Supply Chain Risk Management Practices: The Strategic Pathways to Enhanced Sustainability Performance of Ghanaian Firms

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Abstract

This study examines how supply chain risk management (SCRM) practices influence the sustainability performance (SUSP) of Ghanaian manufacturing SMEs. Focusing on five key dimensions—Risk Identification (RID), Risk Assessment (RA), Risk Mitigation (RM), Risk Continuous Improvement (RCI), and Risk Performance (RP) evaluation — the research uses a quantitative approach with data from 304 firms in Ghana's Ashanti Region. Data were collected via structured questionnaires and analysed using Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS software. The results show that all five SCRM dimensions have a significant and positive impact on sustainability outcomes, with Risk Performance having the greatest impact. The study concludes that SMEs adopting comprehensive and structured risk management practices are more likely to achieve environmental, social, and economic sustainability while strengthening their operational resilience. Therefore, SMEs should integrate comprehensive risk identification mechanisms, adopt structured risk assessment frameworks, institutionalise coordinated risk management systems, cultivate a continuous improvement culture, and develop performance indicators to monitor the effectiveness of risk management as strategic pathways to enhanced sustainability performance.

Key words: Supply chain, risk management, sustainability performance, Ghana, SMEs.

Introduction

In the current unstable global business landscape, Supply Chain Risk Management (SCRM) has become a vital strategic ability, especially for small and medium-sized enterprises (SMEs) in the manufacturing sector. These businesses are more susceptible to disruptions because they often have fewer resources and less flexibility in their structures, as noted by Wieland and Wallenburg (2012). SCRM refers to the systematic identification, assessment, and mitigation of risks within a supply chain to reduce vulnerabilities and ensure operational continuity. These risks may be operational (e.g., supplier failures), environmental (e.g., climate-related events), or socio-political (e.g., policy changes), and their effective management enables firms to maintain stable operations and respond effectively to disruptions (Fan et al., 2017).

SMEs form the backbone of Ghana's private sector, making significant contributions to job creation, income generation, and economic growth (Abor & Quartey, 2010). However, they operate in an increasingly complex and turbulent environment characterised by frequent supply chain disruptions, infrastructure deficits, fluctuating market demands, resource constraints, and regulatory uncertainties (Acheampong & Boateng, 2022). These risks can undermine sustainability performance. Sustainability performance, in the context of supply chain management, refers to an organisation's ability to achieve objectives related to the triple bottom line: economic efficiency, environmental protection, and social equity (El Baz & Ruel, 2021). Sustainable supply chains are those that balance profitability with environmental stewardship and social responsibility, contributing to both firm-level resilience and broader developmental goals (Kleindorfer et al., 2005).

Traditionally, risk management has been approached from an enterprise-wide perspective, integrating methodologies such as the ISO 31000 framework to harmonise diverse practices (Almeida et al., 2019). Over time, the field has expanded to include both reactive measures—addressing incidents post-occurrence—and proactive strategies focused on early detection of potential threats (Baryannis et al., 2018). Foundational works by Wagner and Bode (2008) and Bernstein and Bernstein (1996) further emphasise the dynamic nature of risk and the importance of considering both internal and external sources of disruption.

With globalisation, supply chains have become more complex and interdependent, exposing firms to multifaceted risks that require sophisticated risk management models (Ho et al., 2015; Pournader & Kach, 2020). Supply chain risk mapping, typically a four-step process—identification, evaluation, mitigation, and control—has become essential for navigating these interdependencies (Lufika et al., 2022). Case studies, such as Ericsson's proactive approach following a sub-supplier disruption, underscore the importance of anticipating risks (Norrman & Jansson, 2004).

In response to these challenges, the integration of key SCRM practices—Risk Identification, Risk Assessment, Risk Mitigation, Risk Continuous Improvement, and Risk Performance Evaluation—is essential to support SMEs' pursuit of sustainability goals. Risk Identification involves systematically recognising and documenting potential hazards that may negatively impact an organisation's objectives (Siraj & Fayek, 2019; Tchankova, 2002). Risk Assessment entails evaluating

the likelihood and consequences of identified risks to prioritise response strategies (Aven, 2016), while Risk Mitigation is the process of implementing actions to reduce the impact or likelihood of adverse events (Chang et al., 2015). In addition, Risk Continuous Improvement involves the ongoing enhancement of risk management processes through the use of feedback and performance data (Galli, 2020). Risk Performance on the other hand reflects an organization's ability to manage and address risks that impact its operations and strategic goals (Zsidisin & Ritchie, 2008).

Although research on sustainable supply chain management is growing, most empirical studies still focus on multinational companies in developed countries. There is limited evidence on how SMEs in developing economies, including Ghana, manage sustainability in their supply chains (Ojha et al., 2018; Scholten et al., 2019). Most businesses in Ghana are SMEs, and they make up more than 90% of all firms. These enterprises are highly exposed to supply chain disruptions and face strong pressure to operate sustainably. Although awareness of sustainability is increasing among Ghanaian SMEs, many still struggle to meet sustainability targets. Their efforts are often affected by weak risk management systems and limited institutional support (Acheampong & Boateng, 2022).

Moreover, implementing robust SCRM practices poses challenges, including organisational inertia, resource limitations, and integration of disparate data sources (Choudhary et al., 2022). Cybersecurity threats, cognitive biases, and inconsistencies in risk perception further complicate risk strategy execution (Hubbard & Seiersen, 2023; Sato et al., 2020). Addressing these issues requires investments in both technology and training to foster an organisational culture of risk awareness (Park et al., 2016). The lack of empirical evidence on how SCRM influences sustainability outcomes in Ghanaian SMEs creates uncertainty for managers and policymakers. Without a cohesive risk management framework, many SMEs experience operational inefficiencies, unanticipated costs, and reduced competitiveness, ultimately undermining their long-term viability (Aduhene-Chinbuah & Peprah, 2024; Ganiyu, 2025). Addressing this knowledge gap is essential for building resilience and enabling SMEs to navigate complex business environments.

This study investigates the extent to which supply chain risk management practices influence the sustainability performance of Ghanaian SMEs. It specifically examines how risk identification, risk assessment, and risk mitigation impact economic, environmental, and social outcomes. The study contributes theoretically by integrating risk management and sustainability frameworks within an SME context in a developing economy. Practically, it offers actionable insights for managers and policymakers aimed at enhancing operational resilience and long-term sustainability.

The study reveals several important findings regarding the relationship between supply chain risk management practices and sustainable performance among manufacturing SMEs in Ghana's Ashanti Region. Risk identification was found to significantly enhance sustainability performance by enabling early detection of potential disruptions. Risk assessment contributes to better decision-making through systematic evaluation of risk likelihood and impact. Risk mitigation strategies demonstrate substantial positive

effects on sustainability outcomes by addressing threats proactively. Continuous improvement in risk management processes strengthens organizational adaptability to emerging sustainability challenges. Notably, risk performance exhibited the strongest influence on sustainable performance, indicating that achieving risk-related objectives serves as a critical lever for sustainability advancement.

Methodologically, this study employed a quantitative research design using Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyse data from 304 manufacturing SMEs. Stratified random sampling was used to ensure representation across eight manufacturing sub-sectors. The study utilized validated measurement scales adapted from previous research. PLS-SEM was selected for its ability to handle complex models with multiple constructs while accommodating non-normal data distributions. This approach enabled rigorous testing of the relationships between five dimensions of supply chain risk management practices and sustainable performance.

This study makes three key contributions to the literature. First, it extends the theoretical understanding of how specific risk management practices influence sustainability outcomes in resource-constrained SME contexts, addressing a gap in existing literature that predominantly focuses on large enterprises. Second, it provides empirical evidence from a developing economy context, specifically Ghana, where manufacturing SMEs face unique supply chain challenges. Third, it offers practical insights for policymakers and industry practitioners by identifying which risk management practices have the strongest impact on sustainability performance, thereby guiding resource allocation and intervention priorities.

The remainder of this paper is organised as follows: The literature review discusses relevant theories and empirical findings, forming the basis for hypothesis development. The methodology section outlines the research design and data collection procedures. This is followed by the results section, which presents the study's findings. The discussion interprets these findings with regard to existing literature. Finally, the conclusion summarises key insights and offers policy recommendations, study limitations, and avenues for future research.

Literature Review

Theoretical review

Dynamic Capabilities Theory

Dynamic capabilities theory is a framework in strategic management that explains how organisations adapt to rapidly changing environments by reconfiguring their resources and competencies (Bleady et al., 2018). It builds on the resource-based view of the firm; however, it emphasises that merely possessing valuable resources is not sufficient to achieve sustainable competitive advantage (Gremme & Wohlgemuth, 2017). Firms must develop the ability to sense opportunities and threats in their environment, seize emerging opportunities by mobilising resources, and reconfigure or transform their existing resource base (Vu, 2020). With supply chains, dynamic capabilities are essential in helping organisations anticipate, sense, and respond to disruptions caused by various risks (Land et al., 2022). These capabilities facilitate the integration of new technologies and innovative practices into supply chain operations, thus enhancing resilience and agility (Wang et al., 2020). The relationship between dynamic capabilities and risk management in supply chains becomes particularly significant when considering

the complexities of the modern business environment (Gani et al., 2023). Furthermore, Yan et al. (2022) emphasise that the ability to coordinate and synchronise activities across the supply chain is a core component of dynamic capabilities that directly impacts firm performance. Moreover, dynamic capabilities play a pivotal role in enhancing supply chain resilience, which is defined as the ability to prepare for and respond to disruptive events (Barhmi, 2023).

Resource-Based View (RBV) Theory

The Resource-Based View (RBV) originated from the work of Penrose in 1959, who argued that firms grow by effectively utilising their internal resources. The theory was later formalised by Wernerfelt in 1984 and advanced by Barney in 1991, who positioned RBV as a leading framework for explaining why some firms achieve superior performance (Sousa et al., 2021). RBV asserts that organisations gain competitive advantage when they possess valuable, rare, inimitable, and non-substitutable resources (Purnomo, 2024). These resources may include tangible assets, intangible capabilities, knowledge, and organisational processes that competitors cannot easily replicate (Iruthayasamy, 2021). The theory emphasises that internal strengths, rather than external market conditions, form the foundation of long-term competitiveness (Lubis, 2022). RBV further assumes that resources are heterogeneously distributed across firms and that such differences persist over time because some resources are difficult to transfer or copy (Salmi et al., 2024). It also assumes that firms are capable of identifying, developing, and protecting their strategic assets in order to maintain advantage (El Nemar et al., 2025).

From the RBV perspective, risk management practices represent strategic organisational capabilities that enable firms to anticipate, withstand, and recover from disruptions. These capabilities become valuable resources because they reduce vulnerability, enhance supply chain stability, and support long-term sustainability performance (Chao, 2024). RBV suggests that risk management should not be seen as a generic process, but rather as a strategic activity that leverages a firm's distinctive resources—such as knowledge, technology, and human capital—to identify, assess, and mitigate risks effectively (Mishra et al., 2019). When firms develop strong risk assessment systems, supplier monitoring structures, and mitigation strategies, these practices evolve into inimitable competencies that competitors cannot easily replicate, giving the organisation a sustained advantage (Naseer et al., 2017). In environments characterised by uncertainty, effective risk management becomes a rare and strategic internal capability that protects the firm from operational failures and environmental fluctuations (Bogodistov & Wohlgemuth, 2017). RBV therefore explains that organisations with well-developed risk management routines possess unique internal strengths that directly enhance their resilience, efficiency, and sustainability outcomes (Jaber & Hamoud, 2018).

Stakeholder Theory

Stakeholder Theory was introduced by Freeman in 1984 as a response to traditional views that prioritised shareholders over other parties involved in organisational activities (Mahajan et al., 2023). The theory argues that organisations exist within a network of relationships involving various stakeholders, including employees, customers, suppliers, communities, and regulators (Freeman, 2023). Its central premise is that long-term

success depends on understanding and balancing the interests of all stakeholders rather than focusing solely on profit maximisation (Barney & Harrison, 2020). The core components of the theory include identifying relevant stakeholders, analysing their needs and expectations, and integrating these interests into organisational decision-making (Goyal, 2022). It emphasises mutual value creation, ethical conduct, and accountability in managing relationships (Freudenreich et al., 2020). Stakeholder Theory assumes that stakeholders have legitimate claims on organisational actions and that their interests can affect or be affected by corporate behaviour (Dmytriyev et al., 2021). It also assumes that organisations operate in complex environments where cooperation and trust are essential for stability (Kivits & Sawang, 2021). The theory further assumes that addressing stakeholder concerns enhances organisational legitimacy and sustainability (Jones et al., 2018).

Stakeholder theory provides a useful foundation for understanding supply chain risk management practices by emphasising the need to consider the interests and expectations of all parties who can influence or be influenced by organisational actions (Jum'a et al., 2024). In supply chains, stakeholders such as suppliers, customers, employees, regulators, communities, and investors play critical roles in shaping risk exposure and determining effective responses (Oliveira et al., 2023). The theory suggests that firms can reduce vulnerabilities and enhance sustainability performance when they actively engage stakeholders, understand their risk-related concerns, and incorporate their input into decision-making processes (Landolo et al., 2025). It argues that risks often emerge from misaligned interests, weak communication, and failure to address stakeholder expectations. Therefore, effective risk management requires collaboration, transparency, and trust across the supply chain network (Dao & Phan, 2023). Stakeholder theory assumes that firms have a responsibility to manage risks in ways that protect stakeholder interests and maintain long-term relationships (Pradesa et al., 2021). It also assumes that addressing stakeholder concerns enhances legitimacy and strengthens the resilience of the supply chain (Battaglia et al., 2025).

Empirical review

Risk identification and sustainable performance

Risk identification is the foundational component of any risk management framework. It involves systematically detecting potential sources of risk that could affect an organisation's objectives (Wiengarten et al., 2016). In today's environment, the scope of risk identification extends beyond traditional financial or operational risks to include strategic risks, reputational risks, cybersecurity threats, and other risks emerging from supply chain disruptions (Deiva Ganesh & Kalpana, 2022). For instance, supply chain risk management has evolved to incorporate geopolitical tensions or pandemics, which can lead to long-term impacts on production and customer service delivery (Reynolds, 2024). The use of new technologies such as artificial intelligence and advanced analytical tools is also improving how organisations detect risks. These technologies help firms analyse large and complex datasets and identify unusual patterns before they develop into major problems (Baryannis et al., 2018). Integrating risk identification into business process modelling also helps managers detect risks early. This approach allows them to build risk detection into their strategic activities and reduce potential

weaknesses before they occur (Bojanić & Stevanov, 2023). Effective risk identification enables organisations to anticipate potential challenges and integrate risk mitigation strategies, thereby promoting long-term sustainability (Buganova et al., 2021). According to Ismael and Shealy (2018), systematic risk identification leads to better project outcomes by allowing organisations to navigate uncertainties present in complex environments. Based on the above empirical evidence, we propose the following hypothesis:

H1: There is a significant relationship between risk identification and sustainability performance.

Risk assessment and sustainable performance

Risk Assessment is critical in evaluating the likelihood and potential impact of identified risks. This phase involves qualitative and quantitative methods to measure risk severity and prioritise resource allocation (Kwak et al., 2018). The analytical techniques employed in risk assessment range from traditional risk matrices to advanced statistical models and decision support systems, which help contextualise risks relative to an organisation's strategic objectives (Choudhary et al., 2022; Tarei et al., 2020). In practice, organisations in different sectors, including supply chain management and the medical devices industry, now use comprehensive assessment frameworks. These frameworks help them estimate both how likely a risk is to occur and how much damage it could cause if it happens (Sharma & Luthra, 2023).

In the medical device industry for instance, risk analysis plays a critical role in meeting safety and regulatory requirements. Firms are required to comply with frameworks such as the EU Medical Device Regulation (EU MDR) 2017/745, which sets standards for the production, marketing, and distribution of medical devices in the EU (Sharma & Luthra, 2023). Similarly, in critical civil infrastructure like energy and urban fire risk management, frameworks integrating resilience assessment with risk evaluation enable authorities to plan effective preventive and reactive measures (Leal et al., 2022). According to Zio (2018), risk assessment is the systematic process of evaluating vulnerabilities to potential threats and proposing appropriate solutions to minimise an organisation's overall risk exposure. Miemczyk and Luzzini (2019) stress the importance of aligning supply chain risk assessment with the Triple Bottom Line (TBL) framework to enhance both resilience and sustainability. Duong et al. (2023) assert that incorporating risk assessment into infrastructure planning significantly improves project lifecycle sustainability by reducing cost overruns and delays. Choudhary et al. (2022) emphasise that while risk assessment in supply chains generates prioritised risks, these priorities remain unclear until appropriate evaluation criteria are established. Thus, the proposed hypothesis is that:

H2: There is a significant relationship between risk assessment and sustainability performance.

Risk mitigation and sustainable performance

Risk Mitigation, which ensues after a thorough assessment, focuses on developing and implementing strategies to reduce the frequency or impact of adverse events. This step is particularly challenging as it requires organisations to balance cost considerations with the need for robust safeguards (Kern et al., 2012). Effective risk

mitigation strategies may include diversifying supply sources, enhancing cybersecurity measures, enacting regulatory compliance protocols, or investing in technological innovations to fortify operations against disruptions (Reynolds, 2024). In supply chain management, companies have adopted multifaceted risk mitigation strategies that involve establishing contingency plans, diversifying supplier bases, and building redundant systems (backup components or processes) to absorb potential shocks (DuHadway et al., 2019). In a similar vein, the integration of risk mitigation strategies into business process models has enabled organisations to proactively adjust their operations to pre-empt risk materialisation, thereby preserving operational continuity (Bojanić & Stevanov, 2023). Real-world cases, such as the comprehensive risk treatment process observed in an educational institution, illustrate how systematic mitigation efforts can substantially lower risk levels by continuously refining process design and response outcomes (Sari & Setyaningrum, 2022). The iterative nature of these processes, which often incorporate feedback from performance evaluations, further enhances the robustness of mitigation measures and underpins long-term organisational resilience.

One significant approach to risk mitigation is the development of supplier relationships, which involves supplier-development initiatives that can positively influence supply risk management performance (Kumar et al., 2018). According to Sağlam et al. (2020), such activities are critical in reducing uncertainties and overall risks within supply chains. For instance, establishing strong relationships with suppliers enables better communication and collaboration, which are essential for identifying and mitigating risks proactively (Um & Han, 2020). Firms exhibiting a coordinated approach to risk management can foster a culture where risks are systematically identified and addressed; thus enhancing their overall supply chain performance (Huong Tran et al., 2016; Rajagopal et al., 2017). Similarly, Manhart et al. (2021) propose buffering and bridging as two generic but distinct risk mitigation strategies invoked by firms to manage and prepare for the occurrence of supply chain risk. Chang et al. (2015) argue that there is no single risk mitigation strategy that is universally effective; rather, the appropriateness of a strategy depends on the specific environmental factors surrounding a supply chain. Based on the above-presented empirical evidence, we propose the hypothesis below:

H3: There is a significant relationship between risk mitigation and sustainability performance

Risk continuous improvement and sustainable performance

Risk Continuous Improvement is a critical component that ensures the risk management process remains dynamic and adaptive in the face of continuous change (Mayer et al., 2016). A static risk management system is inadequate when dealing with rapidly evolving threats and shifting market conditions (Kwak et al., 2018). The incorporation of technological innovations, such as data analytics, machine learning, and simulation models, facilitates the continuous monitoring and analysis of risk data, allowing adjustments to be made proactively (Baryannis et al., 2018; Zou et al., 2017). For example, enterprises in the Fast-Moving Consumer Goods (FMCG) sector are increasingly integrating behavioural science into operational risk management frameworks to address decision-making biases and social dynamics, thus enhancing their overall adaptability and performance (Asuzu,

2024). Furthermore, supply chain management-related firms have benefited from continuous improvement by systematically reviewing risk events and updating their risk registers and contingency plans based on lessons from previous disruptions (Tummala & Schoenherr, 2011). This ongoing process not only minimises the recurrence of errors but also contributes to a culture of resilience, where risk management evolves as a central strategic function rather than a reactive or ad hoc exercise (McMaster et al., 2020). Lepistö et al. (2022) emphasise that continuous risk management facilitates the realisation of profitability by helping firms implement continuous improvement methods that address vulnerabilities identified in risk assessments. According to Havierniková and Betáková (2020), effective continuous risk management enhances business resilience, but many SMEs fail to integrate structured risk management due to limited financial and human resources. Zighan and Ruel (2023) describe how continual improvements create an adaptable culture that empowers SMEs to absorb changes and prevail over time. Kalogiannidis et al. (2024) highlight that artificial intelligence can enhance predictive risk assessments, allowing firms to better prepare for and respond to potential disruptions, ultimately leading to improved business continuity and performance. We therefore hypothesise that:

H4: There is a significant relationship between risk continuous improvement and sustainability performance.

Risk performance and sustainable performance

Risk Performance evaluation is a critical component of the risk management process (Khameneh et al., 2016). It involves the continuous measurement of the effectiveness of risk management strategies and the overall risk posture of the organisation (Florio & Leoni, 2017). Risk performance reflects how effectively risk management practices reduce uncertainty and potential losses while supporting organisational objectives (Ghazieh & Chebana, 2021; Ritchie & Brindley, 2007). Robust performance evaluation metrics enable organisations to compare anticipated risk mitigation results with actual outcomes, thereby identifying gaps between planned responses and real-world performance. This allows for timely recalibration of strategies to keep pace with evolving threats (Balaji et al., 2024). In the context of supply chain risk minimisation, risk performance encompasses the ability to anticipate potentially disruptive events, implement appropriate risk mitigation strategies, and ensure the robustness of supply chain operations (Sukwadi & Caesar, 2022). For instance, empirical studies have shown that effective performance evaluation frameworks in supply chain risk management can significantly reduce the financial and operational impacts of disruptions by enabling faster recovery and more strategic decision-making (Abbadi & Ahmad, 2021; Bracci et al., 2024)

Research indicates that companies engaging in corporate social responsibility (CSR) activities tend to enjoy better financial conditions, including reduced default risks and improved financial sustainability, as these initiatives attract investors looking for lower-risk opportunities (Cheng et al., 2014). Integrating sustainability into risk management provides long-term benefits, encouraging organisations to adopt a proactive approach rather than managing risks reactively as they arise (Yazo-Cabuya et al., 2024). Such strategies often lead to improved operational efficiencies, reduced costs, and greater resilience against market fluctuations (Silvius, 2018). Moreover,

firms that embrace sustainability-oriented risk management practices are better equipped to navigate regulatory changes and shifts in consumer preferences, both of which can affect their operational viability (Truong Quang & Hara, 2017). The alignment of sustainability objectives with risk management enhances risk assessment frameworks and fosters innovative practices within the organisation (Schulte & Hallstedt, 2018; Shad et al., 2019). Giannakis and Papadopoulos (2016) indicate that managing supply chain sustainability through effective risk assessment not only addresses sustainability-related risks but also promotes cost efficiency and competitive advantage. Additionally, the findings from Multaharju et al. (2017) illustrate that risk management strategies can effectively balance environmental concerns with operational resilience, thereby aligning sustainability objectives with robust risk frameworks in shipping and logistics. Based on the empirical evidence presented above, we propose the hypothesis below:

H5: There is a significant relationship between risk performance and sustainability performance.

Conceptual framework

The conceptual framework in Figure 1 below illustrates how key supply chain risk management practices collectively drive sustainability performance. It shows a sequential but interconnected process. Risk identification enables firms to recognise potential disruptions across the supply chain. Risk assessment follows by evaluating the likelihood and impact of these risks. Risk mitigation involves implementing strategies that reduce or eliminate identified threats. Risk continuous improvement ensures that risk processes are reviewed and enhanced over time. Risk performance reflects how effectively these practices function to maintain supply chain stability. Together, these components strengthen a firm's capacity to prevent, manage, and recover from risks. The framework proposes that when firms consistently apply these practices, they improve operational resilience and resource efficiency. This, in turn, enhances sustainability performance by supporting long-term environmental, social, and economic outcomes.

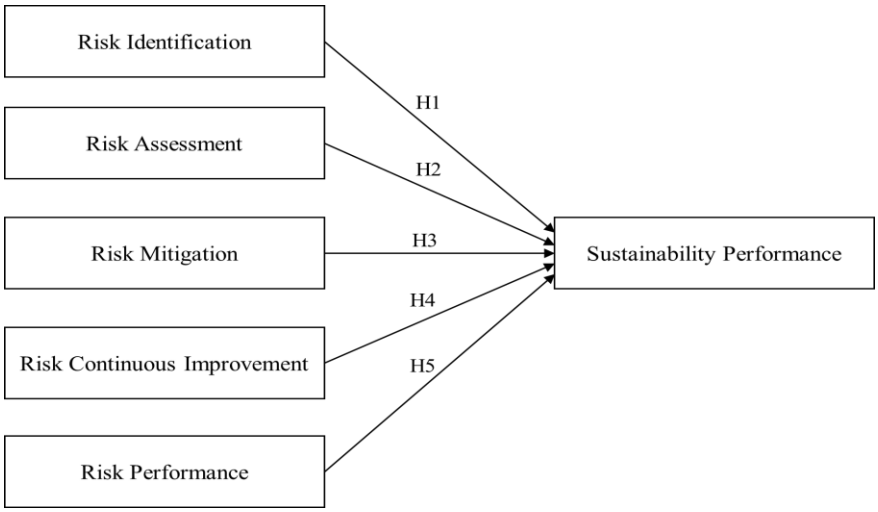

Figure 1: Conceptual Model
Source: Authors' Construct.

Methodology

Population and sample

The study specifically targeted managers of Small and Medium-sized Enterprises (SMEs) operating in Ghana's Ashanti Region. The Region was purposefully selected due to its diverse and vibrant industrial landscape, which offers a representative context for examining supply chain dynamics. By concentrating on the manufacturing sector within the broader field of supply chain management, the study aimed to generate rich and contextually grounded insights into the implementation and effectiveness of Supply Chain Risk Management Practices (SCRMP) among SMEs. This approach was considered appropriate for capturing sector-specific risks and mitigation strategies prevalent in a key economic hub. Manufacturing SMEs were specifically targeted because they operate in an increasingly complex and turbulent environment characterised by frequent supply chain disruptions, resource constraints, and regulatory uncertainties (Acheampong & Boateng, 2022). These conditions make it imperative for SMEs to adopt effective strategies to manage supply chain risks and enhance their sustainability performance.

To ensure a representative and sectorally diverse sample, 400 manufacturing firms were selected from those registered with the Ghana Chamber of Commerce and the Association of Ghana Industries (AGI) using a structured (probability) sampling approach. This study employed a stratified random sampling technique to ensure representative coverage across the diverse manufacturing sub-sectors within Ghana's Ashanti Region. Stratified random sampling was considered the most appropriate approach given the heterogeneous nature of the manufacturing sector and the need to capture sector-specific variations in supply chain risk management practices. The use of stratified random sampling offered several methodological advantages for this study. First, it enhanced the precision of estimates by reducing sampling error, as within-stratum variance is typically lower than population variance (Singh & Masuku, 2014). Second, it ensured representation across all key manufacturing sub-sectors, allowing for meaningful sub-group analysis and comparison (Cohen, 2025). Third, the probability-based nature of the sampling technique strengthened the external validity of the findings, enabling generalization to the broader population of manufacturing SMEs in the Ashanti Region (Latpate et al., 2021).

The population was divided into eight distinct strata corresponding to major manufacturing sub-sectors: (1) Food and Beverage, (2) Textiles (Apparel and Garments), (3) Paper and Paper Products, (4) Pharmaceuticals and Chemicals, (5) Rubber and Plastics, (6) Furniture, (7) Automotive (Assembly and Repair), and (8) Electricals (Metal and Fabricated Metals) (see Table 1). This stratification was undertaken to ensure that each manufacturing sub-sector was adequately represented in the final sample, thereby enhancing the generalizability of the findings across the broader manufacturing SME landscape. All firms met the following SME criteria: independent and non-affiliated (Boso et al., 2013; Wiklund & Shepherd, 2011); majority-owned by entrepreneurs (Goedhuys & Sleuwaegen, 2010); employ 5–500 employees (Wiklund & Shepherd, 2011); involved in manufacturing or productive services with at least 5 years of operation (Morgan et al, 2012); with verifiable executive contacts (Khavul et al., 2010).

Table 1: Percentage of Firms by Manufacturing Sectors

Sector	% of Firms
Food/beverage	24
Textiles (apparel & garments	26
Paper/paper products	5
Pharmaceuticals/chemicals	5
Rubber/ plastics	7
Furniture	17
Automotive (assembly & repair)	6
Electricals (metal & fabricated metals)	10

Source: Authors' Construct

Instrument development

In developing the methodology, the scale development procedures outlined by Boateng et al. (2018) were followed, beginning with a comprehensive literature review to understand existing measurement constructs. All items in our measurement instrument were adapted from previous studies and modified to align with our specific research context. The data collection tool consisted of a closed-ended questionnaire structured into seven distinct sections. The first section gathered demographic information about participating firms, including industry type, ownership structure, organisational size, and employee count. The second section examined risk management practices, with statement items adapted from Kern et al. (2012), categorising these practices into five sub-groups: Risk Identification, Risk Assessment, Risk Mitigation, Risk Continuous Improvement, and Risk Performance. The third section addressed sustainable performance measures, drawing from the work of Salvador et al. (2023) and Adam et al. (2014). Respondents rated their perception of each measurement item on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Data collection

Of the firms invited to participate via telephone and email, 382 agreed to take part in the study, reflecting a high initial acceptance rate. Before administering the survey, informed consent was obtained from both the firms and the individual respondents, thereby ensuring adherence to ethical research protocols. The data collection took place over four months, from October 2024 to January 2025. During this period, all 382 consenting respondents were invited to complete a structured questionnaire. Upon completion of the data collection phase, a total of 382 questionnaires were returned. However, 78 responses were excluded due to incomplete data or missing critical information, resulting in 304 valid and analysable responses. This yielded a final effective response rate of 79.58%, which is considered robust for survey-based research in organisational settings.

Data analysis

The raw questionnaire data were initially entered into Microsoft Excel and subsequently imported into the Statistical Package for Social Sciences (SPSS) for descriptive statistical analysis. To conduct inferential analysis, the study employed Partial Least Squares Structural Equation

Modeling (PLS-SEM) using SmartPLS 4 software. The choice of PLS-SEM was strategically informed by its methodological advantages, particularly in contexts involving relatively small sample sizes. Unlike Covariance-Based SEM (CB-SEM), which emphasises model fit, PLS-SEM prioritises the predictive accuracy of the model, making it especially suitable for exploratory studies or those with limited data availability. Additionally, PLS-SEM is capable of handling non-normal data distributions and is appropriate for ordinal or Likert-scale variables, both of which were features of the current study's data. A key consideration in the application of PLS-SEM is the sample size requirement, which suggests that the number of observations should exceed ten times the highest number of structural paths directed at any single construct in the model. With a final sample of 304 respondents, this condition was satisfactorily met, as the most complex construct in the model received fewer structural paths than the threshold would demand. This confirms the methodological appropriateness of PLS-SEM for the analysis undertaken in this study.

Upon receipt of the questionnaires, a systematic data screening process was conducted to identify and address data quality issues. Each questionnaire was manually inspected for completeness, consistency, and validity before being entered into the database. Missing data were analysed using Little's Missing Completely at Random (MCAR) test in SPSS to determine the pattern and mechanism of missingness. The analysis revealed that missing data points constituted approximately 8.5% of the total dataset. Little's MCAR test yielded a non-significant result ($\chi^2 = 156.42$, df = 148, $p = 0.314$), indicating that data were missing completely at random, which justified the use of deletion methods. The decision to use listwise deletion rather than imputation was justified by: (1) the MCAR nature of the missing data, (2) the sufficient remaining sample size for PLS-SEM analysis, and (3) the avoidance of introducing bias through imputation methods. Harman's Single-Factor Test was used as one of the statistical remedies to assess common method bias. An exploratory factor analysis was conducted by loading all items onto a single factor. The first factor explained 34.2% of the total variance, which is below the 50% threshold. This result shows that common method bias is not a serious issue in the dataset.

The structural model examining the relationships between supply chain risk management practices and sustainable performance can be expressed mathematically as follows:

$$SP = \beta_0 + \beta_1(RI) + \beta_2(RA) + \beta_3(RM) + \beta_4(RCI) + \beta_5(RP) + \zeta$$

Where:

SP= Sustainable Performance (endogenous variable)
RI = Risk Identification
RA = Risk Assessment
RM = Risk Mitigation
RCI = Risk Continuous Improvement
RP = Risk Performance
β_0 = intercept
β_1, β_2, β_3, β_4, β_5 = path coefficients representing the effects of risk management practices on sustainable performance
ζ = structural error term

Results

Descriptive statistics

Table 2 below presents the demographic characteristics of the respondents (n = 304). The data indicate that the majority of respondents were male (67.8%, n = 206),

while females constituted 32.2% (n = 98). With respect to age distribution, half of the participants (50.0%, n = 152) were between 35 and 49 years, followed by 27.6% (n = 84) aged between 20 and 34 years. The remaining 22.4% (n = 68) were aged 50 years or older. Regarding educational qualifications, 25.3% (n = 77) of the respondents held a first degree, while 25.0% (n = 76) possessed a postgraduate qualification (MSc/PhD). A further 20.1% (n = 61) had completed a diploma or HND, 15.1% (n = 46) had SHS, vocational, or technical education, and 14.5% (n = 44) reported having other or professional qualifications. In terms of job titles, 55.3% (n = 168) of the respondents were managing directors or supervisors, whereas 44.7% (n = 136) were owners, proprietors, or CEOs. Most respondents (55.3%, n = 168) reported employing between 30 and 99 full-time staff, followed by 33.2% (n = 101) with 5 to 29 employees, and 11.5% (n = 35) employing between 100 and 500 workers. Concerning operational tenure, 40.8% (n = 124) of the firms had been operating for 5 to 10 years, 33.2% (n = 101) for more than 15 years, and 26.0% (n = 79) for 11 to 15 years.

Table 2: Demographic Characteristics of Respondents (N = 304)

Variable	Category	Frequency	Percentage
Gender	Male	206	67.8
	Female	98	32.2
Age Group	20–34 years	84	27.6
	35–49 years	152	50.0
	50 years and above	68	22.4
Education Level	SHS/Vocational/Technical	46	15.1
	Diploma/HND	61	20.1
	First Degree	77	25.3
	Postgraduate (Masters/Doctorate)	76	25.0
	Other/Professional	44	14.5
Job Title	Owner/Proprietor/CEO	136	44.7
	Managing Director/Supervisor	168	55.3
Number of employees	5–29	101	33.2
	30–99	168	55.3
	100–500	35	11.5
Operational Tenure	5–10 years	124	40.8
	11–15 years	79	26.0
	>15 years	101	33.2

Note: SHS = Senior High School
Source: Authors' Construct

The measurement model

Table 3 presents the reliability, convergent validity, outer loadings, and Variance Inflation Factor (VIF) values for all the

constructs and their respective indicators. The results show that all constructs demonstrated acceptable levels of internal consistency, as indicated by Cronbach's Alpha (CA) and Composite Reliability (CR) values exceeding the recommended threshold of 0.70. The Average Variance Extracted (AVE) for each construct was also above 0.50, confirming adequate convergent validity. The outer loadings of all indicators were above the acceptable level of 0.50.

Table 3: Reliability, convergent validity, outer loadings and variance inflation factor

Construct	Indicator	Outer Loading	CA	CR	AVE
RID	RID1	0.695	0.789	0.813	0.545
	RID2	0.592			
	RID3	0.681			
	RID4	0.838			
RA	RA1	0.724	0.754	0.759	0.514
	RA2	0.716			
	RA3	0.671			
	RA4	0.733			
	RA5	0.706			
RM	RM1	0.831	0.740	0.771	0.576
	RM2	0.770			
	RM3	0.666			
RCI	RCI1	0.515	0.769	0.792	0.502
	RCI2	0.968			
	RCI3	0.716			
RP	RP1	0.841	0.775	0.783	0.518
	RP2	0.579			
	RP3	0.630			
	RP4	0.617			
SUSP	SUSP1	0.768	0.874	0.878	0.666
	SUSP2	0.792			
	SUSP3	0.812			
	SUSP4	0.860			
	SUSP5	0.844			
	SUSP6	0.768			

Table 3 presents the results of the Fornell-Larcker criterion used to assess discriminant validity among the study constructs. According to this criterion, discriminant validity is established when the square root of the Average Variance Extracted (AVE) for each construct, shown along the diagonal in bold, is greater than

the correlations between that construct and the others. The diagonal values for RA (0.717), RCI (0.709), RID (0.738), RM (0.759), RP (0.719), and SUSP (0.816) all exceed the corresponding off-diagonal inter-construct correlations, thereby confirming that each construct shares more variance with its indicators than with other constructs. This result provides evidence of satisfactory discriminant validity in the measurement model.

Table 4: Fornell-Larcker Criterion

	RA	**RCI**	**RID**	**RM**	**RP**	**SUSP**
RA	0.717					
RCI	0.425	0.709				
RID	0.496	0.453	0.738			
RM	0.511	0.380	0.470	0.759		
RP	0.434	0.402	0.399	0.368	0.719	
SUSP	0.460	0.547	0.378	0.383	0.669	0.816

Table 5 presents the Heterotrait-Monotrait (HTMT) ratio of correlations, which is used to assess discriminant validity among the constructs. The HTMT values between all construct pairs are below the recommended threshold of 0.85, indicating that the constructs are empirically distinct from each other. Notably, the highest HTMT value is observed between RP and SUSP (0.843), which still falls within the acceptable range. These results provide further evidence that discriminant validity is adequately established in the measurement model.

Table 5: Heterotrait-Monotrait (HTMT) Ratio

	RA	RCI	RID	RM	RP	SUSP
RA						
RCI	0.318					
RID	0.708	0.286				
RM	0.729	0.387	0.717			
RP	0.695	0.163	0.744	0.640		
SUSP	0.568	0.133	0.491	0.496	0.843	

The Structural model

Table 6 illustrates the results of the path analysis examining the relationship between various dimensions of risk management and sustainability performance. The findings reveal that all hypothesised paths were statistically significant and accepted. Risk Identification (RID) has a significant positive effect on Sustainability Performance (SUSP), with a path coefficient of 0.151 at the 0.001 significance level. Risk Assessment (RA) also shows a significant positive relationship with SUSP,

with a coefficient of 0.161 ($p < 0.05$). Additionally, Risk Mitigation (RM) is positively associated with SUSP, with a path coefficient of 0.112 ($p < 0.05$). Risk Continuous Improvement (RCI) also demonstrates a significant effect on SUSP, with a coefficient of 0.097 ($p < 0.05$). Lastly, Risk Performance (RP) has the strongest positive impact on Sustainability Performance, with a coefficient of 0.257, significant at the 0.001 level. These results underscore the importance of all the examined risk management constructs in enhancing sustainability performance.

Table 6: Path analysis

Hypothesis	Hypothesized Path	Path Coefficient	SE	t-value	Decision
H1	RID → SUSP	0.151***	0.035	4.334	Accepted
H2	RA → SUSP	0.161*	0.064	2.533	Accepted
H3	RM → SUSP	0.112*	0.047	2.376	Accepted
H4	RCI → SUSP	0.097*	0.039	2.475	Accepted
H5	RP → SUSP	0.257***	0.051	5.039	Accepted

Note: ***$p < 0.001$, **$p < 0.01$ and *$p < 0.05$

Table 7 presents the coefficient of determination and predictive relevance for the model. The R-squared value for Sustainable Supply Chain Practices (SUSP) is 0.491, indicating that approximately 49.1% of the variance in SUSP is explained by the model. The adjusted R-squared value of 0.482 suggests minimal shrinkage, confirming the model's explanatory strength. Additionally, the predictive relevance (Q^2) value of 0.446 exceeds the recommended threshold of 0, demonstrating that the model has adequate predictive relevance for SUSP.

Table 7: Coefficient of determination and predictive relevance

	R-square	R-square adjusted	Predictive relevance (Q^2)
SUSP	0.491	0.482	0.446

Discussions

Risk identification and sustainable performance

The analysis reveals that Risk Identification (RID) has a significant positive effect on Sustainability Performance (SUSP). This suggests that organisations that are proactive in identifying potential risks in their supply chains are more likely to enhance their sustainability outcomes. The ability to detect risks early enables firms to develop strategies that reduce environmental and operational disruptions, thereby strengthening sustainable practices. Identifying risks reflects SMEs' proactive engagement with stakeholder concerns such as environmental and social issues (Freeman, 1984). From the RBV perspective, risk identification represents a valuable internal capability that contributes to competitive advantage (Barney, 1991).

This finding implies that integrating risk identification into supply chain operations is a critical step toward achieving long-term sustainability goals. The findings support those of Silvius (2018), who contends that integrating sustainability into risk identification leads to more holistic project risk management by including environmental and social risks alongside traditional concerns. This broader lens improves long-term project outcomes and stakeholder trust. The findings also align with those of Enyoghasi and Badurdeen (2023), who assert that combining risk likelihood and impact analysis enables better sustainable product design by assessing how risks affect performance across the product lifecycle. This results in more resilient and sustainable innovations. Also, de Sousa Jabbour et al. (2024) posit that identifying risks in supply chains contributes positively to a company's social sustainability reputation, especially when paired with digital tools. This signalling effect enhances transparency and stakeholder engagement.

Risk assessment and sustainable performance

The results also show that Risk Assessment (RA) positively influences Sustainability Performance. This indicates that evaluating the likelihood and potential impact of identified risks contributes to better decision-making in sustainability initiatives. Risk assessment reflects SMEs' analytical capabilities (Barney, 1991) and their ability to sense and evaluate changes in the external environment, aligning with the sensing dimension of dynamic capabilities (Teece, 2007). When organisations assess risks accurately, they can prioritise and allocate resources more efficiently, leading to improved environmental, social, and economic outcomes. This underscores the importance of systematic risk evaluation in driving sustainable supply chain performance. The study findings corroborate that of Izvercianu and Ivascu (2012), who conducted a study in Romanian enterprises. Their findings demonstrate that integrating risk assessment with sustainability indicators across technological, environmental, economic, and social areas improves sustainability performance and planning accuracy. Additionally, Padgett and Li (2016) argue that applying risk-based sustainability metrics to structural design alternatives allows engineers to assess lifecycle costs, emissions, and resilience, enhancing overall sustainability in hazard-prone regions. Furthermore, Linder and Sexton (2014) assert that a decision-analysis approach linking risk and sustainability assessments helps overcome regulatory barriers and align investment decisions with long-term sustainable development goals.

Risk mitigation and sustainable performance

Moreover, the analysis confirms a significant positive relationship between Risk Mitigation (RM) and Sustainability Performance. This means that organisations that implement structured and strategic approaches to mitigating risks are more likely to achieve higher sustainability performance. Effective risk mitigation practices help firms to mitigate threats and capitalise on opportunities in a way that aligns with their sustainability objectives. This finding implies that embedding risk mitigation into operational strategies enhances an organisation's resilience and sustainability. The study findings align with those of Chand (2021), who used a Graph Theoretic Approach (GTA) to assess multiple types of risks (e.g., supply, financial, operational), leading to effective mitigation recommendations and better performance in sustainable manufacturing systems. Elmsalmi et al. (2017) used the Cross-Impact Matrix

Multiplication Applied to Classification [(MICMAC), a structural analysis tool used in strategic foresight and systems thinking to analyse the relationships and influences between key variables or factors in a complex system] method and found that sustainable development practices directly reduce supply chain risks, offering managers a framework to prioritize risk-reducing practices for better sustainability outcomes.

Risk Continuous Improvement and sustainable performance

In addition, Risk Continuous Improvement (RCI) is found to have a significant positive impact on Sustainability Performance. This suggests that ongoing efforts to refine and improve risk-related processes contribute meaningfully to sustainability outcomes. Organisations that continuously review and enhance their risk strategies are better equipped to adapt to changing conditions and emerging sustainability challenges. This implies that a culture of learning and process optimisation is essential for sustainable supply chain success. The study findings support those of Coşkun and Akgül (2022), who used continuous fuzzy risk analysis to track and improve process sustainability and found that by looping failure mode evaluations into regular assessments, companies enhanced long-term sustainable process development. The study findings also align with those of Gosse et al. (2017), who found that risk management embedded into project planning, not just as a one-time analysis but as a continuous feedback mechanism, enhanced sustainability in built environment projects, showing that dynamic adaptation to risks drives better environmental and social results. Dewi et al. (2024) also found that effective enterprise risk management, when systematically improved over time, enhances the positive effects of sustainability strategies on competitive advantage, especially under long-term analysis.

Risk Performance and sustainable performance

Finally, Risk Performance (RP) exhibits the strongest positive influence on Sustainability Performance among all the examined constructs. This indicates that the extent to which organisations achieve their risk-related objectives plays a vital role in determining their sustainability performance. High-risk performance reflects effective implementation of risk controls and mitigation strategies, which in turn support sustainable operations. This finding implies that measuring and improving risk performance is not only a risk-related objective but also a strategic lever for sustainability advancement. In Indonesian banks, Rampisela (2023) found that effective corporate risk management improved sustainability-related financial performance. They contend that sustainable finance alone had a limited effect unless mediated by reduced company risk, showing the central role of risk performance in translating sustainability goals into outcomes. Snippe and Kara (2023) conducted a case-based study of 51 organisations and found that companies with effective strategic risk leadership, particularly those integrating risk into sustainability strategy-were more likely to implement SDG-aligned practices and achieve higher sustainability performance. Scholtens and van't Klooster (2019) found that banks that actively manage sustainability-related risks, such as environmental liabilities and social governance issues, have lower default risk and reduced systemic financial risk, confirming a direct link between risk performance and long-term sustainability in the banking sector.

Conclusion

The purpose of the study was to examine the impact of supply chain risk management practices on the sustainability performance of Ghanaian SMEs. The findings indicate that effective risk management practices significantly enhance sustainability performance. The analysis shows that Risk Identification positively influences sustainability, suggesting that SMEs that proactively detect supply chain risks are better positioned to reduce disruptions and achieve sustainable outcomes. Similarly, Risk Assessment also has a positive effect, indicating that evaluating the likelihood and impact of risks enhances decision-making and resource allocation for sustainability initiatives. Moreover, the study confirms that Risk Mitigation positively affects sustainability performance. This implies that structured approaches to managing risks help SMEs align their operations with sustainability goals and build resilience. The positive relationship between Risk Continuous Improvement and sustainability performance further suggests that ongoing enhancements in risk processes contribute to adaptive and sustainable supply chain operations. Most notably, Risk Performance demonstrates the strongest positive impact on sustainability performance. This finding highlights the importance of achieving risk-related objectives as a strategic pathway to sustainability. Effective implementation of risk controls and consistent performance monitoring supports sustainable operations. In summary, the study establishes that all five dimensions of supply chain risk management (Risk Identification, Risk Assessment, Risk Management, Risk Continuous Improvement, and Risk Performance) play vital roles in enhancing the sustainability performance of Ghanaian SMEs. These insights underscore the need for SMEs to integrate comprehensive risk management strategies into their operations to drive long-term sustainability and competitiveness.

Recommendations

Based on the findings of the study, several recommendations are proposed to enhance the sustainability outcomes of SMEs through effective risk management. First, SME managers should prioritise the integration of risk identification mechanisms into their supply chain operations. By proactively detecting potential risks, firms can prevent disruptions and align their activities with sustainability objectives. Training and capacity-building initiatives should be introduced to help staff recognise and report potential risks early. Second, SMEs should adopt structured risk assessment frameworks that allow for systematic evaluation of identified risks. This will enable them to make informed decisions, allocate resources efficiently, and implement appropriate mitigation strategies that support environmental and social sustainability. Third, it is recommended that SMEs institutionalise comprehensive risk management systems that are aligned with their sustainability goals. These systems should include clear policies, roles, and procedures for managing supply chain risks in a coordinated manner. Fourth, firms should embrace a culture of continuous improvement in risk-related practices. Regular reviews, feedback mechanisms, and updates to risk strategies are necessary to ensure responsiveness to changing business environments and emerging sustainability challenges. Furthermore, SMEs should develop performance indicators to monitor and evaluate their progress in managing risks. Tracking risk performance not only strengthens internal controls but also provides strategic insights that can drive sustainability improvements.

To strengthen supply chain risk management and sustainability among manufacturing SMEs, several policy interventions are recommended. The Association of Ghana Industries (AGI) should establish quarterly risk management forums where SMEs can share best practices and challenges. These forums would facilitate peer learning and knowledge exchange across sectors. The National Board for Small Scale Industries (NBSSI) should develop subsidized training programs on risk assessment and mitigation strategies. These programs should be delivered through workshops and online platforms for wider accessibility. The Ministry of Trade and Industry should integrate risk management requirements into national SME development policies. This integration would ensure alignment between support programs and sustainability objectives. Financial institutions, supported by the Bank of Ghana, should design specialized loan products for SMEs investing in risk management infrastructure. These products should offer favourable terms to encourage adoption. The Ghana Standards Authority should incorporate risk performance metrics into SME certification schemes. This would create incentives for continuous improvement. The Ghana Chamber of Commerce should facilitate SME supplier networks to enable collective risk mitigation through shared resources. Finally, the Environmental Protection Agency should develop simplified risk assessment templates tailored for manufacturing SMEs.

Limitations and further research

This study is subject to several limitations that should be acknowledged. First, the analysis was limited to SMEs located in the Ashanti Region of Ghana. As a result, the findings may not fully reflect the experiences and practices of SMEs in other regions, particularly those operating in different economic, regulatory, or cultural environments. This regional focus limits the generalizability of the results to the broader population of Ghanaian SMEs. Second, the study employed a cross-sectional design, capturing data at a single point in time. This approach does not allow for the observation of changes in risk management practices or sustainability performance over time. Future research could adopt a longitudinal approach to better understand the dynamic relationship between supply chain risk management and sustainability outcomes. Third, the use of Partial Least Squares Structural Equation Modelling (PLS-SEM), while appropriate for exploratory analysis and small to medium sample sizes, may limit the robustness of causal inferences. Although the sample size of 304 was adequate for the analysis, future studies could benefit from larger and more diverse samples to improve statistical power and enhance the generalizability of the findings. Further research could also explore the moderating or mediating roles of variables such as firm size, industry type, or technological adoption in the relationship between risk management practices and sustainability performance. Expanding the geographical scope and incorporating qualitative methods could offer deeper insights into the contextual factors shaping SME sustainability in Ghana.

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