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Article

Enhancing supply chain resilience: The role of security practices and performance in mitigating disruptions in ghana's manufacturing sector

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Abstract: The study examined the mediating role of supply chain security performance on the relationship between supply chain security practices and supply chain disruptions occurrences in the manufacturing industry in Ghana. Drawing on a survey of 336 manufacturing firms, dynamic capability, and contingency theories were applied using structural equation modeling (SEM) to test the conceptual model. It was discovered that both direct and indirect hypotheses supported the findings of the study. The results indicate that Ghanaian manufacturing firms have made progress in implementing supply chain security measures. The findings revealed that the adoption of comprehensive supply chain security practices is positively associated with improved performance metrics, including reduced inventory losses and damages, faster order fulfillment and delivery times, lower costs related to security incidents, and enhanced brand reputation and customer trust. Policymakers can leverage these insights to develop support programs aimed at strengthening the security capabilities of manufacturing firms, ensuring they are equipped to compete effectively in both local and global markets, improving security performance, and reducing the likelihood and impact of supply chain disruptions. In the quest of bridging the gap between theory and practice, this research contributes valuable knowledge to the discourse on supply chain security in developing countries, offering a roadmap for enhancing resilience and performance in the manufacturing sector.

Keywords: supply chain; security practice; disruption; security performance; manufacturing firms

1. Introduction

In today's intricate global supply chain networks, mitigating supply chain disruption has become a paramount concern for organizations across diverse industries (Chowdhury and Quaddus, 2016; Srivastava and Rogers, 2022). Supply chains are increasingly vulnerable to a myriad of disruptive events, including natural disasters, geopolitical tensions, cyber-attacks, labor strikes, and epidemics (Hassija et al., 2020; Hamidu et al., 2023; Park et al., 2016). The COVID-19 pandemic alone caused widespread supply chain disruptions, with 94% of Fortune 1000 companies experiencing supply chain disruptions arising from COVID-19 (Liou et al., 2023). These disruptions can have severe consequences, such as production delays, stockouts, financial losses, and damage to brand reputation (Kanike, 2023; Tong et al., 2022; Tse et al., 2016). According to a report by the Business Continuity Institute (2022), supply chain disruptions cost about 80.3% of businesses not less than €1 million per year.

Therefore, implementing robust supply chain security practices and enhancing supply chain security performance have emerged as critical strategies to reduce the occurrence and impact of supply chain disruptions. Supply chain security measures include a broad range of activities that seek to safeguard supply chain assets, such as information and operations, from being exposed or deviating from planned procedures (Park et al., 2016; Speier et al., 2011). Supply chain security practices encompass a comprehensive set of measures aimed at protecting the integrity, reliability, and continuity of supply chain operations. These security practices can be both physical and procedural, such as access control and surveillance systems, employee training, risk evaluations, and contingency plans.

The successful implementation of supply chain security practices is identified as a crucial factor that can affect supply chain performance as supply chain disruptors become more prevalent (Ambulkar et al., 2015; Kurniawan et al., 2017). By fortifying these security measures and improving supply chain security performance, organizations strive to safeguard their supply chains against various threats, thereby minimizing the likelihood of disruptions. A report by Wellener et al. (2022), published by Deloitte, revealed that companies with strong supply chain security practices and high-security performance experienced 43% fewer disruptions compared to those with weaker security measures. However, the relationship between supply chain security practices, supply chain security performance, and the occurrence of disruptions is not well understood, and empirical evidence is scarce. According to Asamoah et al. (2022), only a limited number of studies have explored the direct impact of security practices and performance on supply chain disruption occurrences. This research gap is concerning, as supply chain disruptions can have far-reaching consequences. For instance, a study by Hendricks and Singhal (2005) found that supply chain disruptions can lead to a 33%–40% lower stock return for affected companies relative to their industry peers.

Despite the growing importance of supply chain security in enhancing organizational performance, there is a notable gap in empirical research specifically addressing how the mediating role of supply chain security performance influences the interplay between supply chain security practices and supply chain disruption occurrence within the manufacturing industry in Ghana. Previous studies have primarily focused on general supply chain management practices and disruptions, often overlooking the critical role that supply chain security performance plays in mitigating risks and enhancing efficiency (Birkie et al., 2017; El-Baz and Ruel, 2021; Park et al., 2016). The objectives of this study are to 1) evaluate the impact of supply chain security practices and severity of supply chain disruptions in the manufacturing sector in Ghana and 2) analyze the mediating role of supply chain security performance in the relationship between security practices and disruption occurrences. The findings of this research have significant implications for supply chain professionals, policymakers, and academic researchers alike. By identifying the most impactful security practices and the importance of security performance, organizations can prioritize their investments and resources to fortify their supply chains against potential disruptions. The remainder of the study begins with a thorough literature review, which is followed by a theoretical introduction and the paper's model, which investigates the study's hypothesis. The methodology is presented leading to the data

analysis and results which are then succeeded by the findings of the study, implications, and limitations.

2. Theory and hypotheses development

2.1. Dynamic capability and contingency perspectives

The study used the dynamic capabilities theory and the contingency theory as theoretical underpinnings to investigate the causes and effects of supply chain security (SCS) practices. The resource-based view gives rise to the dynamic capabilities theory, which highlights a firm's competitive advantage stemming from its ability to adapt efficiently to changes in turbulent and dynamic environments (Asamoah et al., 2021). The ability of a company to build, integrate, and reconfigure internal and external resources through organizational processes to respond to changes in the competitive environment and develop new strategies that create value is known as dynamic capabilities (Eisenhardt and Martin, 2000; Teece et al., 1997). According to Eisenhardt and Martin (2000) and Singh et al. (2019), dynamic capability, in other words, looks at a company's capacity to recognize and seize opportunities as well as reorganize resource bases for long-term competitive advantage in a volatile environment. The study is subject to two applications of dynamic capabilities theory. Initially, a strong organizational security culture is a valuable intangible resource that businesses can use to their advantage to adapt to supply chain disruptions (Kumar and Anbanandam, 2020). Second, a firm's capacity to endure and prosper in such conditions will depend on the dynamic capabilities it can create and implement. Supply chain disruptions represent extremely turbulent and unstable environments (Yu et al., 2019).

According to contingency theory, there is no one ideal way to manage processes like leadership, organizing, and decision-making because various environments have distinct antecedents and outcomes (Lawrence and Lorsch, 1967; Luthans, 1976). It challenges the idea that there is a single, best approach to managing an organization by highlighting the importance of situational factors in organizational management (Burns and Stalker, 1961; Donaldson, 2001). According to Lawrence and Lorsch (1967), contingency theory looks at how both internal and external environmental factors affect organizational behavior. While external variables are mostly independent of a single organization, internal variables, like structures, processes, and technologies, can be influenced by management (Grĕotscha et al., 2013). According to the theory, both internal and external factors influence the best decisions and actions taken by organizations (Park et al., 2016). According to the study, a company's organizational security culture—which is influenced by its exposure to supply chain risks—determines how much it adopts supply chain security practices, which in turn determines how well the company can reduce supply chain disruptions, as illustrated in **Figure 1**. For comprehending and enhancing supply chain security procedures in Ghana's industrial sector, both theories provide strong frameworks. The contingency theory highlights the significance of context-specific tactics catered to the particular internal and external elements influencing the organization, dynamic capabilities theory offers insights into how the firm might create and deploy resources to adapt to and minimize disturbances. All these theories support the necessity for a flexible,

nuanced strategy to improve supply chain security and lower the frequency of disruptions in Ghana's manufacturing industry.

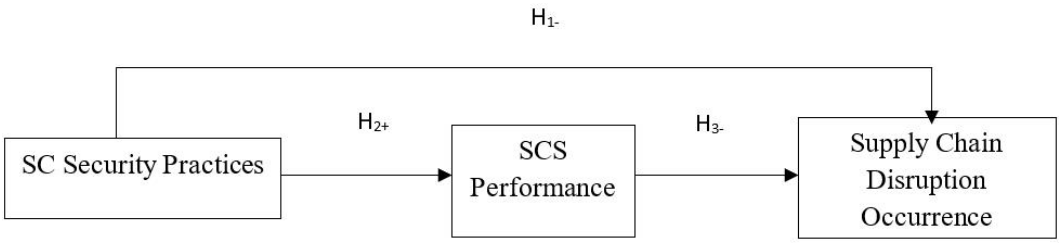

Figure 1. Conceptual framework.

2.2. SC security practice on supply chain disruption occurrence

To safeguard organizations against a variety of risks and threats, supply chains must implement sound security practices, especially in the areas of information management security, human resource security, and facility management security (Hammi et al., 2023). From the contingency theory perspective, the implementation of security practices is contingent on various internal and external factors, such as organizational size, industry, and environmental uncertainties (Liu et al., 2023). In the context of SC security practices, contingency theory suggests that organizations may adopt different security measures in these three key areas based on their specific contingencies, such as the nature of their supply chain operations, the level of risk exposure, and the availability of resources (Akın Ateş et al., 2022). Effective information management security practices, such as data encryption, access controls, and secure communication protocols, can help protect the integrity and confidentiality of supply chain data, reducing the likelihood of disruptions caused by cyber-attacks, system failures, or data tampering (Jażdżewska-Gutta and Borkowski, 2022). Similarly, robust human resource security measures, including thorough background checks, security clearances, and employee training, can minimize the risk of insider threats, human errors, or negligent actions that could lead to supply chain disruptions (Abdelaziz et al., 2024). Comprehensive facility management security, encompassing physical access controls, surveillance systems, and emergency response procedures, can safeguard the physical assets and infrastructure critical to the supply chain, protecting against external threats like theft, vandalism, or natural disasters that could disrupt the flow of goods and materials (Abdelaziz et al., 2024). By implementing these SC security practices, organizations can enhance their overall supply chain resilience and reduce the occurrence of disruptive events, leading to more reliable deliveries, improved customer satisfaction, and a stronger competitive position in the market (Jażdżewska-Gutta and Borkowski, 2022). However, as suggested by the dynamic capability theory, organizations need to continuously adapt and reconfigure their security practices to respond to the ever-changing business environment and emerging threats (Eisenhardt, 2021). The dynamic capabilities perspective emphasizes the importance of organizational learning, agility, and the ability to sense and seize opportunities for enhancing security practices (Huma et al., 2020; Zsidisin, 2022).

The adoption and implementation of SC security practices are also influenced by external institutional pressures, as suggested by Institutional Theory (Ahmed et al.,

2020; Alshumrani et al., 2022). Coercive pressures from government regulations, normative pressures from professional associations, and mimetic pressures from imitating successful competitors have been identified as key drivers for organizations to enhance their security related to information management, human resources, and facilities practices (Boahen, 2023; Burdon and Sorour, 2020; Nirmal et al., 2023). However, the mere presence of institutional pressures does not guarantee the effective implementation of SC security practices. Internal organizational factors, such as top management support and resource availability, also play a crucial role, as emphasized by the contingency theory perspective (Al Hadwer et al., 2021; Weerabahu et al., 2023). A balanced approach that considers both external institutional pressures and internal organizational contingencies is essential for sustainable security outcomes (Weerabahu et al., 2023). In the quest of integrating contingency theory and the dynamic capabilities theory, this study offers a thorough understanding of the variables influencing the association between supply chain disruption events and SC security practices. The results emphasize how crucial it is to respond to external institutional pressures, put in place efficient monitoring and incentive systems, and make sure that internal organizational resources are available and supportive of the successful implementation of information management security, human resource security, and facility management security practices to lessen the likelihood of supply chain disruptions. Building upon prior study findings, the following hypothesis is proposed:

H1a: There is a significant relationship between human resource security on supply chain disruption occurrence.

H1b: There is a positive relationship between Supply Chain Disruption Occurrence on information management security.

H1c: Supply Chain Disruption Occurrence is significantly impacted negatively by facility management security.

2.3. SC security practices on SCS performance

Sound security practices in supply chains are crucial for protecting organizations from various risks and threats (Hassija et al., 2020). Drawing on contingency theory and the dynamic capabilities theory, this study examines the impact of SC security practices on Supply Chain Security (SCS) performance. Contingency theory suggests that the implementation of security practices is contingent on various internal and external factors, such as organizational size, industry, and environmental uncertainties (Jabeen et al., 2022). In the context of SC security practices, contingency theory posits that organizations may adopt different security measures based on their specific contingencies, such as the nature of their supply chain operations, the level of risk exposure, and the availability of resources (Akın Ateş et al., 2022). Effective SC security practices can lead to improved SCS performance, such as enhanced supply chain resilience, reduced lead times, and better delivery reliability, as organizations become better equipped to handle contingencies and uncertainties (Abdelaziz et al., 2024; Naghshineh and Carvalho 2022; Wang et al., 2023).

The dynamic capabilities theory, on the other hand, suggests that organizations need to continuously adapt and reconfigure their security practices to respond to the

ever-changing business environment and emerging threats (Al-Al-Msiedeen and Al Sawalqa, 2021). In the context of SC security practices, organizations with strong dynamic capabilities can sense and seize opportunities for enhancing their security measures, thereby improving SCS performance (Eisenhardt, 2021). These dynamic capabilities can be developed through organizational learning, agility, and the ability to integrate and reconfigure resources (Zsidisin et al., 2024; Zsidisin, 2022). External institutional pressures, as suggested by Institutional Theory (Ahmed et al., 2020; Alshumrani et al., 2022) also influence the adoption and implementation of SC security practices. Coercive pressures from government regulations, normative pressures from professional associations, and mimetic pressures from imitating successful competitors have been identified as key drivers for organizations to enhance their SC security practices (Boahen, 2023; Burdon and Sorour, 2020; Nirmal et al., 2023). However, the mere presence of institutional pressures does not guarantee the effective implementation of SC security practices and improved SCS performance. Internal organizational factors, such as top management support and resource availability, also play a crucial role, as emphasized by the contingency theory perspective (Al Hadwer et al., 2021; Weerabahu et al., 2023). A balanced approach that considers both external institutional pressures and internal organizational contingencies is essential for sustainable SCS performance outcomes (Weerabahu et al., 2023). By integrating contingency theory and the dynamic capabilities theory, this study provides a comprehensive understanding of the mechanisms through which SC security practices influence SCS performance. The findings underscore the importance of aligning with external institutional pressures, implementing effective monitoring and incentive systems, and ensuring the availability of internal organizational resources and support for the successful implementation of SC security practices and the enhancement of SCS performance. Hence, the following hypothesis is proposed:

H2a. There is a significant relationship between Human resource security on Supply Chain Security (SCS) performance.

H2b. There is a positive relationship between Information management security on Supply Chain Security (SCS) performance.

H2c. Supply Chain Security (SCS) performance is significantly improved by facility management security.

2.4. SCS performance on the occurrence of supply chain disruptions

According to contingency theory and the dynamic capabilities theory, the performance of a supply chain system (SCS) and the occurrence of supply chain disruptions are closely interrelated. Contingency theory suggests that the effectiveness of supply chain practices is contingent on various internal and external factors, such as organizational size, industry, and environmental uncertainties (Gruchmann, 2022; Ilhan, 2020). This perspective implies that the vulnerability of a supply chain to disruptions may depend on the degree of fit between the supply chain practices and the specific contingencies faced by the organization (Alkhuzaim et al., 2022; Zsidisin, 2022). The dynamic capabilities theory, on the other hand, highlights the importance of adapting and reconfiguring organizational resources and capabilities to respond to changes in the business environment (Furr and Eisenhardt, 2021; Vitolla et al., 2020).

In the context of supply chains, this theory suggests that organizations with strong dynamic capabilities may be better equipped to sense and respond to potential disruptions, thereby enhancing the overall resilience and agility of the supply chain system (Ketchen et al., 2020; Zsidisin et al., 2024).

Empirical studies have provided support for the relationship between these theoretical perspectives and SCS performance and supply chain disruption occurrence. For instance, Azadegan et al. (2020) found that a lack of fit between supply chain practices and organizational contingencies, as well as deficiencies in dynamic capabilities, were both associated with a higher likelihood of supply chain disruptions. Similarly, Burkhart and Bode (2024) demonstrated that misalignment between supply chain risk management practices and organizational contingencies, as well as weak dynamic capabilities, could undermine the effectiveness of these practices, thereby increasing the vulnerability of the supply chain to disruptions. Furthermore, Ambulkar et al. (2023) showed that organizations with strong dynamic capabilities could enhance their supply chain resilience and agility, which in turn can mitigate the impact of supply chain disruptions. Additionally, Shevchenko et al. (2020) found that a lack of alignment between supply chain practices and environmental contingencies, as well as insufficient dynamic capabilities, could lead to a higher incidence of supply chain disruptions. The resource dependence theory and agency theory provide a useful theoretical framework for understanding the complex interplay between SCS performance and the occurrence of supply chain disruptions. By addressing the power imbalances, information asymmetries, and conflicts of interest within the supply chain, organizations can enhance their resilience and mitigate the risk of disruptions. Building upon prior study findings, the below hypothesis is formulated:

H3. SCS Performance has a significant positive effect on Supply Chain Disruption Occurrence.

2.5. Mediating role of SCS performance on the relationship between SC security practice and supply chain disruption occurrence

The contingency theory suggests that the effectiveness of supply chain security (SCS) practices is contingent on various internal and external factors, such as organizational size, industry, and environmental uncertainties (Jiang et al., 2023; Alkhuzaim et al., 2022). SCS practices can help organizations align their operations with these contingencies and reduce their vulnerability to disruptions (Chand et al., 2022; González-Zapatero et al., 2021). However, the effectiveness of these practices is contingent on the overall performance of the SCS. The dynamic capabilities theory, on the other hand, highlights the importance of adapting and reconfiguring organizational resources and capabilities to respond to changes in the business environment (Furr and Eisenhardt 2021; Vitolla et al., 2020). SCS practices can help organizations develop and leverage their dynamic capabilities, such as sensing and seizing opportunities, which can mitigate the impact of supply chain disruptions (Barney et al., 2021; Huma et al., 2020). Nonetheless, the overall effectiveness of the SCS acts as a mediator between the impact of SCS practices and the occurrence of disruptions.

Empirical research has demonstrated that the relationship between supply chain disruptions and SCS practices is strongly influenced by SCS performance. For instance, Sturm et al. (2023) found that the implementation of SCS practices, such as supply chain risk management and supply chain visibility, could enhance SCS performance, which in turn can reduce the likelihood of supply chain disruptions. Similarly, Ambulkar et al. (2023) showed that organizations with strong dynamic capabilities, such as supply chain resilience and agility, could mitigate the impact of supply chain disruptions. Furthermore, Azadegan et al. (2020) found that a lack of fit between SCS practices and organizational contingencies, as well as deficiencies in dynamic capabilities, were both associated with a higher likelihood of supply chain disruptions, but that these relationships were mediated by the overall performance of the SCS. Likewise, Chand et al. (2022) demonstrated that misalignment between supply chain risk management practices and organizational contingencies, as well as weak dynamic capabilities, could undermine the effectiveness of these practices, thereby increasing the vulnerability of the supply chain to unexpected events. Understanding the mediating role of SCS performance in the relationship between SCS practices and supply chain disruption occurrence is made easier by using the theoretical frameworks provided by the contingency theory and the dynamic capabilities theory. By enhancing the overall performance of the supply chain system, organizations can leverage their SCS practices to mitigate the risk of disruptions and maintain a competitive advantage. Building upon prior study findings, the following hypothesis is proposed:

H4a. The association between supply chain disruption occurrence and human resource security is positively mediated by SCS Performance.

H4b. Supply Chain Disruption Occurrence and Information Management Security are positively mediated by SCS Performance.

H4c. Supply Chain Disruption Occurrence and Facility Management Security are positively mediated by SCS Performance.

3. Methodology

3.1. Research approach and design

This study employed a quantitative research approach to objectively evaluate and measure the relationships between the research variables (Creswell, 2014; Saunders et al., 2016). Specifically, an explanatory research design was adopted to investigate the influence of supply chain security practices on supply chain disruption occurrence, and the moderating role of supply chain security performance on this relationship.

3.2. Instrument development and pilot testing

A structured questionnaire was utilized as the primary data collection instrument, administered to supply chain managers of manufacturing firms. The research model's latent constructs measurement items were taken from earlier studies and adjusted as needed to improve clarity and contextual fit. The responses were recorded on a 5-point Likert scale with a neutral midpoint, ranging from "1-Strongly disagree" to "5-Strongly agree." Asamoah et al. (2022) stipulated the dependent variable, supply chain

disruption occurrence, which includes internal, supplier, and customer disruption. Cigolini et al. (2016) provided the items measuring supply chain security performance, while Asamoah et al. (2023) provided the items for supply chain security practice, such as facility management security, human resource management security, and information management security. Two academic experts and two industry practitioners carefully examined the questionnaire to make sure the adapted items were appropriate and understandable. With their help, the items were improved to better fit the study's setting. A pilot study was then carried out using a sample of ten respondents, under Saunders et al. (2016)'s suggestion regarding pilot sample sizes. There can be more analysis because the pilot responses verified that the scale items, instructions, and questions were clear. Next, to minimize potential biases and guarantee consistency, the study constructs' reliability was assessed.

3.3. Sample and data collection

The study was conducted within the Greater Accra Metropolis in Ghana, which hosts a significant concentration of manufacturing firms across various industries, including paper, food and drink, chemicals and pharmaceuticals, wood, and textiles manufacturing (Akubia and Bruns, 2019; Asare and Angmor, 2015). This localization of manufacturing operations formed the basis for selecting the study area. The target population comprised supply chain managers, plant managers, manufacturing managers, purchasing managers, and presidents/CEOs of manufacturing firms within the Accra metropolis, who are responsible for supply chain operations. A sample size of 336 respondents was determined, adhering to the recommended sample size guidelines for structural equation modeling (SEM) analyses (Comrey and Lee, 1992; Kline, 2011; Hair et al., 2010). A non-probability convenience sampling technique was employed to obtain a broad sample coverage within a short time and at a lower cost. The Dillman (1978) survey methodology was followed for data collection. Initial mailings were sent to the intended recipients, followed by reminders and phone calls after two weeks, where necessary.

3.4. Data analysis

The collected data was entered into Excel software and cleaned to eliminate potential errors. Both descriptive statistics (mean, standard deviation, skewness, and kurtosis) and inferential statistics (SEM) were utilized for analysis. SEM was chosen as the primary statistical technique due to its effectiveness in investigating connections between latent variables (Hair et al., 2012). First, common method bias was assessed using the single-factor test in SPSS and the common factor test in AMOS. When the number of factors was fixed at one, the common variance explained by a single factor was 19.5% (Harman, 1976). Additionally, a shared latent factor was applied to each item in the initial measurement model to investigate common method bias further. The analysis followed a two-step approach: (1) construction of a measurement model using reliability and validity testing, and (2) path coefficient analysis and structural modeling (Anderson and Gerbing, 1988). The findings of the measurement model and the SEM, comprising 5 constructs with 36 items, were evaluated to analyze the measurement reliability and validity, as well as the hypothesized relationships.

4. Results

As per the findings of Comrey and Lee (1992), a sample size of 100 is considered extremely poor, 200 to be fair, 300 to be good, 500 to be very good, and 1000 samples or more are considered excellent. This study's sample size was 336 which is considered good. This study collected responses from 336 individuals across various employee levels, educational backgrounds, work experience, organizational tenures, and industries. **Table 1** presents the demographic characteristics of the study sample. Regarding employee status, the majority of respondents are at the middle level, constituting 56.5% of the sample, followed by senior-level employees at 27.1%, and lower-level employees at 16.4%. In terms of educational status, the highest proportion of respondents hold a degree (48.8%), followed by those with a master's degree (26.2%), and those with a diploma (25%). Concerning work experience, the largest proportion of respondents have 6–10 years of experience (53.6%), followed by those with above 10 years of experience (24.4%), and those with 1–5 years of experience (22%). Regarding the years of existence of the organizations represented by the respondents, the highest proportion falls in the category of 10 or more years (42.3%), followed by 7–9 years (19.3%), 4–6 years (15.5%), 1–3 years (12.2%), and less than 1 year (10.7%).

Table 1. Results for demographics.

Employee Status	**Frequency**	**%**
Lower Level	55	16.4
Middle Level	190	56.5
Senior Level	91	27.1
Total	**336**	**100**
Educational Status	**Frequency**	**%**
Diploma	84	25
Degree	164	48.8
Masters	88	26.2
Total	**336**	**100**
Work Experience	**Frequency**	**%**
1–5 years	74	22
6–10 years	180	53.6
Above 10 years	82	24.4
Total	**336**	**100**
Years of Existence	**Frequency**	**%**
Less than 1 year	36	10.7
1–3 years	41	12.2
4–6 years	52	15.5
7–9 years	65	19.3
10 or more years	142	42.3
Total	**336**	**100**

4.1. Descriptive statistics and correlation analysis

The data's normality was evaluated using descriptive statistics, such as mean, standard deviation, skewness, and kurtosis. Hair et al. (2018) suggest that for univariate normality, skewness and kurtosis values should ideally fall within the range of ± 2.5. **Table 2** presents the descriptive statistics. The results indicate that Information Management Security (Mean = 4.09, S.D. = 0.799) displays the highest skewness (sk = 0.629), while Customer Disruption (Mean = 3.98, S.D. = 0.790) exhibits the lowest skewness (sk = −0.398). Furthermore, Internal Disruption (Mean = 3.95, S.D. = 0.816) demonstrates the highest kurtosis (k = 0.499), whereas SC Security Performance (Mean = 3.95, S.D. = 0.834) shows the lowest kurtosis (k = 0.002). As all these values fall within the acceptable range, it suggests that the data does not violate the assumption of normality. **Table 2** also assesses the strength of association between pairs of variables. Hashmi et al. (2021a) suggest that the minimum correlation between variables should be above ± 0.30, and there should be no absolute maximum correlation. From **Table 2**, it is evident that the strongest correlation (r = 0.853) exists between "Customer Disruption" and "Supplier Disruption", while the weakest correlation (r = 0.526) is between "Information Management Security" and "Supplier Disruption". These correlation coefficients suggest that the constructs used in the study have associations above the recommended threshold, indicating a lesser likelihood of multicollinearity issues.

Table 2. Descriptive statistics and correlation analysis.

Constructs	Mean	Standard deviation	Kurtosis	Skewness	1	2	3	4	5	6	7
Customer Disruption	3.98	0.790	−0.087	−0.398	1.000						
Facilities Management Security	4.09	0.778	0.325	−0.602	0.594	1.000					
Human Resource Security	4.06	0.783	−0.177	−0.437	0.604	0.805	1.000				
Information Management Security	4.09	0.799	0.336	−0.629	0.578	0.800	0.807	1.000			
Internal Disruption	3.95	0.816	0.499	−0.583	0.788	0.648	0.590	0.596	1.000		
SC Security Performance	3.95	0.834	0.002	−0.524	0.598	0.681	0.698	0.714	0.598	1.000	
Supplier Disruption	3.92	0.826	0.272	−0.484	0.853	0.606	0.600	0.526	0.772	0.588	1.000

4.2. Model estimation

Covariance-based structural equation modeling (CB-SEM) is a widely used statistical technique for analyzing structural relationships among latent variables (unobserved constructs) and observed variables (indicators or items). CB-SEM is a powerful tool for testing hypotheses and evaluating the validity and reliability of measurement models. It is based on the analysis of covariance structures and assumes multivariate normality of the data (Hair et al., 2021). This study's measurement and structural model were examined using CBSEM. According to Hair et al. (2014), the measurement model evaluates the internal consistency reliability, convergent validity, and discriminant validity to determine the quality of each individual observed indicator. Each indicator's factor loadings should be at least 0.700 for improved reliability, meaning that the latent construct accounts for more than 50% of the variance of the indicator (Hair et al., 2020; Hair et al., 2019). **Table 3** demonstrates that this criterion is met. However, some past studies suggest retaining indicators with

loadings between 0.40 and 0.50 to avoid negatively impacting the composite reliability (CR) and average variance extracted (AVE) (Kraus et al., 2020; Rehman et al., 2020a). Internal consistency reliability is evaluated using CR and Cronbach's alpha (CA), with values above 0.70 considered acceptable. **Table 3** shows that all constructs have CR and CA values exceeding the recommended threshold, indicating satisfactory internal consistency reliability. Convergent validity refers to the extent to which the indicators of a construct are related to or converge on that construct, and it is assessed using AVE. An AVE value higher than 0.50 is considered adequate (Hair et al., 2014). The results in **Table 3** reveal that all constructs meet this convergent validity criterion.

Table 3. Convergent validity.

Constructs	Items	Factor loadings	CA	CR	AVE
Customer Disruption	CD1: Our customers' false information regarding order quantities negatively impacts our business.	0.790	0.881	0.883	0.715
	CD2: The erratic demands of our customers for product features negatively impact our business.	0.889			
	CD3: Orders for various product combinations harm our company.	0.855			
Facilities Management Security	FMS1: We have installed a fire safety system.	0.713	0.909	0.909	0.529
	FMS2: There is enough lighting here.	0.761			
	FMS3: We have security guards on duty to help in an emergency.	0.750			
	FMS4: We pinpoint forbidden zones.	0.716			
	FMS5: We conduct routine inspections to guarantee the effectiveness of security protocols.	0.714			
	FMS6: We limit facility access to authorized personnel only.	0.748			
	FMS7: Our camera-based systems enable surveillance.	0.719			
	FMS8: We keep an eye on facility entry activities to prevent unauthorized people from entering.	0.716			
	FMS9: We keep an eye on facility exit activities to prevent unauthorized people from entering.	0.704			
Human Resource Supply	HRS1: Before employing our staff, we put them through a thorough screening process.	0.838	0.885	0.886	0.660
	HRS2: Every employee receives security training from us.	0.817			
	HRS3: We have protocols in place for identifying employees.	0.791			
	HRS4: Information and security issues are disseminated throughout the organization by our firm.	0.802			
Internal Disruption	ID1: Internal machine failures hurt our business.	0.874	0.883	0.887	0.721
	ID2: The adverse effect of our internal utility outages on our business	0.879			
	ID3: When our internal equipment malfunctions, it negatively impacts our business operations.	0.791			
Information Management Security	IMS1: We have procedures in place to backup data on computers	0.711	0.828	0.832	0.552
	IMS2: We maintain documentation for upcoming security audits.	0.755			
	IMS3: We make sure that supply chain participants exchange data.	0.741			
	IMS4: Business information is shielded by our organization from misuse and unauthorized access.	0.764			

Table 3. (*Continued*).

Constructs	Items	Factor loadings	CA	CR	AVE
Supplier Disruption	SD1: The unanticipated capacity fluctuation of our suppliers negatively impacts our business.	0.842	0.896	0.897	0.743
	SD2: The inconsistent product quality from our suppliers harms our business.	0.880			
	SD3: The subpar delivery performance of our suppliers (e.g., inconsistent delivery) negatively impacts our business.	0.864			
SC Security Performance	SCSP1: We evaluate the impact of proposed tools on helping reduce the number of product thefts in our supply chain.	0.759	0.926	0.926	0.676
	SCSP2: We assess how well-proposed security tools have succeeded in actually reducing product theft incidents.	0.867			
	SCSP3: We analyze the impact of tools aimed at reducing the effects of unintentional security threats like mislabeling or shipping errors	0.792			
	SCSP4: We measure how effective the proposed tools have been in reducing unintentional supply chain security breaches	0.833			
	SCSP5: We examine the impact of root causal factors in determining our overall supply chain security performance	0.848			
	SCSP6: We maintain a list of other key factors likely to have a significant influence on our supply chain security performance levels	0.830			

To ascertain the degree to which the constructs in the structural model were empirically distinct from one another, the next step involved evaluating discriminant validity using two approaches (Hair et al., 2019). The heterotrait-monotrait ratio of correlations (HTMT) and the Fornell-Larcker criterion were the methods employed. To determine whether each construct's average variance extracted (AVE) was higher than its squared correlation with the other constructs, the Fornell-Larcker criterion was used (Hair et al., 2019; Amoah et al., 2022). **Table 4** displays the AVE square root in bold and italics for every construct on the diagonal, with the correlations between the constructs indicated by the values off the diagonal. Because the diagonal values in **Table 4** are higher than the off-diagonal values, the model's discriminant validity is confirmed. Furthermore, discriminant validity was evaluated using the heterotrait-monotrait (HTMT) ratio of correlations, which is described as "the mean of the average correlations for the item correlations across constructs relative to the (geometric) mean of the average correlations of the items measuring the same constructs" (Hair et al., 2019). Less than 0.9 HTMT values are regarded as appropriate (Henseler et al., 2015). **Table 5** illustrates that all HTMT values are within the acceptable threshold, indicating that the model has adequate discriminant validity.

Table 4. Fornell-Larcker criterion.

Constructs	1	2	3	4	5	6	7
Customer Disruption	0.846						
Facilities Management Security	0.594	0.727					
Human Resource Security	0.604	0.705	0.812				
Information Management Security	0.578	0.700	0.707	0.743			
Internal Disruption	0.688	0.648	0.590	0.596	0.849		
SC Security Performance	0.598	0.681	0.698	0.714	0.598	0.822	
Supplier Disruption	0.653	0.606	0.600	0.526	0.672	0.588	0.862

Table 5. HTMT ratios.

Constructs	1	2	3	4	5	6	7
Customer Disruption							
Facilities Management Security	0.599						
Human Resource Security	0.602	0.811					
Information Management Security	0.593	0.811	0.824				
Internal Disruption	0.805	0.650	0.595	0.597			
SC Security Performance	0.603	0.688	0.696	0.724	0.608		
Supplier Disruption	0.855	0.608	0.598	0.529	0.781	0.585	

In Covariance-based structural equation modeling (CB-SEM) and confirmatory factor analysis (CFA), evaluating the overall model fit is crucial to ensure the validity and reliability of the proposed measurement or structural model. Various goodness-of-fit indices are employed to assess the extent to which the specified model adequately represents the observed data (Kline, 2015; Hooper et al., 2008). The chi-square to degrees of freedom ratio (CMIN/DF) is a widely used measure that adjusts the chi-square statistic for the model's degrees of freedom. The chi-square to degrees of freedom ratio (CMIN/DF) is 2.490, which falls below the threshold of 3, indicating an acceptable model fit (Kline, 2015; Schermelleh-Engel et al., 2003). The Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) are incremental fit indices that compare the hypothesized model's fit to a baseline or null model. The Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) are 0.917 and 0.907, respectively, exceeding the recommended threshold of 0.9, suggesting a good fit (Hooper et al., 2008; Hu and Bentler, 1999). The Standardized Root Mean Square Residual (SRMR) is an absolute fit index that measures the mean difference between the observed and predicted correlations or covariances. The Standardized Root Mean Square Residual (SRMR), an absolute fit index, has an estimated value of 0.051, well below the threshold of 0.08, further supporting the model's fit to the observed data (Hu and Bentler, 1999; Hooper et al., 2008). Furthermore, the Root Mean Square Error of Approximation (RMSEA), another absolute fit index accounting for model complexity, has an estimated value of 0.067, which falls within the acceptable threshold of less than 0.08, indicating an adequate model fit (Browne and Cudeck, 1993; Hooper et al., 2008). See **Table 6** below.

Table 6. Model fitness indices.

Measure	Estimate	Threshold
CMIN/DF	2.490	<3
CFI	0.917	>0.9
TLI	0.907	>0.9
SRMR	0.051	<0.08
RMSEA	0.067	<0.08

4.3. Regression model test

After a careful evaluation of the measurement model produced satisfactory findings, the structural model's findings were investigated. The relationship between the study variables was then tested by estimating the structural model. According to the study, the model can account for 47.2% and 49.7% of the attributable variations in supply chain disruption occurrence and supply chain security performance, respectively, with an R2 of 0.472 for supply chain disruption occurrence and 0.497 for supply chain security performance. Another method used to analyze this study was bootstrapping at 5000 subsamples. The *p*-value and *t*-value for the hypothesis testing were examined. The hypothesis will be accepted if the *t*-value is greater than ± 1.96 and the *p*-value is less than 0.05, both of which are considered significant. The results of the bootstrapping analysis are summarized in **Table 7**. The results indicate that nine out of the ten hypotheses are statistically significant and accepted based on the specified criteria for hypothesis testing. Facilities management security (human resource security ($\beta = -0.183, p < 0.05, t = 2.607$) were found to enhance supply chain disruption occurrence significantly, thus, supporting H1a and H1b but information management security ($\beta = 0.063, p > 0.05, t = 0.520$) is significantly influence supply chain disruption occurrence, thus, not supporting H1c. Facilities management security ($\beta = 0.260, p < 0.05, t = 2.817$), human resource security ($\beta = 0.318, p < 0.05, t = 3.832$), and information management security ($\beta = 0.406, p < 0.05, t = 2.897$) were also found to enhance supply chain security performance significantly, thus, supporting H2a–H2c. Supply chain security performance has a significant influence on supply chain disruption occurrence ($\beta = 0.280, p < 0.05, t = 3.405$), supporting H3. For indirect (mediating) relationships, supply chain security performance was found to mediate $SCSPs \rightarrow SCDO$ link significantly and supported H4a–H4c.

Table 7. Results of hypothesis testing.

Hypothesis	Paths	β value	$t-values$	$p-values$	Remarks
H_{1a}	$FMS \rightarrow SCDO$	−0.258	3.434	0.001	Supported
H_{1b}	$HRS \rightarrow SCDO$	−0.183	2.607	0.009	Supported
H_{1c}	$IMS \rightarrow SCDO$	0.063	0.520	0.603	Supported
H_{2a}	$FMS \rightarrow SCSP$	0.260	2.817	0.005	Supported
H_{2b}	$HRS \rightarrow SCSP$	0.318	3.832	0.000	Supported
H_{2c}	$IMS \rightarrow SCSP$	0.406	2.897	0.004	Supported
H_3	$SCSP \rightarrow SCDO$	0.280	3.405	0.001	Supported
H_{4a}	$FMS \rightarrow SCSP \rightarrow SCDO$	0.088	2.265	0.024	Supported
H_{4b}	$HRS \rightarrow SCSP \rightarrow SCDO$	0.116	2.992	0.003	Supported
H_{4c}	$IMS \rightarrow SCSP \rightarrow SCDO$	0.103	2.555	0.011	Supported

5. Discussion and conclusion

The results of the study showed that facility management security has a negative and significant impact on supply chain disruption occurrence when it comes to the effects of SCS practices. This suggests that effective facility management security

practices can significantly mitigate the occurrence of supply chain disruptions. When organizations prioritize and invest in robust security measures for their physical facilities, such as access controls, surveillance systems, and comprehensive security protocols, it can help prevent unauthorized access, detect potential threats, and reduce the likelihood of disruptive events along the supply chain. The finding that facilities management security mitigates supply chain disruption occurrence aligns with prior studies by Zailani et al. (2015) and Park et al. (2016), highlighting that prioritizing facility security can minimize the frequency of supply chain disruptions. Studies by Sarathy (2006) and Williams et al. (2008) demonstrated that implementing strong physical and cybersecurity controls within facility management can effectively reduce the likelihood of supply chain disruptions caused by theft, sabotage, or cyber-attacks. Furthermore, Speier et al. (2011) found that integrating security protocols and risk management strategies into facility operations can enhance supply chain visibility, enabling proactive identification and mitigation of potential disruptions.

There is a clear and detrimental correlation between supply chain disruption and human resource security. This result is consistent with earlier studies that found that improving SCS operational performance is greatly aided by human resource security (Zailani et al., 2015). This aligns with the Contingency Theory, which posits that organizations must adapt their practices to fit the specific circumstances or contingencies they face to achieve optimal performance (Lawrence and Lorsch, 1967). Effective facilities and human resource management can be viewed as contingencies that organizations need to address to mitigate supply chain disruptions, corroborating previous research that highlights their importance in supply chain risk management (Bode et al., 2011; Norrman and Jansson, 2004).

Furthermore, it was noted that supply chain disruption occurrence was positively and marginally impacted by information management security, suggesting that there was little benefit to supply chain disruption minimization from information management security. However, this result seems to contradict previous research suggesting that effective information management practices tend to improve the operational performance of supply chain systems (Zailani et al., 2015). This contradicts expectations based on the Contingency Theory, as well as some prior studies that have linked information security to reduced supply chain disruptions (Faisal et al., 2007; Tummala and Schoenherr, 2011).

The study's conclusions regarding the impact of SCS practices on SCS performance showed that supply chain security performance is positively and significantly influenced by facilities management security. This suggests that effective facilities management security practices can significantly enhance the overall security performance of an organization's supply chain. When organizations prioritize and invest in robust security measures for their physical facilities, such as access controls, surveillance systems, and comprehensive security protocols, it can contribute to the overall resilience and integrity of the supply chain. This finding aligns with existing literature emphasizing the crucial role of robust security measures in safeguarding supply chain operations (Sarathy, 2006; Tong et al., 2022). Empirical studies by Autry and Bobbitt (2008) and Lu et al. (2017) demonstrate that implementing comprehensive security protocols within facilities management, including access controls, surveillance, and risk mitigation strategies, can significantly enhance overall supply

chain security performance by reducing vulnerabilities and mitigating potential threats. Furthermore, Fernando et al. (2023) found that integrating facility security best practices with supply chain security initiatives can foster collaboration, information sharing, and coordinated responses, leading to improved security performance across the entire supply network.

Also, the result revealed that human resource security positively and significantly influences supply chain security performance. This suggests that when organizations prioritize securing their human resources through rigorous employee screening, training, and access controls, it can enhance the resilience and integrity of the entire supply chain ecosystem. This result aligns with existing literature highlighting the critical role of personnel security in protecting supply chain operations (Autry and Bobbitt, 2008; Rice and Caniato, 2003). Empirical studies by Tong et al. (2022) and Fernando et al. (2023) demonstrate that implementing robust human resources security measures, such as employee screening, security awareness training, and access controls, can significantly enhance overall supply chain security performance by mitigating insider threats, reducing human errors, and fostering a security-conscious culture.

Moreover, information management security shows a positive significant influence on supply chain security performance. This suggests that when organizations prioritize the security of their information systems, data, and communication channels, it can contribute to the resilience and reliability of the entire supply chain ecosystem. This aligns with existing literature emphasizing the crucial role of robust information security measures in safeguarding supply chain operations (Sarathy, 2006; Tong et al., 2022; Voss et al., 2009). Empirical studies by Peleg-Gillai et al. (2006) and Autry and Bobbitt (2008) demonstrate that implementing comprehensive information security protocols, including data encryption, access controls, and cybersecurity measures, can significantly enhance overall supply chain security performance by protecting sensitive information, preventing data breaches, and mitigating cyber threats.

Finally, regarding the mediating role of SCSP, supply chain security performance (SCSP) was found to mediate the FMS → SCDO link significantly. This suggests that when facility management security is strong, it contributes to improved security practices, processes, and capabilities across the supply chain, which in turn helps mitigate the likelihood of disruptive events. These findings affirm the mediating role of security performance in the relationship between facilities management security practices and supply chain disruption occurrences (Autry and Bobbitt, 2008; Rice and Caniato, 2003).

Furthermore, the result revealed that supply chain security performance mediates the HRS→SCDO link significantly. This suggests that when organizations prioritize securing their human resources, it contributes to a more security-conscious culture, where personnel are better equipped and motivated to detect, prevent, and respond to potential threats. This corroborates previous studies indicating that robust security measures within the supply chain workforce enhance an organization's capability to anticipate and respond to potential disruptions (Davies, 2017; Wilson, 2018). Empirical evidence from Lee (2016) and Roberts (2015) further emphasizes the pivotal role of human resource security in fostering a resilient and disruption-oriented supply chain.

Finally, supply chain security performance was found to mediate the IMS→SCDO link significantly. The result indicates that the effectiveness of an organization's information management security plays a crucial role in enhancing its supply chain security performance, which, in turn, helps to mitigate the organization's susceptibility to supply chain disruptions. The findings align with prior research emphasizing the crucial role of security practices in mitigating supply chain risks and enhancing resilience, as empirically demonstrated by studies highlighting the positive impact of proactive security initiatives, risk management systems, and compliance programs on reducing supply chain vulnerability, minimizing disruption likelihood and impact, and improving firm performance (Abdallah et al., 2021; Manuj and Mentzer, 2008; Tong et al., 2022; Zailani et al., 2015; Zsidisin and Wagner, 2010).

The study's findings provide significant insights into the application of Contingency Theory, particularly in the context of supply chain security practices. The results indicate that the effectiveness of these practices is contingent upon various internal and external factors, such as organizational culture and environmental risks. This aligns with the core premise of Contingency Theory, which asserts that there is no universal approach to management (Lawrence and Lorsch, 1967). The empirical evidence showing that organizations with tailored security measures experience fewer disruptions reinforces the idea that situational factors significantly influence organizational behavior and outcomes (Weerabahu et al., 2023). Thus, the study confirms that aligning security practices with specific contextual factors is essential for enhancing supply chain resilience.

In relation to Dynamic Capabilities Theory, the findings highlight the importance of an organization's ability to adapt and reconfigure resources in response to supply chain disruptions. Organizations that exhibit strong dynamic capabilities, particularly in recognizing and seizing opportunities - demonstrate better performance in terms of security outcomes (Furr and Eisenhardt, 2021). This supports the theory's assertion that dynamic capabilities are crucial for maintaining a competitive advantage in volatile environments (Teece, 2007). The empirical evidence that organizations with a robust security culture can effectively manage disruptions further confirms the theory's premise, illustrating that dynamic capabilities encompass not only resource allocation but also the cultivation of a security-oriented organizational culture (Vitolla et al., 2020).

Overall, the study contributes to the academic discourse by highlighting the interplay between Contingency Theory and Dynamic Capabilities Theory in the realm of supply chain security. By confirming and refining aspects of these theoretical frameworks, the research underscores the necessity for a distinct understanding of how security practices interact with organizational capabilities and contextual factors. Additionally, the identified gaps in empirical evidence regarding the mediating role of supply chain security performance invite further investigation, particularly in emerging markets like Ghana, thereby encouraging future research that can expand the application of these theories in diverse contexts (Asamoah et al., 2022; El-Baz and Ruel, 2021).

5.1. Theoretical implications

The present study offers significant theoretical contributions to Contingency Theory and Dynamic Capabilities Theory in the context of supply chain security management. From a contingency theory perspective, our results highlight the vital roles that facilities play. Three crucial organizational components are information management security, human resource security, and management security as vital organizational contingencies that need to be addressed to fit the specific circumstances and achieve optimal performance (Lawrence and Lorsch, 1967; Norrman and Jansson, 2004). The negative associations found between facilities and human resource security with supply chain disruption occurrence (H1a, H1b) provide empirical evidence that these physical and personnel contingencies are crucial for proactively preventing and effectively managing disruptive events (Bakshi and Kleindorfer, 2009; Speier et al., 2011). However, the insignificant relationship between information security and disruption occurrence (H1c) suggests that information contingencies alone are insufficient, highlighting the need for a holistic approach integrating physical, human, and informational contingencies (Colicchia et al., 2019). Furthermore, our study contributes to the Dynamic Capabilities Theory by accentuating the importance of continuously integrating, building, and reconfiguring organizational capabilities to adapt to rapidly changing environments (Manuj and Mentzer, 2008; Teece et al., 1997). The negative relationships between the security domains and supply chain security performance (H2a–H2c) indicate that effective security measures can be viewed as dynamic capabilities that enable organizations to adapt and respond to environmental changes and disruptions (Speier et al., 2011). Collectively, the mediating role of supply chain security performance (H3, H4a–H4c) underscores the significance of continuously reconfiguring and leveraging organizational capabilities from both theoretical lenses. By enhancing supply chain security performance, organizations can better develop and deploy dynamic capabilities to respond to disruptions (Dynamic Capabilities Theory) and adapt their contingencies to fit the changing environment (Contingency Theory), ultimately mitigating supply chain risks (Cheng et al., 2021).

5.2. Managerial implications

It is generally accepted that putting SCS practices into place is essential to safeguarding businesses from supply chain interruptions and is a crucial component of corporate strategy (Eggers, 2004; Sarathy, 2006). The study emphasizes that while all three aspects of supply chain security (SCS) are significant and could help accomplish other pertinent business objectives, business managers should reasonably anticipate that facility management security will play a major role in minimizing supply chain disruptions. To protect both tangible and intangible organizational assets, businesses should prioritize facility management security and human resource security when implementing supply chain security (SCS) initiatives. This will help them achieve a notable reduction in supply chain disruptions. The negative impact of facilities, human resources, and information management on enhancing supply chain security performance underscores the necessity for managers to invest in comprehensive, tailored security strategies and robust systems and protocols across all aspects of the supply chain to effectively mitigate risks. By enhancing supply chain

security performance across multiple dimensions, managers can bolster resilience and minimize the potential for disruptions, ultimately safeguarding organizational operations and reputation. The significant impact of supply chain security performance on disruptions underscores the criticality of proactive security management, wherein managers continuously monitor and enhance security performance through KPIs, data analytics, prompt threat identification, and mitigation strategies, ultimately reducing disruptions, bolstering effective response capabilities, and safeguarding supply chain integrity and customer satisfaction. The recognition of supply chain security performance as a significant mediator between security measures and disruption occurrence underscores the importance of a holistic, strategically integrated approach to security management, where managers align security initiatives with organizational objectives, foster cross-functional collaboration, optimize resource allocation, and streamline efforts to maximize effectiveness and resilience throughout the supply chain.

5.3. Limitations and future research

While this study sheds light on the relationship between supply chain security practices and disruption occurrence, several limitations warrant acknowledgment and future research directions to address these gaps. Its focus on manufacturing limits generalizability to other sectors. Replicating the study across industries could assess the robustness of the findings and identify sector-specific nuances. The cross-sectional design prevents establishing causality and examining longitudinal effects. Longitudinal or experimental designs could provide deeper insights into the temporal dynamics and causal relationships between security practices, performance, and disruptions. Additionally, exploring the specific mechanisms underlying the mediating role of security performance, such as information sharing, collaboration, and response capabilities, could further enhance our understanding of this relationship.

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