance.
H3	There is a positive and significant relationship between data integration and sustainable supply chain performance.
H4	There is a positive and significant relationship between organizational sustainability goals and sustainable supply chain performance.
H5	There is a positive and significant relationship between technology readiness and sustainable supply chain performance.

4. Result and discussions

4.1 Result

Table 2. Descriptive Correlations

SL. NO.	Variables	Mean	STD.	1	2	3	4	5	6	7	8	9	10	11
1	Gender	1.62	0.76	1										
2	Age	36.43	1.56	0.165	1									
3	Experience with Predictive Analytics	2.51	0.71	0.178	0.041	1								
4	Technological Proficiency	2.42	0.61	0.145	0.159	0.272*	1							
5	Role in the Supply Chain	4.62	1.41	0.112	0.061	0.065	.555**	1						
	Awareness of Sustainability Initiatives	3.22	1.22	0.115	0.087	0.076	0.421**	0.342**						
6	Supply Chain Transparency	3.71	1.32	0.068	0.062	0.276*	0.231**	0.368**	1					
7	Predictive Analytics Accuracy	3.44	0.67	0.187	0.089	0.094	0.562***	0.574***	0.364*	1				
8	Data Integration	3.65	1.77	0.163	0.573***	0.156*	0.221**	0.465**	0.146*	0.223*	1			
9	Organizational Sustainability Goals	3.67	0.74	0.165	0.475**	0.087	0.118	0.561***	0.265*	0.442**	0.494**	1		
10	Technology Readiness	3.49	1.89	0.167*	0.089	0.287**	0.456**	0.586***	0.487**	0.419***	0.468**	0.532**	1	
11	Sustainable Supply Chain Performance	3.89	1.89	0.179*	0.093	0.279**	0.457**	0.587***	0.476**	0.487***	0.489***	0.456***	.0476***	1

Source: Processed data by SPSS (2024)

In this study, Pearson's correlation analysis was conducted using SPSS software (version 25) to evaluate the relationships among the variables influencing sustainable supply chain performance. The findings, as detailed in Table 2, provide both descriptive statistics and correlation coefficients. These results highlight significant positive correlations between the independent variables (IVs) and the dependent variable, sustainable supply chain performance (SSCP), with varying strengths of association across the different IVs. Table 2 reveals that all independent variables have statistically significant positive correlations with the SSCP. For instance, supply chain transparency demonstrates a moderate positive correlation ($r=0.476**$, $p < 0.01$), indicating that improved transparency in supply

chain operations enhances SSCP. Similarly, predictive analytics accuracy showed a strong positive correlation ($r=0.487***$, $p<0.001$), emphasizing the critical role of precise predictive tools in achieving sustainable performance goals.

Data integration also exhibited a strong positive correlation ($r=0.489***$, $p<0.001$) with SSCP, underlining the importance of seamless data-sharing systems in adapting to dynamic market demands. Moreover, organizational sustainability goals ($r=0.456***$, $p<0.001$) and technology readiness ($r=0.476***$, $p<0.001$) show robust correlations with the SSCP, reinforcing the significance of fostering sustainable practices and investing in technological innovation to enhance supply chain outcomes. Additional insights reveal that demographic variables such as gender have a weak yet significant correlation ($r=0.179*$, $p<0.05$) with SSCP, while age demonstrates a strong correlation with both data integration ($r=0.573***$, $p<0.001$) and sustainability goals ($r=0.475**$, $p<0.001$). Furthermore, experience with predictive analytics positively correlated with technological proficiency ($r=0.272*$, $p<0.05$), suggesting that individuals with greater technical expertise are better equipped to leverage predictive tools effectively.

This analysis provides a comprehensive understanding of the intricate relationships among the variables within the research framework. Each independent variable plays a pivotal role in driving the SSCP, shedding light on the multifaceted dynamics influencing sustainability initiatives among manufacturing firms in Dhaka. These findings underscore the significance of predictive analytics, data integration, and organizational readiness in fostering sustainable supply chain performance, contributing valuable insights to the emerging field of sustainable supply chain management.

Table 3. Relationships between IVs and DV

Name of Variables	Sustainable Supply Chain Performance	t value	p-value	VIF
Gender	0.178*	2.131	0.0411	1.761
Age	0.273*	2.761	0.029	1.651
Experience with Predictive Analytics	0.123*	1.967	0.047	1.961
Technological Proficiency	0.271*	2.781	0.028	2.789
Role in the Supply Chain	0.389**	3.921	0.004	2.761
Awareness of Sustainability Initiatives	0.324**	`3.781	0.005	2.891
Supply Chain Transparency	0.589***	5.089	0.000	1.891
Predictive Analytics Accuracy	0.487***	4.761	0.000	1.871
Data Integration	0.578***	5.671	0.000	1.561
Organizational Sustainability Goals	0.422**	4.621	0.000	1.781
Technology Readiness	0.079	1.231	0.654	1.561
R^2	0.776			
Adj. R^2	0.651			
F	7.763***			

Note: *p<0.05, **p<0.01, ***p<0.001
Source: Processed data by SPSS (2024)

Table 3 illustrates the significant relationships between the independent variables (IVs) and the dependent variable (DV), “sustainable supply chain performance” in the manufacturing industry. The analysis confirmed a significant alignment with the hypothesized framework, showcasing the impact of various factors on sustainable supply chain performance. Hypothesis one (H1) assumes that there is a positive and significant relationship between supply chain transparency and sustainable supply chain performance. As shown in Table 3, supply chain transparency has the strongest positive effect on

SSCP, significant at the 0.1% level (β=0.589∗∗∗, t=5.089, p < 0.001). Therefore, H1 is accepted. This indicates that transparency and visibility within the supply chain are critical drivers of sustainability. Transparent practices enhance sustainability by fostering accountability and trust. Hypothesis two (H2) proposes that there is a positive and significant relationship between predictive analytics accuracy and sustainable supply chain performance (SSCP). As shown in Table 3, the predictive analytics accuracy has a significant positive influence on the SSCP, significant at the 0.1% level (β=0.487∗∗∗, t=4.761, p < 0.001). Therefore, H2 is accepted. This suggests that accurate analytics can improve supply chain sustainability by enabling precise decision-making. Higher accuracy in predictive tools leads to better sustainability.

Hypothesis three (H3) proposes that there is a positive and significant relationship between data integration and sustainable supply chain performance. As shown in Table 3, data integration has a very strong positive impact on SSCP, significant at the 0.1% level (β=0.578∗∗∗ t=5.671, p < 0.001). Therefore, hypothesis H3 is accepted: integrated data systems enhance coordination and efficiency, both of which are essential for sustainability. Improved data integration contributes significantly to the overall sustainability of the supply chain. Hypothesis four (H4) posits a positive and significant relationship between organizational sustainability goals and sustainable supply chain performance. As shown in Table 3, organizational sustainability goals have a strong positive relationship with SSCP, significant at the 1% level (β=0.422∗∗ t=4.621 p=0.001). Therefore, H4 is accepted. Clear goals drive organizations to align their practices with sustainability objectives. Defined sustainability goals enhance the focus on sustainable practice.

Hypothesis five (H5) proposes that there is a positive and significant relationship between technology readiness and sustainable supply chain performance. As shown in Table 3, technology readiness was not statistically significant, with a p-value exceeding 0.05 ((β=0.079, t=1.231, p > 0.654). Therefore, H5 is rejected. This suggests that technology readiness alone does not directly impact the sustainable supply chain performance.

Furthermore, the R2 value of0.776 indicates that the independent variables collectively explain 77.6% of the variance in sustainable supply chain performance, demonstrating a very strong model fit. The adjusted R2 value of 0.651 confirms that, even after accounting for the number of predictors, the model explains 65.1% of the variance, reflecting a robust and meaningful model. The F-statistic (F=7.763∗∗∗) confirms the model's overall statistical significance, validating that the independent variables collectively impact SSCP. Additionally, All Variance Inflation Factor (VIF) values were below 5, indicating no serious multicollinearity among the predictors, ensuring the reliability of the regression results.

4.2 Discussion

The primary objective of this study was to explore the role of predictive analytics in enhancing the sustainable supply chain performance of manufacturing firms in Dhaka, Bangladesh. By employing a quantitative research design, the study examined the relationships between supply chain transparency, predictive analytics accuracy, data integration, organizational sustainability goals, technology readiness, and sustainable supply chain performance. Data were collected from 211 manufacturing firms using stratified random sampling and structured questionnaire surveys. The analysis revealed several important findings that contribute to understanding how predictive analytics influences sustainable supply chain performance. The results indicate that supply chain transparency, predictive analytics accuracy, data integration, and organizational sustainability goals all have a positive and significant influence on sustainable supply chain performance. However, technology readiness was not significantly related to sustainable supply chain performance, suggesting that technological capabilities alone may not be sufficient to drive sustainability without the presence of other enabling factors.

The results suggest that implementing predictive analytics in supply chains can lead to significant improvements in sustainability performance. Specifically, supply chain transparency is identified as a crucial factor. This finding is consistent with the existing literature, which emphasizes that

transparency fosters trust among stakeholders, facilitates better decision-making, and enhances the overall sustainability of supply chains (Oyewole, Okoye, Ofodile, & Ejairu, 2024). Transparent data sharing and communication enable more accurate predictions and improved responsiveness to supply chain challenges, thereby supporting sustainable practices in the industry. Predictive analytics accuracy has also emerged as a key driver of sustainable supply chain performance. The ability to make accurate predictions regarding supply and demand, potential disruptions, and resource allocation is critical for optimizing the sustainability of supply chains. This finding aligns with previous studies that have highlighted the role of predictive analytics in forecasting and operational optimization, which can reduce waste, lower carbon emissions, and increase efficiency (Aitken, Esain, & Williams, 2021).

Moreover, the importance of data integration cannot be overstated. In today's complex and interconnected supply chains, integrating data from various sources, whether internal or external, is essential for gaining a holistic view of the supply chain and making informed decisions. This finding aligns with the conclusions of several researchers who have noted that effective data integration is critical for the efficient functioning of modern supply chains (Behl et al., 2024). The study also highlighted that organizational sustainability goals significantly influence supply chain performance. This reinforces the idea that a company's commitment to sustainability must be aligned with its supply chain operations to drive meaningful performance improvement (Das & Hassan, 2022). When organizations prioritize sustainability at the strategic level, it cascades down to operational practices, influencing how supply chains are managed and evaluated in the long run. However, the lack of a significant relationship between technology readiness and sustainable supply chain performance presents an interesting paradox. While technology readiness is often regarded as a critical factor for the successful implementation of new technologies(Farrukh Shahzad, Liu, & Zahid, 2025), the findings suggest that having the necessary technological infrastructure and skills alone is not sufficient to ensure sustainable outcomes. This highlights the need for a more comprehensive framework that includes not only technology but also organizational culture, leadership, and commitment to sustainability.

The results of this study align with several key findings in the supply chain management and sustainability literature. For example, supply chain transparency has consistently been highlighted as a critical factor in improving sustainability outcomes. According to Jia, Li, Zhang, and Chen (2024),greater transparency in the supply chain enables better collaboration among stakeholders and facilitates more accurate forecasting and decision-making, all of which contribute to improved sustainability performance. The present study reaffirms this notion by demonstrating the positive impact of transparency on sustainable supply chain outcomes. The importance of predictive analytics in supply chain management has attracted growing interest in recent years. Aitken et al. (2021) showed that predictive analytics helps organizations optimize their supply chains by anticipating disruptions, streamlining operations, and improving sustainability. The findings of the current study extend this body of research by specifically linking the accuracy of predictive analytics to enhanced sustainable supply chain performance, providing empirical evidence of the benefits of accurate data-driven decision-making in sustainability efforts.

Data integration plays a pivotal role in modern supply chains. Researchers such as Apolaagoa et al. (2023) have argued that the ability to integrate diverse data sources enables supply chain managers to make more informed decisions, leading to enhanced operational performance and sustainability. This study supports this argument, highlighting the importance of data integration in achieving sustainable outcomes within the supply chain. Regarding organizational sustainability goals, the study's findings are consistent with those of Jia et al. (2024), who suggested that organizations with a strong commitment to sustainability are more likely to attain sustainable supply chain performance. By aligning sustainability goals with operational strategies, firms can manage resources, reduce waste, and improve supply chain efficiency, all of which contribute to long-term sustainability. However, the study’s findings on technology readiness challenge the conventional view that technological infrastructure is a prerequisite for sustainability in the supply chain. While technology remains important, the absence of a significant relationship between technology readiness and sustainable

supply chain performance suggests that other factors, such as organizational culture, leadership, and alignment of goals, may play an equally or more important role in determining sustainable outcomes.

The findings of this study are consistent with those of several previous studies but also offer new insights into the role of predictive analytics in sustainable supply chain management. For instance, Jia et al. (2024) emphasized the importance of transparency and data integration in enhancing supply chain sustainability. These studies found that firms with more transparent and integrated supply chains are better equipped to make informed decisions, leading to improved sustainability performance. The present study supports this perspective by demonstrating a significant positive relationship between these factors and sustainable supply chain performance. Furthermore, the positive influence of predictive analytics on supply chain sustainability identified in this study aligns with the findings of Munim, Vladi, and Ibne Hossain (2023),who reported that predictive analytics can optimize supply chain operations and improve sustainability outcomes by enabling more accurate forecasting and minimizing resource waste. Similarly,Atieh Ali, Sharabati, Allahham, and Nasereddin (2024)support this conclusion, arguing that predictive models enable firms to anticipate disruptions, optimize resource use, and enhance supply chain resilience, which are key contributors to sustainability.

However, the study's results regarding technology readiness diverged from some previous literature. Studies such as those by Karmaker, Bari, et al. (2023)have traditionally emphasized technology readiness as a crucial factor for adopting new technologies, including those aimed at enhancing supply chain sustainability. However, the present study found no direct relationship between technology readiness and sustainable supply chain performance, suggesting that simply having technological tools and infrastructure is insufficient to drive sustainability. This highlights the need for a more holistic approach that considers not only technological capacity but also other enabling factors, such as organizational culture and sustainability orientation.

5. Conclusion

This study provides valuable insights into the factors influencing sustainable supply chain performance in the manufacturing industry. The findings suggest that supply chain transparency, predictive analytics accuracy, data integration, and organizational sustainability goals play significant roles in enhancing sustainability outcomes. However, the study also highlights the importance of adopting a more holistic approach to technology adoption, as technology readiness alone does not guarantee sustainable results. These findings contribute to the growing body of literature on sustainable supply chain management and provide actionable insights for practitioners seeking to improve supply chain sustainability. Future research should explore the role of other enabling factors, such as organizational culture and leadership, in facilitating the adoption of sustainable supply chain practices in the construction industry. Additionally, longitudinal studies examining the long-term impact of predictive analytics and related factors on supply chain sustainability would provide valuable insights.

Implications of the study

The findings of this study have several important practical implications for managers in the manufacturing sector, particularly those involved in supply chain management (SCM). First, this study emphasizes the need to prioritize supply chain transparency and data integration as foundational strategies for enhancing sustainability. Firms should invest in systems and processes that facilitate seamless data sharing among all stakeholders to enable more informed decision-making and better sustainability outcomes. Second, the accuracy of predictive analytics should be a key focus for supply chain management. By leveraging predictive models that accurately forecast demand, disruptions, and resource requirements, firms can optimize their operations, reduce waste, and enhance overall supply chain sustainability. Finally, organizations should align their sustainability goals with their supply chain operations. A clear strategic commitment to sustainability can guide decision-making and resource allocation, fostering sustainable practices across the supply chain.

The theoretical implications of this study suggest that supply chain transparency, predictive analytics accuracy, data integration, and organizational sustainability goals are critical constructs that contribute to sustainable supply chain performance. This study extends existing theories in supply chain management by highlighting the importance of data-driven decision-making, transparency, and alignment of sustainability goals with operational practices, offering a comprehensive model for understanding sustainability in manufacturing supply chains. Future theoretical frameworks should incorporate these dimensions to develop more holistic approaches to studying sustainable supply chains.

Limitations and Directions for future Studies

Despite its valuable contributions, this study has some limitations. First, the research is limited to manufacturing firms in Dhaka, Bangladesh, which restricts the generalizability of the findings to other regions and industries. The cross-sectional design employed captures a snapshot of the current state of predictive analytics in supply chain performance; however, it does not account for long-term changes or trends, limiting the ability to assess causal relationships over time. Additionally, this study focuses primarily on organizational-level factors, which may overlook individual-level influences or industry-specific nuances that could impact predictive analytics adoption. Future research could employ longitudinal designs to track the evolution of predictive analytics adoption and its long-term effects on sustainability. Expanding the scope to include other sectors beyond manufacturing and incorporating multi-country data would offer broader insights into how contextual factors influence the role of predictive analytics in the manufacturing sector. Furthermore, future studies could explore the influence of organizational culture and employee engagement on driving predictive analytics adoption, as well as the integration of emerging technologies such as AI and machine learning in sustainable supply chain practices.

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