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RESEARCH PAPER

Unlocking Sustainability through Supply Chain Visibility: Insights from the Manufacturing Sector of Bangladesh

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ABSTRACT

Goal: This research delves into sustainable supply chain management within the context of manufacturing companies in Bangladesh, aiming to unravel the complexities and dynamics of supply chain visibility (SCV), connectivity, and their influence on economic, social, and environmental performance.

Design/Methodology/Approach: Employing a contingent Resource-Based View perspective, the study develops a hierarchical model, formulates hypotheses, and conducts analyses using Smart PLS 4. It explores the interplay between supply chain connectivity, information sharing, and product complexity in influencing sustainable supply chain performance.

Findings: The study reveals that supply chain connectivity positively impacts information sharing, leading to enhanced SCV. SCV, in turn, positively influences economic, social, and environmental performance. Product complexity is identified as a moderating factor in this relationship.

Research Limitations/Implications: While the findings offer valuable insights, the study's focus on manufacturing companies in Bangladesh implies contextual limitations. Future research could explore diverse settings and delve deeper into the specific mechanisms driving these dynamics.

Practical Implications: This study offers actionable insights for manufacturing firms in Bangladesh, emphasizing the strategic adoption of advanced IT infrastructure to bolster supply chain connectivity. By fostering a culture of real-time information sharing through ICTs, companies can optimize operational efficiency. The research also underscores the importance of tailored approaches to product complexity, providing practical guidance for navigating diverse product portfolios. These practices collectively contribute to improved economic, social, and environmental performance, positioning companies as agile and responsible players in the global supply chain.

Social Implications: The study underscores the broader social implications of sustainable supply chain practices, emphasizing the need for responsible and transparent operations that balance economic prosperity, environmental responsibility, and social considerations.

Originality/Value: This research contributes to the existing body of knowledge by advancing our understanding of sustainable supply chain dynamics, particularly in emerging markets. It offers original insights into the contingent relationships between supply chain connectivity, information sharing, product complexity, and sustainable performance.

Keywords: Sustainable Supply Chain Management; Supply Chain Visibility; Supply Chain Connectivity; Product Complexity; Emerging Markets; Manufacturing Companies; Resource-Based View.

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1 INTRODUCTION

Sustainable Supply Chain Management (SSCM) has become a crucial and all-encompassing management approach, impacting multiple aspects of supply chain performance. This evolution highlights the increasing recognition of the need for a comprehensive approach that combines environmental, social, and economic factors (Mondal *et al.*, 2022; Santiago *et al.*, 2021; Scoones *et al.*, 2020; Teran-Yepez *et al.*, 2020). SSCM, as defined by De Pascale *et al.*, (2021), refers to the seamless integration of various elements. It has become increasingly important in both academic and industrial discussions.

Although there has been a rise in awareness and focus on sustainable supply chains, the actual implementation of sustainable practices and achieving real and effective results in supply chain performance is still a difficult task. The present corporate landscape is marked by several elements that contribute to the complex nature of supply chain operations. These variables encompass heightened intricacies, reduced stock levels, the use of outsourcing strategies, and the worldwide dispersion of supply chain organizations (T. K. Agrawal *et al.*, 2022; DeCampos *et al.*, 2022; Emon *et al.*, 2024; Tiwari, 2021). Organizations must negotiate complex networks of interrelated activities while carefully balancing economic prosperity, environmental responsibility, and social considerations.

The significant ramifications of poorly executed sustainable supply chain strategies were clearly demonstrated in the tragic event of the Bangladesh textile factory fire in 2013. This tragic incident resulted in the deaths of more than 1,130 people, highlighting the significant toll caused by the failure to comprehend and execute sustainable supply chain design (Jimo *et al.*, 2022). Given the occurrence of such occurrences and the increasing recognition of the wider consequences of supply chain operations, prominent multinational corporations like Nestle, ITC, Unilever, and Toyota are shifting their attention towards their upstream suppliers These organizations are actively engaged in the creation of sustainable supply chains that aim to achieve a harmonious balance between profitability, reduced environmental impact, and enhanced quality of life for employees (Ngai *et al.*, 2018).

The claims made by Sakib *et al.*, (2021) emphasize the inherent intricacies involved in constructing supply chains that are capable of being maintained throughout time. Organizational performance now hinges on the ability to navigate uncertainties related to environmental decisions, effectively tackle environmental concerns across the supply chain, and comprehend the interdependencies between supply chains and ecological systems. An important challenge that has been recognized in the literature is the limited visibility within supply chains. This requires further investigation into supply chain visibility as a crucial organizational competency (Baah, Acquah, *et al.*, 2022; Baah, Opoku Agyeman, *et al.*, 2022; Roy, 2021).

Although the significance of supply chain visibility is acknowledged, there are still difficulties in clearly distinguishing between information exchange and SCV (Roy, 2021). This study seeks to fill this void by specifically examining the visibility of the upstream supply chain, with a particular emphasis on the essential capacities of information connectivity and sharing, which are crucial for promoting sustainable supply chain practices. In this connection, the following research questions are formulated to better understand the interaction between the interactions between the SCV factors and dimensions of the firm's sustainability performance: (1) What is the impact of information connection and information sharing on the level of visibility in supply chains? (2) What is the impact of product complexity on the relationship between SCV and social/environmental/economic performance?

This research is based on contingency theory and contingent resource-based view theory (CRBV). The theory suggests that the visibility of the supply chain, which includes connectivity and sharing of information, has an impact on the performance of sustainability (economic, social, and environmental), depending on the complexity of the product (Busse *et al.*, 2017). This study aims to make significant contributions to the current corpus of knowledge. The contributions encompass a thorough examination of the influence of combining resources for SCV on sustainability performance, an analysis of the dependent role of PC, and the integration of the suggested model in CRBV to shed light on this intricate phenomenon.

Furthermore, this research goes beyond making theoretical contributions and offers practical insights into sustainable supply chains in emerging economies. This study aims to provide detailed insights into the challenges and opportunities of sustainable supply chain practices in Bangladesh, which is an emerging market within the BRICs (Brazil, Russia, India, China) context (Dhillon *et al.*, 2023; Suhi *et al.*, 2019). The findings of this study can be valuable for both academia and industry. The study draws on the works of (Alsharari & Aljohani, 2023; R. Andersson *et al.*, 2023; Dyches *et al.*, 2021; Haynes, 2023; Simmie, 2023) to offer nuanced perspectives. This research will specifically focus on manufacturing enterprises in Bangladesh, offering customized insights into the sustainable supply chain dynamics of this industry. This article is pioneering research investigating the SCV dynamics and sustainability practices in the manufacturing industry of Bangladesh. Also highlight that, due to geographic location of Bangladesh in Indo-pacific region, the economic importance of the nation in global supply chain mechanisms has been receiving attention from the academic think tanks as well as industry experts

2 THEORETICAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

2.1 Theoretical Framing

This study employs the contingent 'Resource-Based View' (RBV) approach, based on the principles established by (Collins, 2021). The RBV theory suggests that businesses can achieve a competitive advantage by strategically combining their resources and competencies (Kruesi & Bazelmans, 2023; Pereira & Bamel, 2021). According to Huo *et al.*, (2021), in the field of supply chain dynamics, the connectedness and sharing of information within a supply chain can be advantageous in terms of competition if the resources contain valuable, rare, difficult-to-copy, and non-replaceable traits (Fonseca, 2022). Souto-Otero & Biaowolski, (2021) classifies these resources into five categories: physical, human, financial, technological, and reputational capital. Argyroudis *et al.*, (2020) broaden these classifications to encompass concrete (e.g., infrastructure) and abstract (e.g., IS) assets. Developing capabilities necessitates the combination of resources with particular behaviors and skill sets, as highlighted by (Doz, 2020). The RBV has been prominent in the field of operations and SCM (Manzoor *et al.*, 2022). However, Brandon-Jones *et al.* Mikalef & Krogstie, (2020) point out that there is a lack of research exploring the combination of competencies and resources in this particular area. This study investigates the influence of supply chain connectedness and IS on the capability of SCV, and consequently on the performance of sustainable supply chains, acknowledging the significance of this bundle. RBV critics raise concerns over its lack of sensitivity to context (Farndale *et al.*, 2022; Glassman *et al.*, 2021). In order to tackle this issue, the study adopts the contingent RBV framework, as proposed by Brush and Artz in 1999, while also integrating insights from contingency theory. According to contingency theory, companies should modify their structures and processes in order to match the environment, resulting in improved performance (Sharma *et al.*, 2021). Chahal *et al.*, (2020) contend that within the framework of sustainable supply chains, contingent RBV provides detailed insights by classifying resources and capabilities according to internal and external contingencies. Akpinar & Ozer-Caylan, (2022) emphasize the significance of industry task contexts, including uncertainty, complexity, and munificence, in shaping management decision-making. The study considers PC as a significant contingency variable that can introduce uncertainty.

In light of the above arguments, we can better understand the contextual factors and potential outcomes associated with how and why companies might integrate sustainable practices into their supply chains by using contingency theory and CRBV. The resource-based view (RBV), put forth by Barney (1991), emphasizes the importance that resources and capabilities play in helping businesses gain a competitive edge. In contrast, the contingent RBV postulates that a competitive advantage may be subject to certain limitations. According to (Baia *et al.*, 2020), certain circumstances significantly affect how effective resource bundling and capability building are. According to (Wuebker *et al.*, 2023), decisions made on how to organize, bundle, and leverage the resources may be the cause of the apparent variation in the final result under similar initial conditions. A dynamic resource concept is suggested as a means of addressing environmental uncertainty. Based on existing research, we contend that an organization's resources and capabilities—in this case, supply chain connectivity and supply chain information sharing, collectively referred to as "supply chain visibility"—may have an impact on the sustainability performance of the supply chain, including the economic, social, and environmental aspects, contingent on the complexity of the product (Saqib & Zhang, 2021; Sunmola & Apeji, 2024).

2.2 Hypotheses Development

2.2.1 Development of the Hierarchical Model Specification

In accordance with the recommendations of Hossain *et al.*, (2023), the theoretical framework of this study is structured as a hierarchical model. This model delineates the intricate relationships between individual indicators, sub-dimensions, and higher-order constructs, providing a comprehensive view of the interconnections within the proposed research framework (see Figure 1).

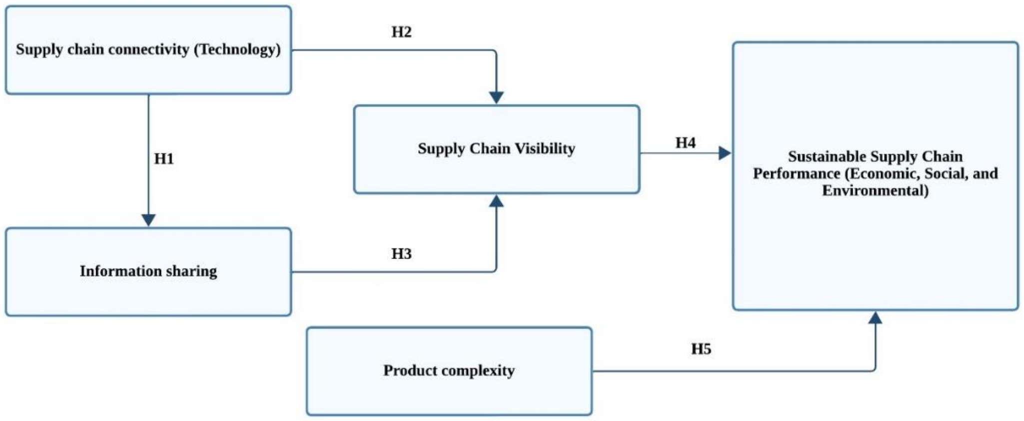

Figure 1 - Proposed Research Framework

The creation of a three-tier reflecting model is in line with the goal of comprehensively capturing the complex character of the theoretical concepts being studied (Jamvsek & Culiberg, 2020). This hierarchical approach enables a detailed examination of the complex interactions among the main variables, enabling a more detailed understanding of the theoretical framework (U. Andersson *et al.*, 2020). Individual indicators are fundamental components that represent the precise aspects contributing to each construct. These indicators together constitute sub-dimensions that encompass the greater dimensions of the theoretical frameworks (Litke *et al.*, 2021). Afterwards, these smaller dimensions combine to produce larger constructs that encompass the main theoretical notions of SCC, IS, and SCV. The study attempts to reveal the intricate relationships inside and across constructs by implementing a hierarchical model. This will offer a well-organized framework for empirical investigation. This methodology improves the clarity and accuracy of the research framework (Di Maddaloni & Davis, 2018), providing a strong basis for evaluating hypotheses and contributing to a more thorough comprehension of the intricate relationship between supply chain dynamics and sustainable performance. The hierarchical model definition functions as a methodological framework, facilitating a systematic analysis of the postulated links and ensuring a thorough study of the theoretical framework (Heindl & Liefner, 2019). To summarize, the hierarchical model specification is a methodological framework that arranges the complex connections among individual indicators, sub-dimensions, and higher-order constructs. This methodology improves the level of analysis and accuracy of the study, creating a foundation for a comprehensive examination of the hypotheses and adding to the wider understanding of sustainable SCM (Cousins *et al.*, 2019; Dubey *et al.*, 2020).

2.2.2 Hypotheses

2.2.2.1 Impacts of Supply Chain Connectivity on Information Sharing

This study posits that establishing robust linkages in the upstream supply chain can result in enhanced information flow and heightened visibility inside the supply chain network, aligning with the principles of the RBV framework. This concept is substantiated by prior study carried out by (Dubey *et al.*, 2020; Kamboj & Rana, 2023; Nandi *et al.*, 2020). According to Adamides & Karacapilidis, (2020), the information technology (IT) infrastructure is considered a tangible resource that is essential for facilitating the exchange of information. The hypothesis is grounded in the fundamental principle of the RBV paradigm, which asserts that strategic resources, when combined, produce distinctive capabilities that enhance the acquisition of a competitive edge (Valaei *et al.*, 2022). Supply chain connectedness and IS are considered to be crucial elements in SCM. They are regarded to enhance visibility, which is a significant organizational capability (Reyes-Rodriguez, 2021). Visibility, in this context, refers to the extent to which the methods and information of a supply chain are transparent and easily accessible. This study contends that establishing a supply chain connection is essential for facilitating effective IS. Connectivity, usually reliant on a robust IT infrastructure, forms the technological foundation necessary for seamless communication and collaboration across the supply chain network (Dubey *et al.*, 2020; Rejeb *et al.*, 2021). Thus, the hypothesis posits that enhancing connection in the upstream supply chain has a positive impact on the interchange of information. In essence, H1 posits that a supply chain that is intricately linked and bolstered by sophisticated IT infrastructure is more inclined to foster a culture of IS. In order to enhance their presence within their supply chains, companies are focusing on the importance of connectivity. This is essential for breaking down isolated sources of information and enabling a more cohesive and transparent flow of data. This hypothesis forms the basis for a practical investigation that seeks to validate the intricate relationship between SCC and information exchange within the framework of sustainable SCM.

H1: Supply chain connectivity positively impacts information sharing.

2.2.2.2 Impacts of Supply Chain Connectivity on Supply Chain Visibility

This study explores the complex relationship between supply chain connection and the overall organizational competence of SCV, using the fundamental concepts of the RBV. According to Roy, (2021), supply chain connectedness is considered an essential requirement that establishes the foundation for the creation of SCV, a more advanced concept. According to the RBV paradigm, firms achieve a competitive advantage by strategically combining and utilizing their distinct resources and capabilities (Keskin *et al.*, 2021). SCC, which is reliant on sophisticated information and communication technologies (ICTs), is a crucial element in SCM. Prior studies by (Baah, Opoku Agyeman, *et al.*, 2022; Dubey *et al.*, 2020; Munir *et al.*, 2020) have shown the crucial significance of supply chain connectedness in promoting enhanced performance within the supply chain. Hypothesis H2 suggests that improved connectedness in the upstream supply chain has a favorable impact on the development of visibility in the same supply chain. The rationale for this is based on the concept that a technologically advanced and strong framework for connecting supply chains establishes the foundation for a transparent and interconnected network of supply chains. As firms allocate resources to improve and expand their technology-based connectivity, the outcome is an increased capacity to gather and distribute crucial information throughout the supply chain, ultimately leading to the achievement of SCV. To summarize, H2 argues that upstream SCC has a beneficial effect by acting as a catalyst, positively affecting the achievement of upstream SCV. This hypothesis enhances the theoretical comprehension of how technology-based connectedness in the supply chain ecosystem has a fundamental impact on defining overall organizational capacities, specifically in terms of gaining visibility into supply chain processes and dynamics.

H2: Supply chain connectivity positively impacts upstream supply chain visibility.

2.2.2.3 Impacts of Information Sharing on Supply Chain Visibility

IS plays a vital role in the complex network of supply chain dynamics. Its impact extends to the whole organizational ability to have insight into the supply chain (Dubey *et al.*, 2020; Huo *et al.*, 2021). Hypothesis H3 investigates the complex correlation between IS and the enhancement of visibility in the supply chain network. Aligned with the RBV paradigm, which emphasizes the need of combining resources and competencies to gain a competitive advantage (Dubey *et al.*, 2020; Maiti *et al.*, 2020), this study considers information exchange as a crucial intangible resource. Ojha *et al.*, (2023) argue that "IS" is a valuable exchange inside businesses, while Huo *et al.*, (2021) emphasize that the value of IS depends on aspects such as its quality. According to Tan *et al.*, (2023), "IS" is intangible, but SCV includes the ability to capture both material and information flows in the supply chain. Hypothesis 3 (H3) suggests that the act of exchanging information has a favorable effect on the ability to see and understand the activities and processes in the upstream supply chain. The foundation for this argument is grounded on the notion that a robust culture of information sharing, supported by advanced information technology, promotes the growth of a transparent supply chain. By actively communicating pertinent and timely information on inventory, sales, demand forecasts, order status, and production plans, organizations provide a solid basis for improving SCV.

H3: Information sharing positively impacts upstream supply chain visibility.

2.2.2.4 Impacts of Supply Chain Visibility on Sustainable Supply Chain Performance

The need of SCV becomes more evident as we navigate the intricacies of modern supply chains. Hypothesis H4 explores the expected effects of SCV on the performance of sustainable supply chains, analyzing the various aspects of economic, social, and environmental results. This hypothesis suggests that SCV has a favorable effect on many performance measures, based on the considerable research conducted by Baah, Opoku Agyeman, *et al.*, (2022) and the comprehensive review conducted by (Dubey *et al.*, 2020; Saqib & Zhang, 2021). Transparent and integrated information flow along the supply chain is anticipated to result in positive consequences across economic, social, and environmental aspects. Roy, (2021) propose that increased SCV is associated with greater inventory levels, product availability, flexibility, responsiveness, and quality - all of which are crucial factors contributing to economic performance. The more comprehensive understanding of SSCP entails adopting a triple bottom line approach, which includes considering economic, social, and environmental factors (Dubey *et al.*, 2020; Neri *et al.*, 2021). H4 primarily focuses on these aspects, suggesting that having visibility into the upstream supply chain has a favorable effect on social, environmental, and economic performance. H4 essentially states that a supply chain that is transparent, achieved through strong visibility, leads to favorable results in social aspects, such as enhanced working conditions and community involvement, environmental aspects, such as decreased ecological impact, and economic aspects, such as improved efficiency and profitability. The interconnection of these elements corresponds to the overarching objectives of sustainable SCM, highlighting the necessity for a healthy equilibrium between economic well-being, social accountability, and environmental guardianship.

H4: Supply chain visibility positively impacts Sustainable Supply Chain Performance.

2.2.2.5 Influence of Product Complexity on Sustainable Supply Chain Performance

In the complex network of supply chain dynamics, the impact of PC on SSCP emerges as a crucial factor. The level of intricacy, diversity, and sophistication within manufacturing processes, known as PC, has the potential to influence the connection between the visibility of the upstream supply chain and the three sustainable outcomes - social, environmental, and economic performance. This hypothesis explores the intricate relationship between the intricacy of product lines and the overall aims of SSCP, drawing inspiration from the issues raised by Afum *et al.*, (2023) regarding managerial challenges related to PC. Essentially, it suggests that the influence of SCV on sustainable results may vary depending on the intrinsic intricacy of the products being handled. This hypothesis is based on the understanding that efficient management of PC is crucial for operational efficiency and overall effectiveness of the supply chain. The text recognizes a slight difference in the current literature about the impact of PC, as emphasized (Dubey *et al.*, 2021; Jaeger & Upadhyay, 2020). By adopting a more nuanced perspective, it argues that skillful management of PC has the ability to act as a strategic tool, improving the performance of the supply chain in a sustainable manner. When firms navigate the complexities of product lines, they can use PC to their advantage as a distinctive strength. Efficiently managing intricate products in the supply chain has the potential to bring about significant changes, enhancing social responsibility, environmental stewardship, and economic sustainability in the field of sustainable SCM.

H5: Product complexity positively moderates the effect of Sustainable Supply Chain Performance.

3 MATERIALS AND METHOD

Study population & sampling framework

This study used a cross-sectional physical and electronic survey of a sample of manufacturing companies in Bangladesh, drawn from the directory of Dhaka Stock Exchange and Chattogram stock Exchange. There are around 46,110 manufacturing firms in the country, out of them 6034 firms are of medium and large size (3178 and 2856 respectively) (BBS, 2020). The present research focused on manufacturing companies because of the socio-economic significance of the sector in national development. Manufacturing industry in Bangladesh experienced a growth of 11 percent and generates a substantial contribution to the nation’s GDP, providing employment opportunities to 5.5 million people of the country (BBS, 2020).

Particularly, the manufacturing firms operating in Dhaka, Narayanganj and Chattogram industrial cities of the country, were targeted in this study that have achieved a specific state of supply chain connectivity and are primarily impacted by supply chain disruptions (Ali *et al.*, 2021). These cities have been chosen because they are more developed economically and have a higher concentration of manufacturing companies than other cities (Ali *et al.*, 2021). Businesses in the chosen cities are more likely to adopt sustainable practices in order to gain a competitive advantage because they are heavily involved in supply chain management (Rupa & Saif, 2022; Sarkar *et al.*, 2020). Since there is no comprehensive list of supply chain professionals employed in the manufacturing sector of the country, purposive sampling method was adopted for data collection (Syed & Mahmud, 2022). The targeted respondents of the survey were upper and middle level supply chain executives, including directors, managers and professional from operations, distribution and logistics related functions who have at least three years of work experience in the field of supply chain management. The confidentiality of all responses was guaranteed, along with their voluntary involvement and anonymity. The purpose of targeting these persons was to guarantee that the data collected accurately reflects the state of supply chain operations and the related areas of interest of the surveyed organizations (Craighead *et al.*, 2011). Because of their increased understanding of the handling of supply chains and the application of visibility techniques, the study's participants are therefore more equipped to handle complex supply chain issues for their companies.

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The survey was provided both physically on-site and by email with a link to a Google Form. To improve the response rate, a phone call reminder and a follow-up email were sent. Between September 2023 and March 2024, data were gathered. Approximately 273 of the 800 questionnaires that were distributed were collected. Following the elimination of questionnaires with incomplete or erroneous answers, 250 valid answers—164 from online surveys and 86 from in-person surveys—were received, translating to a 31.25% response rate. This response rate, when compared to similar investigations in current literature studying supply chain management subjects, is quite excellent and adequate for a hypothesis test, especially given the length of the survey.

The survey questionnaire, designed with established scales derived from pertinent literature, covered crucial aspects such as SCC, IS, SCV, PC, and SSCP. For measuring the SSCP, 5 items scale was adapted from Riaz *et al.*, (2024) and P. Agrawal & Narain, (2023). The survey has two parts, namely, qualifying and main study. Part one of the survey screened respondents working in supply chain domains in the manufacturing firms. Part two of the survey included items on a seven-point Likert scale with anchors ranging from 1 = "strongly disagree to 7 = "strongly agree". The content validity of the survey was assessed by six subject experts from academia and four industry professionals working in of the manufacturing industry. A focused group discussion with 10 respondents was conducted to pre-test the survey. A pilot study was conducted with 58 potential responses. The Cronbach's alpha of all the constructs was found higher than the recommended value of 0.7. The results were shown to the experts, and their feedback resulted in modification of some of the items to make the survey appropriate based on the research context.

The analysis of the collected data was conducted using the SmartPLS 4 software, a powerful tool for Structural Equation Modeling (SEM). SEM was deemed appropriate for its capability to unravel intricate relationships among variables, aligning with the comprehensive nature of this research (Chin *et al.*, 2020; Hasan Emon *et al.*, 2023). The analytical process encompassed evaluating the reliability and validity of the measurement model, scrutinizing the structural model, and subjecting the proposed hypotheses to rigorous testing. By focusing on the survey methodology, this research design provided a precise and efficient way to examine the complex landscape of supply chain practices and sustainability initiatives in the manufacturing sector of Bangladesh.

4 RESULTS AND FINDINGS

Table 1 - Reliability and Validity Analysis

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)	Item No
Supply chain connectivity	0.83	0.84	0.90	0.75	3
Information sharing	0.91	0.91	0.94	0.79	4
Supply Chain Visibility	0.84	0.84	0.93	0.86	2
Product Complexity	0.88	0.88	0.93	0.80	3
Sustainable Supply Chain Performance	0.88	0.94	0.90	0.43	15

Source: Estimated result.

The reliability and validity analysis findings for the measurement model are presented in Table 1. Cronbach's alpha, a metric for assessing internal consistency, serves as an indicator of the dependability of the structures. The supply chain connection has a respectable level of dependability, as shown by a Cronbach's alpha value of 0.83, which suggests a solid internal consistency across its components. IS exhibits a higher degree of reliability, as seen by a Cronbach's alpha of 0.91, indicating robust consistency across its constituent parts. The reliability of SCV and PC is evidenced by Cronbach's alphas of 0.84 and 0.88, respectively. Composite reliability, as measured by rho_a and rho_c, assesses the overall reliability of the constructs by taking into account both the shared variation among items and the mistakes in measurement. The composite dependability scores for supply chain connection, information exchange, and SCV range from 0.84 to 0.91, suggesting a high level of internal consistency and good performance. The product's complexity demonstrates strong dependability, as shown by a composite reliability score of 0.88. The Average variation Extracted (AVE) measures the proportion of variation accounted for by the constructs in relation to the mistakes in measurement. All constructs, with the exception of SSCP, exceed the suggested criterion of 0.5 for AVE, indicating strong convergent validity. The SSCP, as indicated by an AVE of 0.43, is somewhat below the threshold. This suggests that a lesser fraction of the variance is explained by the indicators of SSCP compared to the measurement errors.

Table 2 - Fornell-Larcker Criterion for Discriminant Validity

	Information sharing	Product Complexity	Supply Chain Visibility	Supply chain connectivity	Sustainable Supply Chain Performance
Information sharing	0.89				
Product Complexity	0.71	0.9			
Supply Chain Visibility	0.76	0.73	0.93		
Supply chain connectivity	0.82	0.71	0.72	0.86	
Sustainable Supply Chain Performance	0.84	0.75	0.77	0.79	0.66

Source: Estimated result.

The table shows the Fornell-Larcker Criterion, which is a metric used to assess discriminant validity. Discriminant validity is confirmed when the square root of the AVE for each construct exceeds its correlations with other constructs. Based on this study, IS demonstrates discriminant validity, as its square root of AVE (0.89) exceeds the correlations with PC (0.71), Supply Chain Visibility (0.76), Supply chain connectedness (0.82), and SSCP (0.84). PC has discriminant validity, as its square root of AVE (0.9) surpasses the correlations with other constructs. The square root of AVE (0.93) for SCV is greater than its correlations with other variables, thereby confirming its discriminant validity. The square root of AVE value of 0.86 demonstrates the discriminant validity of supply chain connectedness, as it exceeds the correlations with other variables. The discriminant validity of SSCP is demonstrated by its square root of AVE (0.66), which is greater than its correlations with other variables. The Fornell-Larcker Criterion demonstrates that the measurement model efficiently differentiates between latent variables, guaranteeing sufficient discriminant validity among IS, PC, SCV, Supply chain connectedness, and SSCP.

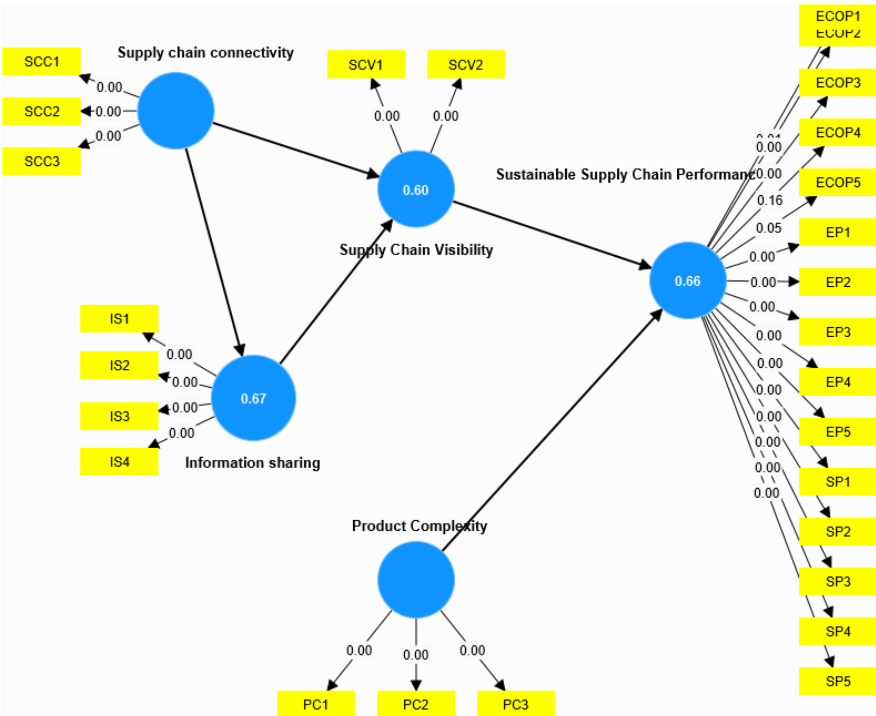

Figure 2 - Structural Equation Modeling (Bootstrapping)
Source: Estimated result.

In the Structural Equation Modeling (SEM) figure 2, the R-square values provide insights into the variance explained by the endogenous variables. IS, as a key variable, accounts for 67% of the variance in its observed indicators. Similarly, SCV explains 60% of the variance in its measured indicators. The overarching construct of SSCP exhibits a substantial explanatory power, with an R-square value of 66%. These high R-square values indicate that the proposed model effectively captures and explains the variability in the respective constructs, reinforcing the robustness of the relationships and contributing to a comprehensive understanding of the examined phenomena.

The SEM figure, with these R-square values, underscores the model's capability to elucidate the intricate dynamics of IS, SCV, and SSCP within the context of manufacturing companies in Bangladesh.

Table 3 - Correlations among Study Variables

	Supply chain connectivity	Information sharing	Supply Chain Visibility	Product Complexity	Sustainable Supply Chain Performance
Supply chain connectivity	1				
Information sharing	0.82	1			
Supply Chain Visibility	0.72	0.76	1		
Product Complexity	0.71	0.71	0.73	1	
Sustainable Supply Chain Performance	0.79	0.84	0.77	0.75	1

Source: Estimated result.

The correlation matrix illustrates the associations among the variables under investigation. There is a significant and positive relationship between supply chain connectedness and both IS ($r = 0.82$, $p < 0.01$) and SCV ($r = 0.72$, $p < 0.01$). The act of sharing information is strongly and favorably associated with SCV (correlation coefficient $r = 0.76$, $p < 0.01$). In addition, there are strong positive relationships between PC and supply chain connection ($r = 0.71$, $p < 0.01$), IS ($r = 0.71$, $p < 0.01$), and supply chain visibility ($r = 0.73$, $p < 0.01$). Moreover, the performance of a sustainable supply chain has positive correlations with all other variables, suggesting a mutual dependency within the model. The strongest link is seen between SSCP and knowledge exchange ($r = 0.84$, $p < 0.01$). These correlation coefficients aid in comprehending the connections between the fundamental concepts in the research.

Table 4 - Hypothesis Testing

	Original sample	Sample mean	Standard deviation	T statistics	P values	Remarks
Supply chain connectivity -> Information sharing	0.82	0.82	0.02	35.73	0	Supported
Information sharing -> Supply Chain Visibility	0.51	0.51	0.07	7.02	0	Supported
Supply chain connectivity -> Supply Chain Visibility	0.3	0.3	0.07	4.06	0	Supported
Supply Chain Visibility -> Sustainable Supply Chain Performance	0.48	0.48	0.07	6.6	0	Supported
Product Complexity -> Sustainable Supply Chain Performance	0.4	0.4	0.08	5.01	0	Supported

Source: Estimated result.

The hypothesis testing research yielded substantial results, offering vital insights into the connections between important factors in the context of SSCM for manufacturing enterprises in Bangladesh. The hypotheses were thoroughly examined, taking into account the initial sample mean, standard deviation, T statistics, p-values, and their consequences. The results significantly confirmed the association between supply chain connectedness and IS, as hypothesized in the first hypothesis. The initial sample mean and standard deviation were 0.82 and 0.02, respectively. This led to a significant T statistic of 35.73 and a p-value of 0, showing a very significant correlation. The second hypothesis, which investigates the influence of IS on SCV, likewise received strong and reliable evidence. The initial sample mean and standard deviation were 0.51 and 0.07, correspondingly. This led to a T statistic of 7.02 and a p-value of 0, indicating a substantial and positive correlation. Regarding the third hypothesis, which proposed that supply chain connectedness had a beneficial impact on supply chain visibility (SCV), the results were in line with what was anticipated. The T statistic, calculated using an initial sample mean of 0.3 and a standard deviation of 0.07, was found to be 4.06. The resulting p-value was 0, indicating a significant influence of connection on visibility. The study suggested that SCV has a favorable impact on SSCP, as stated in the fourth hypothesis. The study corroborated this assertion, as evidenced by an initial sample mean of 0.48, a standard deviation of 0.07, a T statistic of 6.6, and a p-value of 0, signifying a statistically significant and positive correlation. The fifth hypothesis, which examines the influence of PC on SSCP, was well supported. The initial sample mean of 0.4, standard deviation of 0.08, T statistic of 5.01, and a p-value of 0 emphasized the significance of taking PC into account when affecting sustainable supply chain operations.

5 DISCUSSION

This article is pioneering research investigating the SCV dynamics and sustainability practices in the manufacturing industry of Bangladesh. Also highlight that, due to geographic location of Bangladesh in Indo-pacific region, the economic importance of the nation in global supply chain mechanisms has been receiving attention from the academic think tanks as well as industry experts. The study embarked on a comprehensive exploration of sustainable SCM within the context of manufacturing companies in Bangladesh. Rooted in the contingent RBV perspective, the research aimed to unravel the intricate dynamics of SCV and its interaction with variables like SCC, IS, and PC. The overarching goal was to contribute valuable insights to both academic scholarship and practical applications in the realm of sustainable supply chain practices.

The literature on sustainable supply chains benefits from the three intriguing contributions made by this study. To attain sustainability performance, the research initially looks into how resources interact to build supply chain visibility (Dubey *et al.*, 2020). There is ongoing pressure on organizations, particularly in developing nations, to create sustainable supply chains from government agencies or regulating institutions (Dai *et al.*, 2021). It has been well acknowledged that achieving sustainability performance is difficult and that this is typically because of two factors: complexity (Negri *et al.*, 2021) and insufficient visibility (Kamble *et al.*, 2020). What is less known, however, is how supply chain visibility affects economic, social, and environmental sustainability (Saqib & Zhang, 2021). This is true even though the impact of strategic sources and capabilities on visibility is extensively covered in the operational, supply chain and logistics management research (Dubey *et al.*, 2020). In order to bridge this gap observed in previous research (Ahmed *et al.*, 2021), a theoretical model has been presented in this study that argue combining resources such as exchange of data and supply chain connections, enhances the supply chain's visibility and capability and has a positive effect on its environmental and social outcomes. In order to learn more about the significance of visibility in the sustainability dimensions of supply chains, the present research expands on the points made by Dubey *et al.*, (2020) and Baah, Acquah, *et al.*, (2022)

Besides, there is a lack of understanding of the impact that product complexity and variables have in attaining sustainability goals through supply chain visibility. Our claim is supported by the body of research that shows how product complexity affects how visibility affects social, environmental, and financial performance. In order to provide an intriguing perspective on supply chain visibility, we expand upon some previous studies (Dubey *et al.*, 2020) by examining the complexity of products as a contingent variable. Moreover, in dissecting the study's contributions, a pivotal aspect lies in its ability to illuminate the nuanced interactions within sustainable supply chains, particularly within the manufacturing sector of Bangladesh. By addressing the inherent complexities of SCV and considering the moderating role of PC, the research extends our understanding of how organizations can effectively navigate the challenges inherent in sustainable supply chains (Chowdhury *et al.*, 2023). The knowledge generated from this study is poised to be a valuable resource for academia and industry professionals alike, providing pertinent insights for those engaged in sustainable supply chain practices. From a theoretical standpoint, the study's adoption of the contingent RBV perspective serves as a notable contribution, addressing criticisms related to context insensitivity within the RBV framework (Chaubey *et al.*, 2022). The hierarchical model developed provides a structured representation of the complex relationships between indicators, sub-dimensions, and higher-order constructs. Through the hypotheses development, the study extends the RBV logic, proposing that SCC, IS, and PC collectively influence SSCP. This theoretical foundation enriches the existing literature on SCM, offering nuanced insights into the dynamics of sustainability (Seuring *et al.*, 2022). In terms of methodological rigor, the study employed Smart PLS 4, a robust structural equation modeling tool. The substantial sample size of 250 respondents strengthened the research's statistical power. The hierarchical model facilitated a nuanced exploration of relationships, and the hypotheses testing, supported by statistical measures like T statistics and P values, contributed to the methodological rigor of the study. These findings add to the methodological toolkit available for researchers in the field of SCM.

From a practical standpoint, the study's contributions are actionable for manufacturing companies in Bangladesh and similar emerging markets (Jia *et al.*, 2018). The identified relationships between SCC, IS, visibility, and SSCP offer practical guidance for organizations seeking to enhance their sustainability practices. The emphasis on PC as a moderating factor provides companies with insights to tailor their strategies based on the nature of their products, thereby enhancing the practical relevance of the findings. In this regard, for supply chain managers, this study has a number of beneficial implications. Investing in supply chain visibility capabilities increases the social and environmental benefits for firms working in complex environments such as those with significant product variety (Dubey *et al.*, 2020). Generally, businesses are unable to combine sales with their societal and environmental responsibilities (Dubey *et al.*, 2020; Swift *et al.*, 2019). Therefore, our study's findings suggest that taking advantage of a product's complexity might lessen the detrimental effects that the supply chain has on the environment, raise employee living standards, enhance living conditions, and increase profitability. The advantages are, however, noticeably slower, thus in the long run, supply chain sustainability may profit from effective product complexity management.

6 CONCLUSION

This research embarked on a comprehensive exploration of sustainable SCM within the context of manufacturing companies in Bangladesh. Owing to the complexity of their supply networks, businesses in this industry are actively working to increase their visibility and flexibility. In order to support supply chain sustainability outcomes, the current study suggests three approaches: utilizing product complexity, fostering dynamic resources, implementing connectivity and data sharing. The research problem, as delineated in the introduction, revolved around the formidable challenge of achieving tangible and effective SSCP in the face of complexities, reduced inventory levels, outsourcing practices, and the global dispersion of supply chain entities. The devastating consequences of inadequately implemented sustainable supply chain practices, exemplified by the Bangladesh garment factory fire in 2013, underscored the urgent need for a holistic understanding and implementation of sustainable supply chain design. The study's main arguments and important findings are rooted in the adoption of the contingent RBV perspective, focusing on the interplay between SCC, IS, PC, and SSCP. The research emphasizes the contingent nature of these relationships, shedding light on the moderating role of PC in influencing SSCP. Key takeaways from the study underscore the intricate balance required in sustainable supply chain practices. The study not only enriches theoretical perspectives in SCM but also provides practical insights for manufacturing companies in Bangladesh, particularly in navigating challenges associated with PC.

The findings have implications for academia, industry professionals, and policymakers involved in shaping sustainable practices. However, it is essential to acknowledge certain limitations. As noted by Ross & Bibler Zaidi, (2019), the application of survey responses could limit the research's scope. We therefore suggest using alternative approaches to address those questions that might not be answered by a single method, such as the combination of qualitative and quantitative approaches. Again, the contingent resource-based theory thinking greatly influenced the theoretical underpinning of the present research. We think that by examining sustainable supply chain performance, the current study can be expanded to incorporate the natural resource-based concept (Shibin *et al.*, 2020). To a greater extent, institutional theory may be applied in future research to try to comprehend the forces influencing managerial choices on connectivity, performance, and information sharing (Shibin *et al.*, 2020). Further limitations can be the specific focus on manufacturing companies in Bangladesh, and variations in industry contexts.

These issues highlight the need for additional research to compare and refine the research findings from other emerging countries and look at the sustainability and visibility aspects of supply chain operations in a variety of environments. Considering these matters, future research endeavors could explore these dynamics in diverse socio-economic settings and delve deeper into the specific mechanisms through which SCV influences SSCP. In addition, it could be worthwhile to look into how organizational culture, digitalization and industry 4.0 interventions affect the visibility dimensions of supply chains and how these variables play an influential role in improving the sustainable performance metrics. Overall, this study serves as a valuable steppingstone in unraveling the complexities of sustainable SCM, offering a foundation for further exploration and application in diverse global contexts.

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