UNIVERSITY OF EDUCATION, WINNEBA

EXAMINING SUSTAINABLE SUPPLY CHAIN MANAGEMENT PRACTICES AND SUPPLY CHAIN RESPONSIVENESS: THE ROLES OF PROCESS INNOVATION AND DIGITALISATION IN THE MANUFACTURING INDUSTRY OF GHANA

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MASTER OF BUSINESS ADMINISTRATION

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BY

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A dissertation in the Department of Procurement and Supply Chain Management, School of Business, submitted to the School of Graduate Studies, in partial fulfilment of the requirements for the award of the degree of Master of Business Administration (Procurement and Supply Chain Management) in the University of Education, Winneba

NOVEMBER, 2023

DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is solely done by me and that no previously published material by another person or accepted for the award of any other degree of the university was used in my project work except where acknowledgement has been made.

NAME OF STUDENT	INDEX NUMBER	SIGNATURE
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Supervisor's Certification

I hereby certify that the preparation and presentation of this project work were supervised under the guidance of the supervision of project work laid down by the University of Education, Winneba.

NAME: DR EVANS KYEREMEH

SUPERVISOR'S SIGNATURE: …….

DATE: …….

DEDICATION

I offer this work as an appreciation to the Almighty, recognizing His benevolence and power in supporting my progress up to this point. I would like to express my sincere appreciation to my mother for her steadfast support and encouragement during this endeavour, as well as to all those who have provided me with their backing. May divine blessings perpetually be bestowed upon every one of you. Finally, I dedicate this work to myself, contemplating the resilience, resolve, and steadfast conviction in the pursuit of knowledge this far.

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ABSTRACT

In Ghana's thriving manufacturing sector, the discussion on sustainable supply chain management (SCM) has grown rapidly, mirroring worldwide trends in the industry. However, its uptake has been relatively inconsistent within the country and particularly the manufacturing sector. The relationship between process innovation, digitalization, and sustainable practices within the supply chain is highlighted by this evolution. The objectives of the research were to examine the relationship between sustainable supply chain management practices and supply chain responsiveness, investigate the mediating role of process innovation, explore the moderating effect of digitalization. The methodology employed was quantitative, utilizing an explanatory research design. Data was collected through a structured questionnaire from 187 respondents, achieving a 100% response rate. Statistical analyses involved the use of IBM SPSS Statistics 27 and SmartPLS 4 software. The study found a strong relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. This emphasised the importance of incorporating economic, environmental, and social factors into supply chain operations. The emergence of Process Innovation played a crucial role in bridging the gap between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. The positive impact of sustainable practises on Process Innovation has led to an improvement in supply chain responsiveness. In juxtaposition to the literature review, the study identified that Digitalization didn't moderate the relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. The current level of digitization in the Ghanaian manufacturing industry didn't have a significant impact on the relationship between sustainability practises and supply chain responsiveness. The study recommended that it is essential to remain attentive to new technologies and evaluate their potential for seamless integration into supply chain operations. This approach helps companies stay adaptable and quickly respond to market changes. The study concluded by emphasizing the importance of staying attuned to technological trends and consistently assessing new technologies to achieve sustained success in the Ghanaian manufacturing industry.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

In recent years, the concept of sustainable supply chain management (SSCM) has gained significant attention worldwide due to the growing recognition of the importance of environmental conservation, social responsibility, and economic sustainability (Wieland, 2021). This paradigm shift has prompted organisations across various industries to re-evaluate their supply chain practices and adopt strategies that not only enhance operational efficiency but also minimise adverse environmental and social impacts (Chambers et al., 2021). The manufacturing industry, being a key player in the global supply chain, plays a crucial role in driving sustainable practices. In Ghana, a country with a burgeoning manufacturing sector, the need to incorporate sustainability principles into supply chain management practices has become increasingly evident (Altay, Gunasekaran, Dubey, & Childe, 2018). As the industry continues to evolve and expand, there is a pressing need to explore how sustainable supply chain management practices can be integrated into the manufacturing processes in Ghana to achieve economic growth while mitigating environmental degradation and promoting social equity.

One significant aspect of sustainable supply chain management is responsiveness, which refers to the ability of a supply chain to adapt quickly to changes in demand, supply, and market conditions (Williams, Roh, Tokar, & Swink, 2013). In today's dynamic business environment, responsiveness is critical for maintaining competitiveness and meeting customer expectations. Achieving supply chain responsiveness requires the adoption of

innovative practices and technologies that streamline processes and enhance agility (Bugert & Lasch, 2018).

In Ghana's thriving manufacturing sector, the discussion on sustainable supply chain management (SCM) has grown rapidly, mirroring worldwide trends in the industry. Over the past twenty years, SCM has experienced a significant transformation, driven by the need for sustainability and adaptability. The interconnection between process innovation, digitalization, and sustainable practices within the supply chain is highlighted by this evolution (Sharma et al., 2021). Sustainable supply chain management in Ghana's manufacturing sector involves a comprehensive and complex approach. It involves the careful acquisition of raw materials using sustainable methods, the implementation of environmentally friendly manufacturing techniques, and the intentional creation of products that can be recycled and reused (Sharma et al., 2021). These principles are not only aligned with ethical obligations but also function as strategic obligations in responding to the growing need for sustainable products and services.

The necessity for sustainable practices is further emphasised by increasing pressure from stakeholders, customers, and regulatory bodies. Manufacturing firms must take a proactive approach to show their strong commitment to environmental stewardship due to increased environmental concerns and the possibility of resource depletion (Ögmundarson et al., 2020). Process innovation and digitalization play a crucial role in achieving sustainability goals and improving the responsiveness of supply chains in this context. The incorporation of advanced technologies such as artificial intelligence, robotics, and the Internet of Things (IoT) offers exceptional prospects for improving efficiency, reducing inefficiencies, and maximising the use of resources (Duygan et al., 2023).

Furthermore, these technological advancements enhance supply chains by providing immediate visibility and insights based on data, enabling faster decision-making and adaptable responses to market changes. Process innovation acts as a catalyst to connect sustainability imperatives and operational efficiency. At the same time, digitalization is crucial in facilitating the implementation of more flexible and environmentally friendly practices. Manufacturing firms can foster a culture of innovation and collaboration throughout the supply chain ecosystem by utilising digital tools and platforms (Duygan et al., 2023). The combination of process innovation, digitalization, and sustainable supply chain management is leading to a significant change in the manufacturing industry of Ghana. In addition to reducing environmental impact, these collaborative efforts have the potential to improve competitiveness and strengthen market position in a growing consumer market that demands more discerning choices. However, to fully achieve the benefits of these initiatives, it is essential for all parties involved to make a united and determined effort. Collaboration between different industries, along with strategic partnerships, is essential for bringing about significant and widespread change and promoting a culture of sustainability within the manufacturing ecosystem (Chen et al., 2021).

1.2 Problem Statement

The recognition of the significance of sustainability and responsiveness is rapidly growing within the field of supply chain management globally. Nevertheless, an essential area of research that has yet to be explored is the effects of process innovation and digitalization on attaining these goals in Ghana's manufacturing sector (Asamoah, Benjamin, & Francis, 2021). The Ghanaian manufacturing sector encounters obstacles that impede the effective

integration of process innovation and digitalization in supply chain management (Asamoah et al., 2021). These challenges encompass infrastructure deficiencies, limited resource access, and technological competencies. In recent decades, there has been a growing recognition of the critical importance that organisations must place on innovation. Amidst ongoing industrial revolutions, businesses have begun investigating sustainable supply chain management through digitizing their manufacturing processes and products. Academics have invested efforts in these areas, acknowledging the advantages that process innovation and digitalization bring to the industry and the advancement of sustainable methodologies. Nevertheless, incorporating these technologies into the supply chain poses a substantial obstacle for organisations engaged in manufacturing, particularly in developing nations.

Many academic investigations have explored the fundamental aspects of Industry 4.0, its link with the manufacturing sector, and the potential operational transformations and digitalization it offers. Although numerous implications of incorporating sustainable supply chain practices (SSCP) have been examined in the literature, claims regarding the relationship between SSCP and supply chain responsiveness are still insufficient. Contradictory conclusions are reached in the works of Laari (2019) and Ojala (2018) concerning the degree of adaptability demonstrated by a company's supply chain. It could be posited that the integration of process innovation and digitalization may significantly influence the adoption of sustainable supply chain practices in the manufacturing sector, potentially yielding an indirect effect on supply chain responsiveness.

Notwithstanding the increasing acknowledgement of the importance of sustainability in supply chain management, indulgence in sustainable practices within Ghana's

manufacturing sector is still lacking. Existing literature has primarily concentrated on developed nations, necessitating the need to investigate the unique approaches, obstacles, and prospects associated with promoting sustainable supply chain management in developing nations such as Ghana. The introduction of digital technologies, such as the blockchain, data analytics, and the Internet of Things (IoT), has initiated a paradigm shift that requires an exhaustive examination of their effects on the responsiveness and sustainability of supply chains in Ghana's manufacturing industry. The challenges faced by the sector, including constraints on resources, technology, and infrastructure, underpins the importance of this study.

Nevertheless, evidence bridging the link between supply chain responsiveness, digitalization, process innovation, and sustainable supply chain management is also lacking in Ghana's manufacturing industry. Hence, it is imperative to examine the complexities associated with process innovation and digitalization to determine their capacity to enhance the responsiveness and sustainability of supply chains in Ghana's manufacturing industry.

1.3 Purpose of the Study

The purpose of this research is to investigate the link that exists between supply chain responsiveness in Ghana's manufacturing sector and sustainable supply chain management (SCM) practices. The research centres on the mediating function of process innovation and the moderating function of digitalization. The research aims to contribute to theoretical frameworks and practical understanding regarding how process innovation and digitalization contribute to the enhancement of responsiveness in Ghana's manufacturing supply chains and the achievement of sustainability objectives. The research outcomes aim to provide significant contributions to the knowledge base of industry professionals and

managers, aiding in the formulation of effective policies and strategies that foster sustainable operations and enhance the efficiency of supply chains in the manufacturing sector of Ghana.

1.4 Research Objectives

The purpose of this study is to examine sustainable supply chain management and supply chain responsiveness: The roles of process innovation and digitalisation in the manufacturing industry of Ghana. In addition, the following specific objectives are set.

1. To identify the relationship between sustainable supply chain management and supply chain responsiveness.
2. To examine the mediating role of process innovation in the relationship between sustainable supply chain management and supply chain responsiveness.
3. To examine the moderating role of digitalisation in the relationship between sustainable supply chain management and supply chain responsiveness.

1.5 Research Questions

1. What is the relationship between sustainable supply chain management and supply chain responsiveness?
2. What is the mediating role of process innovation in the relationship between sustainable supply chain management and supply chain responsiveness?
3. What is the moderating role of digitalisation in the relationship between sustainable supply chain management and supply chain responsiveness?

1.6 Scope of the Study

This study aims to investigate sustainable supply chain management and supply chain responsiveness in Ghana's manufacturing industry. The study's geographical scope is limited to Ghana, where the manufacturing sector provides a significant role in the nation's economy. The study recognises the distinct challenges and prospects encountered by enterprises operating in the Ghanaian manufacturing sector, including infrastructure inadequacies, resource limitations, and cultural and regulatory peculiarities. The research centres on sustainable supply chain management, which entails the amalgamation of ecologically conscious practises, social accountability, and financial feasibility into the supply chain operations. The study also investigates the concept of supply chain responsiveness, denoting the capacity of a firm to promptly and efficiently address customer requirements and market fluctuations. This study further explores the mediating role of process innovation, which relates to adopting novel techniques, technologies, and procedures to improve supply chain operations' efficacy. Furthermore, the research investigates the moderating impact of digitalisation, which pertains to implementing and utilising digital technologies to facilitate streamlined and flexible supply chain activities.

1.7 Significance of the Study

The study aims to enhance sustainable supply chain management and responsiveness theoretical frameworks and concepts. It intends to achieve this by examining how process innovation and digitalisation affect these fields. The process can facilitate the formulation of new theories or the improvement of pre-existing ones. The study can offer valuable insights for manufacturing industry practitioners and managers in Ghana, enabling them to understand the importance of sustainable supply chain management and responsiveness. It

can guide how process innovation and digitalisation can be leveraged to enhance operational efficiency, environmental sustainability, and customer responsiveness. The study findings can inform strategic decision-making processes within manufacturing organisations in Ghana. Process innovation and digitalisation can aid in developing efficient strategies and policies to promote sustainable practices, enhance supply chain performance, and adjust to changing market conditions.

1.8 Limitations of the Study

Although this research expands on the dynamics of sustainable supply chain management (SCM) and supply chain responsiveness in the manufacturing sector of Ghana, it is important to acknowledge several inherent constraints. First and foremost, it is plausible that SSCM practices and supply chain responsiveness are influenced by factors other than the driving force of process innovation and digitization. Fundamentally, the SSCM discipline is integrated and multidisciplinary. It is apparent that the research does not guarantee the inclusion of all potential antecedents in its model, nor does it provide a comprehensive understanding of all mediating and moderating aspects. Additional constructs could be incorporated into the model; however, doing so would necessitate additional data collection, time, and financial resources, not to mention additional theoretical justification. These factors were not feasible to incorporate at this time. Adding further theoretical constructs and relationships could potentially introduce complexity to the research model.

The theoretical framework of the study was constructed with an emphasis on manufacturing firms, neglecting to account for alternative sectors. Variations could be made to the research model to account for alternative organisational structures, including

wholesalers, service providers, and retailers. Furthermore, to analyse Ghanaian manufacturing firms, the geographical region for which the data were collected was determined. As a result, the applicability of the research findings to different sectors and geographical contexts may be limited.

Furthermore, it is important to consider potential biases that may be present in the selected data collection methods. These biases could include self-reporting biases and social desirability biases, both of which have the potential to affect the accuracy and validity of the study's findings. Further, limitations in resources, such as time, financial support, and access to technological resources or specialised knowledge, might have affected the extent, profundity, and calibre of the investigation carried out. In addition, throughout the study period, external factors such as technological advancements, government policies, or fluctuations in economic conditions may have impacted the findings and interpretations of the research.

Lastly, while the optimal range of sample sizes for structural equation modelling (SEM) analysis is 150-400 (Ullman & Bentler, 2012), SEM functions more effectively with larger samples on average. This study employed 187 samples to evaluate the fit of the entire model with SEM. Therefore, it would be advantageous to evaluate the research model with a more extensive sample size and subsequently corroborate the research results with the supplementary samples.

1.9 Organisation of the Study

This study is divided into five chapters. The background of the study, the problem statement, the objectives of the research, the research questions, the study's theories, the study's scope, and its organisation are presented in the first chapter. The second chapter of

the research examines the literature review that offers the theoretical framework and foundation for empirical studies. In addition, the research methodology is explained in Chapter Three. This chapter describes the research methodology, sample procedure, and procedures, as well as the data gathering and research sources. In addition, the approaches for data analysis were taught. The fourth chapter of this study presents analyses of field data obtained for this research. The fifth chapter of the study concludes with a summary of the significant research findings and suggestions based on those findings.

1.10 Overview of Methodology

The research design of the study involved adopting an explanatory research design. A cross-sectional methodology was employed to gather data on the study's variables. The research approach chosen was quantitative, focusing on systematically gathering numerical data to reveal patterns and correlations. The study was conducted within Ghana's manufacturing sector, with a focus on firms registered under the Association of Ghana Industries in the Greater Accra Region.

A probability sampling technique, specifically simple random sampling, was employed. Primary data was collected through a structured questionnaire, while secondary data sources included scholarly articles and research papers. Data analysis involved using the Smart PLS 4 package and SPSS and descriptive statistics were used to summarize findings. Structural Equation Modeling (SEM) was employed to analyze relationships among variables. Ethical considerations were addressed by obtaining informed consent, ensuring voluntary participation, respecting privacy rights, addressing plagiarism issues, maintaining anonymity, and ensuring confidentiality.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter establishes a framework for the literature review of this study. It establishes the foundation for understanding the basic concepts and the theories that form the basis of the research.

2.2 Theoretical Review

This section explores the theoretical perspectives of the study. These theoretical frameworks provide a structured approach to understanding these concepts' implementation, examination, and progress within a business setting characterised by constant change and development. This review aims to examine these theories to establish a comprehensive theoretical foundation that offers direction for investigating how process innovation and digitalisation contribute to enhancing sustainability and responsiveness in the supply chain of Ghana's manufacturing industry.

2.2.1 Resource-Based View

The Resource-Based View (RBV) theory, initially proposed by Wernerfelt in 1984 and subsequently expanded upon by Barney in 1991, is a fundamental concept in strategic management. It centres on the notion that organisations can achieve and maintain a competitive advantage by efficiently leveraging their distinct resources and capabilities (Wernerfelt, 1984; Barney, 1991). The Resource-Based View (RBV) theory argues that variations in competitive performance among firms can be attributed to resource diversity and limited transferability (Barney, 1991).

RBV posits that firms can bolster their competitive advantage in the context of sustainable supply chain management by strategically allocating resources that are in line with objectives of environmental sustainability (Bag S., Choi, T.-M., Rahman, M. S., Srivastava, G., & Singh, R. K. 2022). According to Baker, 2018, companies that possess resources enabling them to swiftly adapt to changes in market demand, technological advancements, and competitive dynamics are more likely to attain a higher level of supply chain responsiveness. The resources may include effective manufacturing processes, adaptable supplier relationships, and inventive inventory management systems (Baker, 2018).

Incorporating process innovation and digitalisation within the Resource-Based View (RBV) framework enhances firms' capacity to optimise their resource base effectively. According to Gupta and Jain (2017), implementing process innovation can result in reconfiguring supply chain operations, and enhancing efficiency and sustainability. Altay et al. (2018) highlight the significance of digitalisation in facilitating real-time monitoring, data-driven decision-making, and predictive analytics. These advancements contribute to firms' improved resource allocation, enhancing their supply chain responsiveness.

2.2.2 Diffusion of Innovation Theory

The diffusion of innovation theory, as proposed by Rogers (2003), presents a comprehensive framework that outlines sequential stages involved in individuals and organisations adopting innovations. According to Rogers (2003), innovations that demonstrate distinct benefits compared to current practises, align with the values and requirements of the organisation, possess a reasonable level of complexity for implementation, can be tested on a smaller scale, and produce observable outcomes that are more inclined to be embraced. Process innovation and digitalisation are significant factors that substantially impact the diffusion process (Cerca

et al., 2022). Implementing efficient process innovation has the potential to streamline the adoption process by reengineering supply chain processes to accommodate emerging technologies. The digitalisation process has the potential to augment observability by offering concrete evidence of enhancements in performance through the utilisation of real-time data tracking and analytics (Rogers, 2003).

The Diffusion of Innovation theory offers a comprehensive theoretical framework for comprehending the intricate dynamics of innovation adoption, be it in the context of sustainable supply chain management or supply chain responsiveness (Cerca et al., 2022). Firms operating within the manufacturing industry in Ghana can strategically navigate the adoption of new technologies, practises, and processes by acknowledging the various stages of adoption, considering the factors that influence adoption decisions, and understanding the significance of process innovation and digitalisation (Donkor et al., 2021).

2.3 Conceptual Review

The conceptual review presents a framework integrating essential theoretical perspectives and practical applications. This framework includes sustainable supply chain management, responsiveness, process innovation, digitalisation, and Ghana's manufacturing industry.

2.3.1 Sustainability

Sustainability has gained significant prominence in recent years due to the growing recognition of the need to balance economic, environmental, and social considerations in business practices. It encompasses the responsible use of resources and the preservation of ecological systems to ensure the well-being of present and future generations (Bianchi et al., 2022). In supply chain management, sustainability extends beyond traditional economic goals and incorporates environmental stewardship and social responsibility. According to

Elkington's (1997) concept of the "Triple Bottom Line," sustainability involves three interrelated dimensions: economic, environmental, and social. Organisations pursuing sustainable supply chain management aim to create value for shareholders, society, and the environment. This approach aligns with the United Nations' Sustainable Development Goals (SDGs), which provide a global framework for addressing pressing challenges such as climate change, poverty, and inequality (UN, 2015).

In recent years, scholars have highlighted the importance of sustainability in supply chain management within the manufacturing sector. For instance, Carter and Rogers (2018) stressed the role of sustainability in achieving competitive advantage and long-term success. They argued that organisations that adopt sustainable practices could enhance their reputation, attract environmentally conscious consumers, and mitigate risks associated with resource scarcity and regulatory changes. Research by Pagell and Wu (2019) further emphasised the strategic nature of sustainability in supply chains. They suggested that sustainability initiatives should be aligned with business strategies to drive innovation and create value. This resonates with the notion that sustainable supply chain practices, such as waste reduction and energy efficiency, can lead to cost savings and improved operational efficiency (Zhu et al., 2018). Sustainability in supply chain management entails a comprehensive approach encompassing economic, environmental, and social dimensions. It involves integrating sustainable practices throughout the supply chain to achieve long-term success, competitive advantage, and positive impacts on society and the environment (Awunyo-Vitor & Acheampong, 2020).

2.3.2 Supply Chain Management

Supply chain management (SCM) manages the flow of goods and services from the point of origin to the point of consumption (Min, Zacharia, & Smith, 2019). It involves coordinating and managing procurement, production, transportation, storage, information, and financial flows. SCM aims to optimise the supply chain by minimising costs, improving efficiency, and enhancing customer satisfaction (Nabila, James, & Tzu Li, 2022). This involves making strategic decisions about the design, planning, execution, control, and monitoring of the supply chain and collaborating with suppliers, manufacturers, distributors, and customers. Effective SCM requires the use of advanced technologies, such as enterprise resource planning (ERP) systems, transportation management systems (TMS), warehouse management systems (WMS), and electronic data interchange (EDI), to facilitate communication, coordination, and collaboration among supply chain partners. SCM is essential for businesses of all sizes and industries (Nabila et al., 2022). It enables them to better manage their inventory, reduce costs, improve efficiency, and respond quickly to changing customer demands and market conditions.

Osei Tutu (2019) defines supply chains as the most effective means of acquiring information, goods, and services from producers to consumers. It entails the interrelated activities of separate businesses that ultimately deliver goods and services to consumers. Supply chain management oversees and coordinates the various procedures that lead up to the final delivery of a product or service to a customer (Latin American Conference on Logistics and Supply Chain Management, 2019).

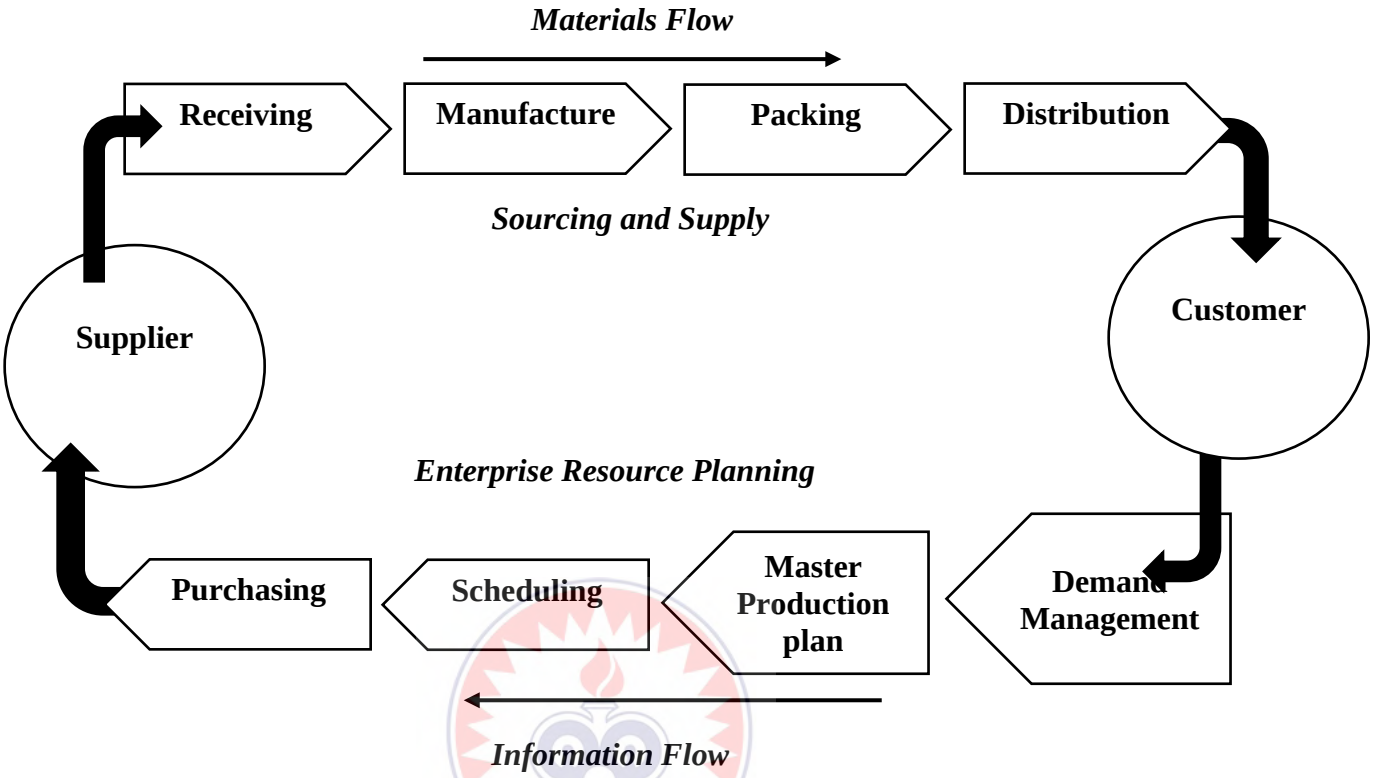

Figure 2. 1 Generic Supply Chain Flows (Martínez-Olvera & Davizon Castillo, 2015)

2.4 Sustainable Supply Chain Practices

Sustainable supply chain practices encompass a range of strategies and actions that organisations adopt to integrate economic, environmental, and social considerations into their supply chain operations (Aguado et al., 2018). These practices aim to achieve long-term viability, minimise negative impacts on the environment, foster social responsibility, and create shared value across the supply chain network. By aligning their operations with sustainability principles, companies can enhance their competitiveness, reputation, and resilience while contributing to broader environmental and societal goals (Kazancoglu et al., 2022). One prominent sustainable supply chain practice is green procurement. This involves

selecting suppliers and partners based on their environmental performance, ethical practices, and adherence to sustainability standards. Green procurement aims to ensure that the entire supply chain operates in an environmentally responsible manner. For instance, organisations may prioritise suppliers that use eco-friendly materials, engage in sustainable production processes, and adhere to fair labour practices (Carter & Easton, 2018).

Waste reduction and recycling are integral components of sustainable supply chain practices. Companies strive to minimise waste generation at various supply chain stages, from production to distribution and consumption (Kouaib et al., 2020). This involves implementing waste reduction strategies, promoting product designs that facilitate recycling, and collaborating with partners to establish effective recycling and recovery systems (Pagell & Shevchenko, 2014). The concept of circular economy, closely tied to sustainable supply chain practices, advocates for the continuous use and regeneration of resources. Organisations embrace circular economy principles by designing products that are easy to repair, upgrade, or disassemble (Zheng & Ge, 2022). This approach promotes the reuse of materials and reduces the reliance on virgin resources, contributing to a more sustainable and resource-efficient supply chain (Geissdoerfer et al., 2017).

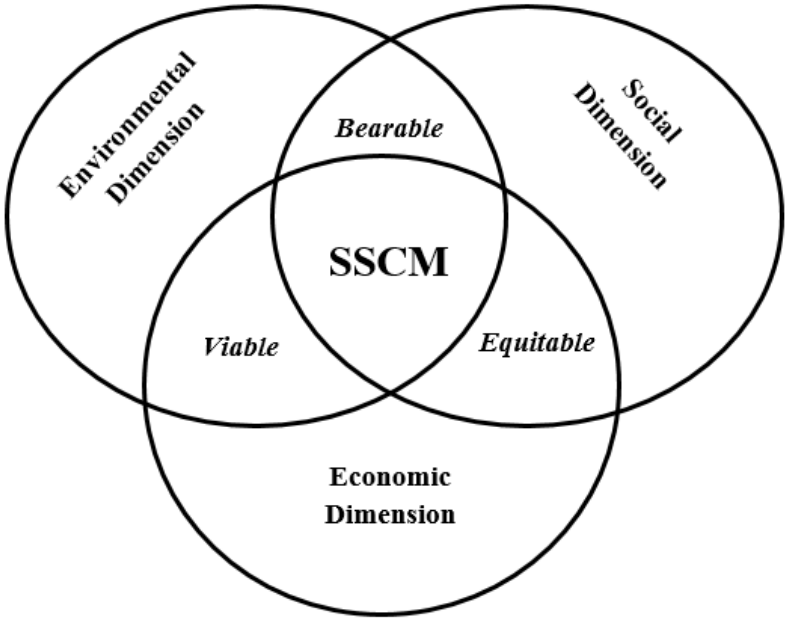

Figure 2. 2 Dimensions of Sustainability (Pandiangan et al., 2022)

2.4.1 Green Management Practices

The growing awareness of environmental sustainability has prompted businesses to adopt green management practices that align economic success with environmental stewardship (Altay et al., 2018). These practices integrate eco-friendly strategies into operations, supply chains, and product lifecycles. Green management demonstrates corporate social responsibility and contributes to cost savings, risk reduction, and enhanced brand reputation (Al-Razgan et al., 2021). Life Cycle Assessment (LCA) is a pivotal green practice that evaluates the environmental impact of a product or service throughout its entire life cycle. LCA assesses factors such as resource consumption, emissions, and waste generation from raw material extraction to disposal. This practice aids in identifying opportunities for reducing the environmental footprint of products (ISO 14040, 2006).

Waste Minimization and Recycling encompass strategies to reduce waste generation and divert materials from landfills. Businesses implement waste reduction programs, prioritise

reusable materials, and establish recycling initiatives. These practices mitigate environmental harm and reduce disposal costs (Bohdanowicz, 2006). Energy Efficiency is a core green practice that optimises energy consumption in operations. Organisations invest in energy-efficient technologies, conduct energy audits, and implement energy-saving measures. By reducing energy consumption, companies lower operational costs and decrease greenhouse gas emissions (UNEP, 2018).

Renewable Energy Adoption involves the integration of clean energy sources such as solar, wind, and hydropower into operations. By transitioning to renewable energy, businesses reduce reliance on fossil fuels, decrease carbon emissions, and contribute to a more sustainable energy landscape (IEA, 2021). Incorporating green practices into Ghana's manufacturing industry holds particular significance. Adopting sustainable practices can address environmental concerns while capitalising on the economic growth potential of the industry. While resource availability and infrastructure challenges might exist, integrating green management practices can lead to resource efficiency, enhanced marketability, and reduced environmental impact.

2.4.2 The Triple Bottom Line

The triple bottom line (TBL) is a sustainability framework that prioritises sustainability by incorporating financial, social, and environmental considerations as distinct bottom-line categories (Jum’a, Zimon, Ikram, & Madzík, 2022). The TBL incorporates wider economic, social, and environmental considerations in addition to the conventional financial bottom line to assess the extent to which an organisation impacts its employees, the local community, and the environment at large (Jamil, He, Wei, Gupta, & Khan, 2023). Generally, this is evaluated utilising the three Ps: profit, people, and the environment.

TBL was first proposed and developed by Elkington in 1994, who coined the term “the three Ps” to describe its focus on employees, infrastructure, and financial success (Agrawal & Singh, 2019). According to Elkington, three main areas comprise a company’s overall performance: the community, the environment, and the bottom line. To put the TBL idea into practice, a framework has been developed to balance the microeconomic performances of various social, economic, and environmental factors (Agrawal & Singh, 2019; Pandiangan et al., 2022).

The TBL framework essentially puts the fundamental doctrines of sustainable development into practice by prioritising environmental, social, and economic goals in an organisational setting. The TBL framework is based on the premise that a company’s well-being should be measured not just by its monetary worth but also by its impact on the environment and its commitment to social responsibility. In other words, businesses will fail in the long run if they do not consider how their actions will affect society, the economy, and the environment (Jum’a, Muhammad, & Dominik, 2022).

Businesses can have a good effect on society and the natural environment while also reaping long-term economic rewards. The TBL captures this nexus of economic, social, and environmental performance. Taking all three performance categories into account at once, the triple button line framework aims to strike a healthy balance between social, environmental, and economic goals to maximise corporate value and ensure the company’s continued success. This is consistent with the sustainable supply chain management strategy, which considers environmental, economic, and social criteria in a company's supply chain activities. Hence, it is argued that the adopted Sustainable Supply Chain Management strategy system is congruent with the principles of the TBL framework, laying the

groundwork for Sustainable Supply Chain Management strategy performance outcomes on the TBL performance pillars (Kouaib, Anis, Sameh, 2020).

2.5 Supply Chain Responsiveness

Supply chain responsiveness refers to the ability of a supply chain to respond quickly and effectively to changes in customer demand, market trends, and other external factors (Jum'a et al., 2022). A responsive supply chain is critical for organisations seeking a competitive advantage in the marketplace. It allows them to adapt to changing conditions and quickly meet customer needs (Jum'a et al., 2022). To achieve supply chain responsiveness, organisations must first understand their customer's needs and preferences and the overall market trends. This information can be used to develop a responsive supply chain strategy designed to meet changing demand patterns and respond quickly to market fluctuations. A responsive supply chain also requires close collaboration and communication with suppliers and other partners in the supply chain. This can include sharing demand forecasts, developing contingency plans, and establishing clear communication channels to ensure all parties are aligned and working together to meet customer needs (Williams et al., 2013).

Organisations may also employ tools and techniques to improve supply chain responsiveness, such as real-time inventory tracking, demand forecasting, and just-in-time (JIT) inventory management. These tools can help organisations optimise inventory levels, reduce lead times, and improve efficiency and responsiveness. Supply chain responsiveness is a critical component of successful supply chain management. By developing a responsive supply chain strategy and employing the right tools and techniques, organisations can improve their ability to respond to changing conditions, meet customer needs, and achieve a competitive advantage in the marketplace (Vali-Siar & Roghanian, 2022).

2.6 Digitalisation

In recent years, digitising the supply chain has become increasingly important. Effective demand forecasting, cost optimisation, and a competitive edge can all be achieved with the help of innovative technologies and their applications in the supply chain (Ageron et al., 2020). The increased visibility and traceability of SCs directly result from the enhanced connectivity made possible by digitalisation. Through digital transformation, businesses can become more adaptable and valuable (Deepu & Ravi, 2023b). Companies can get an edge in the market by better catering to their client's needs thanks to the end-to-end SC connectivity made possible by digitisation. SCD refers to the use of digital technologies by businesses to improve their SC output. As a result of increased connectivity between formerly siloed parts of the business ecosystem, value creation is facilitated by the Fourth Industrial Revolution (Shmatko et al., 2021a). Thanks to digitalisation, more people are paying attention to SC now than ever. Digital technologies such as big data, RFID, cloud computing, the Internet of Things (IoT), and artificial intelligence are being adopted by businesses to better adapt to ever-changing market conditions. SCs are better able to take the initiative and compete in the market when they adopt new digital technology (Li, 2023; Shcherbakov & Silkina, 2021). To improve SC partners' value chain and connectivity, the growing Industry 4.0 is adopting digital technology. It enhances productivity and facilitates the launch of novel goods, services, and business models (Vagstad, 2020).

According to (Cerca et al., 2022), digitalisation manifests primarily in digital goods and services and digital operations. Businesses that lack a digital presence provide traditional goods and services and do most of their work manually. A fully digital company offers end-to-end digital solutions and runs on refined digital workflows. According to the available

literature, digitalisation plays a function in improving productivity. Nodal firms may better organise resources and establish capacities to satisfy the varied needs of consumers thanks to the improvements made possible by SCD in areas such as supply chain visibility, connectivity, innovation, real-time, transparency, speed, and many more.

2.7 Process Innovation

Process innovation in supply chains refers to introducing new methods, tools, or technologies that improve supply chain processes' efficiency, effectiveness, and quality (Helmer, Huynh, & Sue, 2022). It involves identifying, analysing, and implementing new ideas to streamline operations, reduce costs, enhance productivity, and increase customer satisfaction. Examples of process innovation in supply chains include automated material handling systems, real-time tracking and tracing technologies, demand-driven inventory management systems, and collaborative planning, forecasting, and replenishment (CPFR) systems. These technologies can improve visibility, accuracy, and operations speed while reducing errors and delays. Process innovation in supply chains also involves reengineering existing processes to eliminate waste, reduce lead times, and improve quality (Helmer et al., 2022).

Suwignjo, Gunarta, Wessiani, Prasetyo, & Yuwana, 2022 analysed manufacturer process innovation across multiple collection channels. In addition, they investigated how developments in the remanufacturing process influenced the closed-loop supply chain's channel selection and optimal decision-making. Similarly, (Liu & Ma, 2022) investigated how collaboration between manufacturers and retailers on manufacturing process innovation affected the optimal decisions of a closed-loop supply chain and the surrounding ecosystem.

Nevertheless, the manufacturer, not the merchant or third party, typically innovates the production process. Improvements in the manufacturing procedure will have a positive effect

on related businesses (Helmer et al., 2022). A new approach to supply chain management must be better than the status quo. Using only the highest-quality providers and components is a cornerstone of supply chain innovation. Instead, businesses should collaborate with their supply chain to develop and deliver new services and products, prioritising safety and efficiency.

2.8 Empirical Review

According to Ageron, B., Bentahar, & Gunasekaran, A. (2020), digital technologies transform supply chain operations, big data analytics, the Internet of Things (IoT), and blockchain. The authors also highlight the potential benefits and challenges associated with the digitalisation of supply chains, including data security, privacy, and collaboration issues. In a study by Donkor, F., Papadopoulos, T., & Spiegler, V. (2021) on supply chain integration, the authors examine the relationship between supply chain integration and supply chain sustainability in the pharmaceutical industry of the United Kingdom (UK) and Ghana. They adopt a stakeholder and contingency perspective to analyse how different factors influence this relationship in both countries. The paper focuses on understanding how supply chain integration practices enhance sustainability and performance. It also considers the role of stakeholders and contextual factors, such as regulations and infrastructure, in shaping this relationship.

Froio, P. J., & Bezerra (2021) examined environmental sustainability initiatives adopted by logistics service providers in a developing country, an overview of the Brazilian industry. In the paper, the authors investigated the environmental sustainability initiatives adopted by logistics service providers in the context of a developing country, specifically focusing on the Brazilian logistics industry. They provided an overview of the sustainability practices

and strategies implemented by logistics companies in Brazil to reduce their environmental impact. The study explores various dimensions of environmental sustainability, including energy efficiency, waste management, carbon footprint reduction, and adoption of clean technologies in logistics operations. It examined motivations, barriers, and drivers influencing the adoption of sustainable practices by logistics service providers in Brazil.

Similarly, Khan, Ali, Zaman, and Khan (2018) found that green warehousing practices can lead to significant environmental and economic benefits in the construction industry (Khan et al., 2018). By incorporating JIT, TQM, and green supply chain practices, manufacturing organizations can reduce their environmental impact and improve their sustainability performance. Similarly, green warehousing practices can bring significant environmental and economic benefits to the construction industry. These findings suggest that implementing environmentally sustainable practices can positively impact both the environment and the bottom line (Green et al., 2019; Khan et al., 2018).

The study by Jum'a et al. (2022) emphasizes the importance of incorporating sustainability concerns into lean manufacturing practices. The researchers investigate the synergistic effect of lean practices and sustainability-oriented innovation on sustainability performance, using the Triple Bottom Line (TBL) framework to assess the economic, environmental, and social impacts of implementing these practices. The study finds that implementing lean green practices and sustainability-oriented innovation can positively impact all three dimensions of the TBL. In particular, these practices can reduce waste and emissions, improve resource efficiency, increase stakeholder engagement, and enhance financial performance. The authors argue that incorporating sustainability concerns into lean practices can help companies move towards a sustainability paradigm and achieve long-term success. They

suggest that companies adopt a holistic approach to sustainability that considers environmental but also social and economic concerns.

According to a study by (Smith et al., 2021), supply chain innovation positively impacts competitive advantage in the construction industry. The study found that investment in technology and process innovations is necessary to achieve a competitive advantage, and risk management capabilities mediate the relationship between SCI and CA. The buyer-supplier relationship was also found to moderate the SCI-CA relationship, with resilience capability acting as a mediator. The study emphasizes the importance of developing risk management capabilities and investing in technology and process innovations to achieve and maintain a competitive advantage in the construction industry.

Nonetheless, it expressed grave concerns about losing a competitive edge when GSCM methods raise the firms' total cost (Glover, 2018). Another study found that SSCP procedures are more likely to improve operational efficiency than supply chain responsiveness. (Kinget, Saed, & Bruce, 2021) failed to find a strong relationship between SSCM and the firm's profitability. On the other hand, academicians pushed for the implementation of SSCP. Freeman, 2019 determined that based on stakeholder theory, organisations produce favourable externalities when they internally affect both sides (stakeholders). Externalities pressure the organisation to implement eco-friendly policies and reduce resource waste. According to stakeholder theory, meeting stakeholders' expectations will improve organisational performance and raise enterprises' profitability. Few academics asserted that process innovation and digitalisation indirectly impact the responsiveness of organisations' supply chains.

2.9 Conceptual Framework

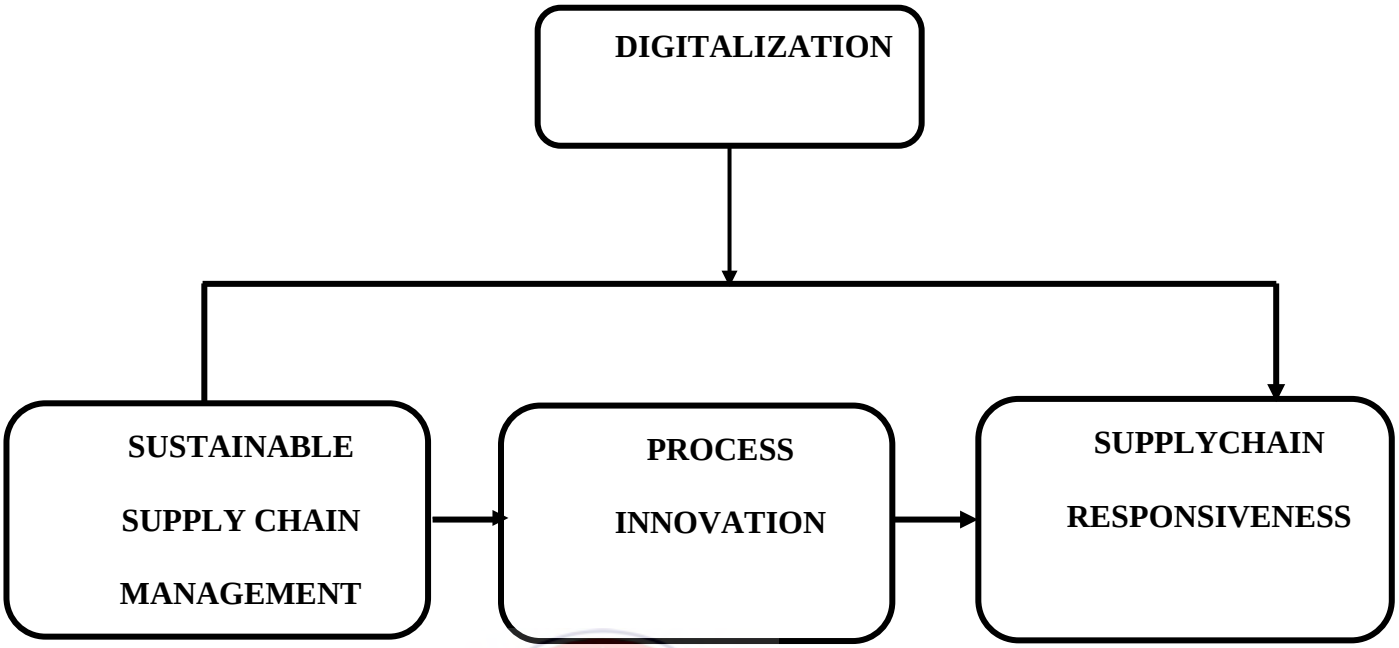

Figure 2. 3 Conceptual Framework

By adopting sustainable practices, supply chains can enhance their efficiency, transparency, and resilience, ultimately leading to improved responsiveness. Using renewable energy sources, reducing waste and emissions, and implementing fair labour practices can result in a more efficient supply chain (Awuena Fiati, 2019). This allows a company to swiftly adjust to demand shifts or supply chain disruptions, like natural disasters or geopolitical events.

Process innovation bridges the gap between sustainable supply chain management and responsiveness. Sustainable supply chain management incorporates environmental, social, and economic factors into operations. On the other hand, supply chain responsiveness refers to how well a supply chain can promptly adapt to shifting market demands. Process innovation focuses on implementing new or improved processes to enhance efficiency, minimise waste, and elevate product quality (C.-J. Chen, 2019). Additionally, process innovation can enhance supply chain responsiveness through improved efficiency and

reduced lead times. Implementing new technologies or automation can help minimise production time while improving logistics and transportation can reduce delivery times. Process innovation bridges the gap between sustainable supply chain management and supply chain responsiveness. It enables companies to effectively pursue their sustainability objectives while adapting to dynamic market demands. As a result, this can ultimately result in greater competitiveness and profitability over time.

Digitisation can significantly improve sustainable supply chain management and responsiveness in Ghana's manufacturing industry. Digitalisation operations allow a manufacturing company to closely monitor supply chain activities, pinpoint inefficiencies, and use data to drive process improvements (Ogbuke et al., 2022). Digitalisation can enhance a company's communication and collaboration with suppliers and customers, improving its supply chain responsiveness. Manufacturing companies in Ghana must prioritise sustainable supply chain management and responsiveness for long-term success. Process innovation and digitisation are crucial for improving sustainable supply chain management and responsiveness. Hence, manufacturing companies in Ghana must embrace these strategies to stay competitive in the global market.

2.10 Chapter Summary

This chapter primarily focuses on three key research areas for establishing a solid foundation for this study. The foundational theories of Supply Chain Management were reviewed, its essential operations were presented, and its recent transition toward sustainability was examined. The terminology related to sustainability in the supply chain is presented, along with the functions of process innovation and digitalisation in attaining supply chain sustainability and the consequent influence on the supply chain's responsiveness. Thus,

Sustainable Supply Chain Management and its constituent components have been extensively discussed. Furthermore, the research issues have been integrated. The research has identified the primary areas of Sustainable Supply Chain Management, which include driving forces, practises, process innovation, digitalisation, and performance. This chapter has presented the theoretical foundations for all aspects of the research phenomenon. The primary drivers behind adopting Sustainable Supply Chain Management are outlined below. The third research component pertains to the theoretical deliberations concerning the performance outcomes of adopting Sustainable Supply Chain Management. The section examines the relevant performance metrics and established performance dimensions of Sustainable Supply Chain Management, drawing on the TBL framework as a theoretical foundation.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the methodology employed in the study. The chapter outlines the research design, data collection methods, data analysis techniques, and ethical considerations adopted for the study.

3.2 Research Design

The research design is the framework that guides the collection, analysis, and interpretation of data in a research study (Creswell & Creswell, 2017). It outlines the procedures and methods that will be used to collect relevant data, as well as how the research questions or objectives will be addressed. The research design is essential for ensuring the study's findings' validity, dependability, and generalizability (Gunasekare, 2015). In social science research, there are three primary types of research designs: exploratory Research Design, descriptive Research Design, and explanatory Research Design.

Aligned with the quantitative approach of this study, the explanatory research design was adopted. The explanatory design enhances comprehension of a specific subject, leading to more objective and robust conclusions that facilitate the generalization of findings (Aggarwal & Ranganathan, 2019; Bloomfield & Fisher, 2019; Leavy, 2022). This design is particularly effective in furnishing factual insights about a particular scenario, involving collecting and analysing substantial data from a considerable target population through descriptive and inferential statistical methods, ensuring efficiency in resource utilization (Vali-Siar & Roghanian, 2022).

The study also employs a cross-sectional methodology. The cross-sectional research methodology entails gathering data from a select group of participants at a particular moment, aiming to capture a momentary representation of the studied variables (Wang & Cheng, 2020).

3.3 Research Approach

The research approach is a structured plan encompassing key steps, from foundational assumptions to data collection methods, analysis, and interpretation (Mehrad & Zangeneh, 2019). There are three primary research methods typically employed in social science studies. Approaches to research include quantitative, qualitative, and mixed methodologies.

The study adopted a quantitative research methodology. Quantitative research systematically gathers and scrutinizes numerical data to reveal patterns, correlations, and tendencies (McLeod, 2019). According to McLeod, 2019, the aim is to quantify variables and conduct hypothesis testing to produce objective and generalizable results. It involves collecting and analyzing numerical data using structured instruments such as questionnaires, surveys, and experiments (Mellinger & Hanson, 2020).

3.4 Study Area

The research was conducted within the framework of Ghana's manufacturing sector, a pivotal component of the country’s industrial landscape (Donkor et al., 2021). The sector encompasses firms spanning different manufacturing sectors (Boadu et al., 2020; Donkor et al., 2021; Omoregie et al., 2019; Stemn, 2019). Among the key contributors to economic growth, the Ghanaian manufacturing sector is vital in generating revenue (import and export duties, tax revenues, GDP), employment, resource utilization, and innovation

(Amoako et al., 2019). The Association of Ghana Industries (AGI) annual report in 2020 highlighted that these two sectors collectively contribute around 44% of the total manufacturing sector's contribution to Ghana's Gross Domestic Product annually (Bamfo et al., 2018).

3.5 Population

The study population is the entire group of individuals or elements the researcher wishes to investigate or draw conclusions about (Hassan, 2021). It represents the larger population from which the sample for the study will be drawn. The study's target population was comprised of 362 manufacturing firms registered under the Association of Ghana Industries (AGI) in the Greater Accra Region of Ghana. The choice of selection and inclusion of firms in Greater Accra was because of the region's dense concentration of manufacturing firms. This diversity allows for a comprehensive representation of different manufacturing sub-sectors, providing a holistic view of the industry landscape within Ghana. Firms registered under AGI showcase a commitment to industry standards, ethics, and professional conduct. Selecting these registered firms ensures credibility and adherence to recognized industry norms, potentially enhancing the reliability of data collected and insights drawn from these firms.

3.6 Sampling Technique

Sampling is a critical aspect of research that involves selecting a subset of individuals or items from a larger population for data collection and analysis. For this study, a probability sampling technique was employed. Precisely, the simple random sampling approach.

Probability sampling is an essential research technique that ensures each member of a population has a known, non-zero probability of being included in a sample (Trochim &

Donnelly, 2018). It employs randomness and probability theory to generate a sample representative of the larger population. Simple random sampling is a type of probability sampling in which each member of the population has an equal and independent probability of being selected for the sample (Kothari, 2014).

3.7 Sample Size

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970

Table 3. 1 Sample Size Determination Table

Krejcie & Morgan's table is based on a population proportion of .50 to ensure maximum sample size and a margin of error of 0.05. For a population size of 362, a 95% confidence level, and a 5% margin of error, using the sample size determination table by Krejcie & Morgan (1970), the study employed a sample size of 187.

3.8 Sources of Data

3.8.1 Primary Data Sources

Primary data was gathered through a survey of Ghana's manufacturing industry. Primary data sources are the original and firsthand data collected directly from the target population or source for a specific research study or investigation (Cerca et al., 2022). These sources involve the collection of new, unique, and context-specific information that had not been previously published or documented. The primary data sources for this study included a structured questionnaire that was administered to the manufacturing firms.

3.8.2 Secondary Data Sources

Secondary data refers to data that other researchers or organisations have already collected for purposes relating to the current study. Secondary data sources provide valuable context and insights to support the research findings. This study's secondary data sources included scholarly articles, books, research papers, and journals on sustainable supply chain management, supply chain responsiveness, process innovation, and digitalisation (Bolander et al., 2021).

3.9 Data Collection Instrument

The primary method used to collect data for the study was a structured questionnaire, which served as the primary data collection instrument. According to Saunders et al. (2009), a structured questionnaire involves administering a standardised set of questions to

respondents, who are expected to respond to a predetermined sequence. A structured questionnaire was deemed appropriate for the quantitative study due to its ability to facilitate the acquisition of objective responses that could be subjected to statistical analysis (Saunders et al., 2009). The instrument utilized in this study encompassed paper-based and electronic formats and was administered to the participants. According to Neelankavil (2007), using structured questionnaires ensured a higher level of consistency, resulting in the acquisition of objective and reliable data. Additionally, it provided enhanced levels of anonymity, privacy, and convenience for participants throughout the completion process

The questionnaire was organized into four sections. Section A comprised the demographic profile of the respondents as well as the organizational profile. Section B questions focused on the first variable, sustainable supply chain management practices. Items in Section C focused on the second variable, supply chain responsiveness, which explored the respondents' views regarding their firms' supply chain responsiveness. Question items in Section D focused on the third variable, process innovation, which explored the respondents' ideas regarding their firms' innovation initiatives. Section E questions were tailored to the study's fourth variable, digitalization practices by the respondents' firms. The process was undertaken to acquire appropriate information to test the research hypotheses. A total of 27 question items were modified to suit the study's objectives.

3.10 Data Analysis and Processing

Data collected underwent analysis using theSmart PLS 4 package and the Statistical Package for the Social Sciences (SPSS). Before analysis, the dataset underwent thorough data cleaning to identify and rectify any missing values or inconsistencies, ensuring the accuracy and reliability of the data. Descriptive statistics, including measures such as

means, standard deviations, and frequencies, were used to summarize and present the key characteristics of the quantitative data, providing an initial overview of the data distribution. Data visualization tools within SPSS were employed to create charts, graphs, and tables that visually represented the quantitative findings, aiding in conveying trends, patterns, and relationships in the data.

Structural Equation Modeling (SEM), a powerful statistical technique for analyzing complex relationships between multiple variables, was employed in this study using SMART PLS to analyze the relationships among Sustainable Supply Chain Management (SSCM), supply chain responsiveness, process innovation, and digitalization. The research model was specified using SMART PLS, including the theoretical relationships among variables. This step involved defining the structural model and the measurement model. Data preprocessing included scaling variables, handling missing data, and ensuring the dataset met the requirements for SEM analysis. SMART PLS estimated the parameters of the structural model, calculating path coefficients, R-squared values, and other relevant statistics to assess model fit. The fit of the SEM model was evaluated to determine how well it represented the relationships in the data, including examining goodness-of-fit indices and assessing the significance of path coefficients.

3.11 Justification for the Use of Smart PLS

The basis for choosing Smart PLS as the analytical instrument for this study is supported by several arguments that are consistent with the research goals and methodological aspects. To begin with, Smart PLS is selected on account of its capability to perform Structural Equation Modeling (SEM), an essential component of the research

methodology. Smart PLS provides a comprehensive framework for analyzing the complex interconnections between Sustainable Supply Chain Management (SSCM), supply chain responsiveness, process innovation, and digitalization within the study's objective of investigating these relationships.

In addition, the ability of the package to process intricate models is crucial for accommodating the multifaceted characteristics of the research investigation. In light of the investigation into the relationships among numerous variables in the study, Smart PLS offers the requisite adaptability and computational capability to efficiently analyze complex models, thus augmenting the profundity and all-encompassingness of the research outcomes. The pragmatic consideration of sample size requirements further contributed to the rationale behind the selection of Smart PLS. In contrast to certain alternative SEM software packages that require more substantial sample sizes to ensure precise analysis, Smart PLS exhibits a high degree of adaptability in its usage, as it can accommodate investigations with comparatively smaller sample sizes while maintaining rigorous analytical standards. This particular attribute offers significant benefits in situations where acquiring a substantial sample size is either unfeasible or resource-intensive.

The ability of Smart PLS to effectively manage non-normal data provides additional support for its appropriateness in this study. Smart PLS provides a dependable solution for conducting SEM analysis in social science research, where data distributions may deviate from normality, thereby ensuring the validity and accuracy of results despite the existence of non-normal data distributions.

3.12 Operationalisation of Constructs

One independent variable, one dependent variable, one meditation variable, and one moderating variable comprised the model for the study. The exogenous variable was assessed using seven indicators (SSP1, SSP2, SSP3, SSP4, SSP5, SSP6, and SSP7) under the independent variable sustainable supply chain management. The dependent variable, which consists of six indicators (SCR1, SCR2, SCR3, SCR4, SCR5, and SCR6), is supply chain responsiveness, which functions as the endogenous variable. As the mediating variable, process innovation was denoted by the following seven indicators: PI1, PI2, PI3, PI4, PI5, and PI7. The moderating factor in this model, digitization, was represented by the following seven indicators: DIGB1, DIGB2, DIGB3, DIGB4, DIGB5, DIGB6, and DIGB7. The trajectories of the model were the subject of three hypotheses that were formulated using latent variables. By employing process innovation as a moderator and digitalization as a mediator, these hypotheses aim to forecast that the endogenous variable supply chain responsiveness will have a positive association with the exogenous variable sustainable supply chain management. Sustainable Supply Chain Management Practices (SSCMP), Supply Chain Responsiveness (SC_RES), Process Innovation (PRO_INOV), and Digitalization (DIGI) are the constructs represented in the study.

To attain long-term sustainability, SSCMP refers to the adoption of environmentally and socially responsible practices throughout the supply chain. The concept of Supply Chain Responsiveness (SC_RES) pertains to the capacity of a supply chain to promptly adjust to fluctuations in market conditions, consumer demand, and additional external variables. Process innovation (PRO_INOV) pertains to the implementation of novel techniques, tools, or technologies to enhance the quality, efficacy, and effectiveness of operations

within a supply chain.

Digitalisation (DIGI) signifies the amalgamation of data-driven strategies and digital technologies with the aim of augmenting visibility, collaboration, and decision-making within the supply chain.

By operationalising these constructs with measurable indicators, the study aims to assess the relationships between sustainable supply chain management practices, supply chain responsiveness, process innovation, and digitalisation. These operationalisations establish the basis for data collection and analysis to address the research objectives.

3.13 Measurement of Variables and Sources

VARIABLE	MEASUREMENT ITEM	SOURCE
SUSTAINABLE SUPPLY CHAIN MANAGEMENT PRACTICES	Renewable Energy Sources	Kothari, D. P., Ranjan, R., & Singal, K. C. (2021).
	Environmental Management and Compliance	López-Concepción, A., Gil-Lacruz, A. I., & Saz-Gil, I. (2022)
	Waste Management and Reduction	Kabirifar, K., Mojtahedi, M., Wang, C., & Tam, V. W. (2020)
	Corporate Social Responsibility (CSR) and Supply Chain Ethics	Modak, N. M., Sinha, S., Raj, A., Panda, S., Merigó, J. M., & de Sousa Jabbour, A. B. L. (2020)
	Sustainable Transportation	Zhao, X., Ke, Y., Zuo, J., Xiong, W., & Wu, P. (2020).
	Sustainable Packaging	Boz, Z., Korhonen, V., & Koelsch Sand, C. (2020)
	Sustainability Reporting and Metrics	Karaman, A. S., Kilic, M., & Uyar, A. (2020)
SUPPLY CHAIN RESPONSIVENESS	Supply Chain Agility and Flexibility	Shukor, A. A. A., Newaz, M. S., Rahman, M. K., & Taha, A. Z. (2021)
	Inventory Management and Visibility	Roy, V. (2021)
	Supplier Relationship Management and Collaboration	Adesanya, A., Yang, B., Bin Iqdara, F. W., & Yang, Y. (2020)
	Production and Manufacturing Agility	Altay et al., 2018)
	Supply Chain Risk Management and Contingency Planning	Pournader, Kach, & Talluri, 2020
	Customer-Centric Supply Chain Management	Gupta, Goswami, Daultani, Biswas, & Allada, 2023

PROCESS INNOVATION	Continuous Improvement and Process Excellence	van Assen, 2021
	Cross-Functional Collaboration and Teamwork	Kolling, Lima-Cruz, & Medeiros, 2022
	Research and Development (R&D) for Process Improvement	Paiva, Ribeiro, & Coutinho, 2020
	Technology Adoption and Process Innovation	Stornelli, Ozcan, & Simms, 2021
	Process Design for Flexibility and Adaptability	Shukor, Newaz, Rahman, & Taha, 2021
	Employee Engagement and Empowerment for Process Innovation	Kolling et al., 2022
	Process Performance Measurement and Evaluation	Goglio et al., 2023
DIGITALIZATION	Digital Transformation in Operations	Zhao, Hong, & Lau, 2023
	Data Analytics and Insight Utilization	Duygan, Fischer, & Ingold, 2023
	Process Automation and Optimization	Helmer, Huynh, & Rossano-Rivero, 2022
	Cybersecurity	Ajayi & Laseinde, 2023
	Cloud Technology Adoption	Giannakis, Spanaki, & Dubey, 2019
	AI and ML Integration	Helm et al., 2020
	Digital Customer Experience	Zhao, Hong, & Lau, 2023b

Table 3. 2 Measurement of variables and sources

3.14 Reliability and Validity

Internal consistency reliability (IR), construct reliability, convergent validity (average variance extracted), and multicollinearity (Inner VIF values) were used to assess the Reliability and Validity of the study's model. The study's indicator and construct reliability were assessed on a threshold value of > 0.7. There was a significant degree of internal consistency among the digitalisation-related components. All three reliability indices (Cronbach's alpha, a, and c) were above the generally accepted criterion of 0.70. All of the elements in the digitalisation variable appeared to be measuring the same concept.

There was also a significant internal consistency among the process innovation-related variables. Both rho_a and c were high, much over the usually recognised threshold of 0.90, indicating a very high level of dependability even though Cronbach's alpha is just below it.

All elements in the process innovation variable appeared to be measuring the same thing. There was a great deal of consistency among the supply chain responsiveness variables. All three indices of dependability (Cronbach's alpha, a, and c) were above the generally accepted criterion of 0.70. All of the supply chain responsiveness variable components also appeared to be measuring the same concept. These analyses indicate a significant internal consistency among the four assessed variables (digitalisation, process innovation, supply chain responsiveness, and sustainable supply chain management practices). High levels of reliability in the measurement of these constructs are consistently indicated by the internal consistency measures (Cronbach's alpha, a, and c).

The study tested convergent validity by examining the AVEs of all the variables in the SEM model. An AVE with a minimum threshold of 0.5 for a construct to show convergent validity has been recommended by Fornell and Larcker (1981), Bagozzi and Yi (1988) and Hair et al. (2011). The results revealed that the AVEs of all the latent variables ranged from 0.648 to 0.655, thus greater than 0.5, indicating that the validity of the measurement scale was convergent. The study further checked multicollinearity using variable inflation factor (VIF) values. Hair et al. (2014) noted that multicollinearity diagnostics is assessed to ensure that the path coefficients are free from bias while minimising the significant levels of collinearity among the predictor constructs. The inner VIF values of the exogenous indicators were DIG (3.305), PI (3.3705), and SSP (3.784), respectively. This showed the absence of multicollinearity between the exogenous variables.

3.15 Ethical Consideration

According to Aberdeen (2013), several key principles should be considered when collecting data, including obtaining informed consent, ensuring voluntary participation,

respecting the right to privacy, addressing plagiarism issues, maintaining anonymity, and ensuring confidentiality. Regarding informed consent, participants were duly informed and made aware of their active participation in the data collection process, with consent acquired from the management of the manufacturing firms under investigation.

All participants in the exercise were free to choose whether or not to participate, and no individual was compelled to do so against their own volition. Furthermore, the attainment of the right to privacy was facilitated by granting respondents the opportunity to complete the questionnaire using their preferred method of communication. Regarding the issue of plagiarism, all pertinent information acquired from diverse sources was paraphrased and duly cited using in-text and end-text references.

Anonymity was maintained by deliberately omitting personal identifiers, such as names and other confidential personal information, which could potentially reveal the participants' identities. These measures safeguarded the confidentiality of the respondents' identities from public exposure. Confidentiality was upheld through the assurance given to respondents that all provided information would be treated as confidential, exclusively used for this study, and not disclosed for any other reason. In conclusion, the research endeavour diligently attended to all potential ethical concerns suitably.

3.16 Chapter Summary

The chapter provides an overview of the basic elements of the research methods, specifically concerning research philosophy, research design, study area, population, sampling procedure, data collection instrument, data collection procedure, and data processing and analysis. The research employed a quantitative methodology. The study's research objectives necessitated the adoption of an explanatory research design. The data

analysis will use descriptive and inferential statistical methods, such as frequencies, percentages, and PLS-SEM. The findings will be presented in the form of tables and figures.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter analyses the study's findings concerning the research objectives. The chapter provides an analysis of sustainable supply chain strategies, with a particular focus on the roles of process innovation and digitization. Furthermore, it explores the impact of these strategies on enhancing supply chain responsiveness. The study's research goals were examined using the partial least squares (PLS) method in structural equation modelling (SEM).

4.2 Demographics of Respondents

This part goes into the demographics of the participants who took part in the study. The general factors being looked at are gender, level of education, length of tenure, and department. This section aims to get an overview of how the sample group is made up. This is to find patterns and differences in the subject population by looking at these essential demographic factors. These perspectives are beneficial for putting other results in context and coming to useful conclusions. It also shows the importance of recognising the sample's variety and usefulness, which gives a helpful background for understanding the study's findings.

Table 4.1 displays the distribution of subjects by gender, with females comprising 58.8% and males constituting 41.2% of the total sample. This indicates that the sample exhibits a balanced distribution of gender. Understanding gender distribution is necessary for

assessing various groups' potential responses and involvement in supply chain sustainability initiatives and technological advancements.

The age groups of the participants exhibit a balanced distribution across a wide range. The most significant proportion of individuals belongs to the age groups of 31-40 and 41-50. This illustrates a varied representation across various age groups. Age groups can have different levels of experience and adaptability to technological advancements. This is particularly relevant in process innovation and digitalisation, as it allows assessing the possibility of adopting and adapting these technologies among various age groups.

Participants' educational backgrounds vary considerably. Bachelor's degree holders are the most numerous, followed by Master's degree holders. About a quarter hold HND or equivalent qualifications, while a lesser proportion hold Doctoral degrees. This indicates that most of the sample has at least a Bachelor's degree. Their educational heritage significantly influences individuals' knowledge and appreciation of sustainable practices and technological advancements. Participants with a higher level of education are more likely to have a deeper understanding of the complexities of supply chain sustainability.

The participants' experience in the manufacturing industry is diverse. Almost half of the participants have between two and five years of experience, and those with more than five years of experience also make up a significant portion. Les participants with less than one year of experience account for approximately one-quarter of the total. This demonstrates an even distribution of experience levels. Length of service in the manufacturing industry is a crucial indicator of participants' exposure to evolving practices. Those with longer tenures may contribute institutional knowledge, whereas those newer to the industry may

offer fresh perspectives on integrating process innovation and digitalisation within supply chain management.

The participants represent diverse manufacturing industry departments. Operations hold the highest position, followed by Procurement, Stores/Finance, and Logistics. This distribution reflects participation from a variety of operational sectors. The department/division to which participants adhere is highly relevant, as different departments may exert varying degrees of influence on supply chain practices. The Operations department may be at the forefront of implementing technological innovations, while the Procurement department could have a pivotal role in selecting suppliers based on sustainability criteria. The responses demonstrate a well-balanced and diverse participant pool concerning various demographic characteristics.

Table 4. 1 Demographics of Respondents

		Frequency	**%**
Gender	Female	110	58.8%
	Male	77	41.2%
Total		**187**	**100.0**
What is your age group?	18-30 Years	34	18.2%
	31-40 Years	95	50.8%
	41-50 Years	45	24.1%
	Above 50 Years	13	7.0%
Total		**187**	**100.0**
Educational Qualification	Bachelor's degree	100	53.5%
	Doctorate	5	2.7%
	HND or Equivalent	23	12.3%
	Master's degree	59	31.6%
Total		**187**	**100.0**

How long have you been working in the Manufacturing Industry?	2 to 5 years	90	48.1%
	Above five years	56	29.9%
	Under a Year	41	21.9%
Total		**187**	**100.0**
Which department/division are you currently working in? (Please select the appropriate option.)	Logistics	17	9.1%
	Operations	77	41.2%
	Procurement	55	29.4%
	Stores/Finance	38	20.3%
Total		**187**	**100.0**

Source: Field Data, 2023

4.3 Familiarity with sustainability and digitalisation

From the data in Table 4.2, most participants have received formal training or education in supply chain management, sustainability, and digitalisation. This suggests that the participants in the study are knowledgeable and educated, which indicates that they have a strong understanding of and ability to participate in sustainable supply chain practices.

Many participants know sustainable supply chain management practices, process innovation, and digitalisation. The participants in this study demonstrate a high level of expertise and familiarity with the concepts being discussed. The participants' high level of understanding indicates their ability to engage with the subject matter effectively.

These findings establish a knowledgeable and potentially involved group of participants who can provide valuable insights on their readiness to understand and contribute to discussions on sustainable supply chain management practises, process innovation, and digitalisation in the Ghanaian manufacturing industry.

Table 4. 2 Familiarity

Do you have formal training or education in supply chain management, sustainability, or digitalisation?		
	N	%
No	23	12.3%
Yes	164	87.7%
How familiar are you with sustainable supply chain management practices, process innovation, and digitalisation in the manufacturing industry?		
Neutral	17	9.1%
Somewhat Familiar	54	28.9%
Somewhat Unfamiliar	16	8.6%
Very Familiar	95	50.8%
Very Unfamiliar	5	2.7%

Source: Field Data, 2023

4.4 Descriptives of main variables

The following section provides the descriptive analysis of the variables under study by accessing the mean, standard deviation, skewness, and kurtosis and subsequently analysing the responses based on them. The variables under investigation are Sustainable Supply Chain Management practices, Supply chain responsiveness, process innovation, and digitilisation.

4.4.1 Descriptives of Sustainable Supply Chain Management Practices

This section analyses the firms' responses regarding sustainable supply chain management practices. This section aims to provide an overview of the current state of sustainability initiatives, concentrating on key practises such as eco-friendly procurement, waste reduction, ethical labour practises, and carbon footprint reduction. Table 4.3 contains the findings for this variable.

Table 4. 3 Sustainability Practices

Descriptive Statistics

Indicator	Mean	S.D	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Using Renewable Energy Sources	4.2	0.791	-1.368	0.178	2.976	0.354
Supplier Audits for Environmental Compliance	4.07	0.786	-0.938	0.178	1.738	0.354
Implementing Waste Reduction Strategies	4.34	0.748	-1.433	0.178	3.499	0.354
Promoting Ethical Labour Practices in the Supply Chain	4.24	0.763	-0.879	0.178	0.592	0.354
Optimizing Transportation for Reduced Emissions	4.03	0.772	-0.896	0.178	1.806	0.354
Investing in Eco-Friendly Packaging Materials	4.21	0.744	-0.992	0.178	2.223	0.354
Tracking and Reporting Sustainability Metrics	4.34	0.81	-1.623	0.178	3.408	0.354

Source: Field Data, 2023

The statistics in Table 4.3 suggest that participants strongly prefer to use renewable energy sources, as evidenced by the high mean score of 4.2. This indicates a positive impression and execution of sustainable energy practises throughout the supply chain. The low standard deviation suggests that the replies are closely around the mean. This indicates a consistent trend among the participants, indicating a common commitment to using renewable energy. The skewness value of -1.368 indicates a subset of individuals with a strong preference for renewable energy sources, as indicated by their high ratings. A high positive kurtosis suggests a substantial consensus supporting renewable energy sources, as answers are concentrated at the extreme ends.

A mean score of 4.07 indicates a high desire to conduct environmental compliance checks on suppliers. This demonstrates a strong commitment to maintaining environmental

standards across the supply chain. The comparatively low standard deviation indicates that responses are near the mean. This demonstrates that there is a consistent tendency among those in favour of supplier verification. The distribution is significantly tilted to the left due to the negative skewness. In other words, a group may agree strongly on supplier inspections.

The mean score of 4.34 suggests a strong commitment to implementing waste reduction measures. This demonstrates the company's efforts to decrease supply chain waste. A low standard deviation shows a steady trend in all individuals' replies. This indicates the responders' coordinated efforts to reduce waste. A negative skewness in the distribution suggests a leftward skew. This shows the presence of a subset of individuals who scored exceptionally well in applying waste reduction measures. The strong positive kurtosis indicates a high level of agreement on waste reduction measures, with little variation in replies.

The high mean of 4.24 reflects the firm's ongoing commitment to supporting ethical work practises. This displays a proactive attitude to ensure fair and ethical treatment of manufacturing workers. Because of the low standard deviation, participant responses are around the mean, showing a continuous trend. This shows that an organisation is working hard to promote ethical employment practises. The negative skewness indicates the distribution is somewhat biased to the left. This shows that some responders may consistently advocate for ethical work practises. Despite considerable diversity in replies, positive kurtosis suggests a high level of agreement with promoting ethical work practises.

Furthermore, a mean score of 4.03 indicates a strong commitment to proactively minimising the environmental effect of transportation in the supply chain, emphasising lowering emissions, as shown in Table 4.3. The low standard deviation indicates that the replies are closely clustered around the mean. This implies that participants have a continuous preference for low-emission transportation practises. Negative skewness shows that a subset of individuals may have a notably high consensus in favour of emission-reducing transportation. Positive kurtosis indicates a high level of agreement in optimising transportation to reduce emissions.

A mean rating of 4.21 indicates a strong commitment to investing in ecologically friendly packaging materials. This is a proactive approach to minimise the environmental effect of supply chain packaging. The low standard deviation implies that responses are tightly clustered around the mean, suggesting a consistent tendency among participants. This signifies a joint effort to invest in ecologically friendly packaging. The distribution has a minor skewness to the left. This indicates a subset of individuals with significantly high scores in their propensity to invest in eco-friendly packaging materials. Positive kurtosis shows some consensus about the desire for eco-friendly packaging materials but with considerable variation in the replies.

The high mean of 4.34 indicates a sufficient commitment to monitoring and reporting sustainability parameters. This displays a proactive strategy to share sustainability activities across the supply chain transparently. Responses are more varied around the mean, as demonstrated by the comparatively large standard deviation.

4.4.2 Descriptives of Supply Chain Responsiveness

Table 4. 4 Supply Chain Responsiveness

Descriptive Statistics						
	Mean	S.D	Skewness	Std. Error	Kurtosis	Std. Error
My organization is able to quickly adjust its supply chain processes in response to changes in market demand or conditions.	4.34	0.804	-1.58	0.178	3.31	0.354
My organization has real-time visibility into inventory levels across the supply chain, enabling swift decision-making.	4.31	0.755	-1.645	0.178	4.449	0.354
My organization collaborates closely with suppliers to ensure quick response times in case of disruptions or changes.	4.41	0.716	-1.775	0.178	5.454	0.354
My organization has the capability to swiftly adjust production and manufacturing processes to meet changing demands.	4.39	0.757	-1.767	0.178	4.694	0.354
My organization has well-defined contingency plans in place to handle unexpected disruptions in the supply chain.	4.2	0.835	-1.731	0.178	4.502	0.354
My organization places a high priority on meeting customer demands and is able to respond quickly to their changing needs.	4.17	0.867	-1.629	0.178	3.898	0.354

Source: Field Data, 2023

According to the results, with a mean score of 4.34, respondents are positive that their organisation can quickly adapt its supply chain procedures to consumer demand and market conditions shifts. Participants are confident that their firms' supply chain operations can be

quickly adapted to meet the needs of a fluctuating market. This demonstrates that the surveyed firms can adjust to new circumstances quickly. The low standard deviation suggests that the responses are clustered closely around the mean. This indicates widespread confidence in the group's ability to respond quickly to market shifts or consumer demand.

Table 4.4 shows that when asked how much they agreed with the statement, "Our company has real-time visibility into inventory levels throughout the supply chain, allowing for quick decisions," the average response was 4.31. Typical respondents think their companies can see inventory levels in real-time, which would help them make better choices more quickly. As a result, it appears that the companies examined had effective inventory management systems in place. The low standard deviation suggests that the responses are clustered closely around the mean. This shows that people are becoming more assured in their company's ability to see inventories in real-time and make quick decisions.

Furthermore, with a mean score of 4.31, it's clear that most respondents strongly believe that their company has full insight into inventory levels at all points in the supply chain. Typical respondents think their companies can see inventory levels in real-time, which would help them make better choices more quickly. As a result, it appears that all the companies examined had effective inventory management systems. The low standard deviation suggests that the responses are clustered closely around the mean. This shows that personnel are becoming more assured in their company's ability to see inventories in real-time and make quick decisions.

Regarding the company's ability to collaborate closely with suppliers to enable quick reaction times in the case of interruptions or modifications, the mean score of 4.41 shows great agreement. On average, respondents felt that their companies put a premium on working closely with their suppliers to ensure quick responses to interruptions and changes. The importance placed on having good connections with suppliers is reflected in the survey results. The low standard deviation suggests that the responses are clustered closely around the mean. Respondents unanimously assess that their company values supplier engagement to ensure quick response times.

A mean score of 4.39 out of 5 suggests widespread agreement that their companies are very responsive to changes in consumer demand. Respondents are confident that their companies can swiftly modify their manufacturing and production procedures to meet changes in customer demand. This suggests that the companies examined use flexible manufacturing methods. The little standard deviation suggests that the responses are clustered closely around the mean value. This shows that most respondents agree that their company can easily change its manufacturing methods.

There is a general agreement that robust backup procedures have been implemented to deal with unexpected interruptions in the supply chain, as shown by the mean score of 4.2 in Table 4.4. Respondents are confident that their companies have well-articulated plans to deal with supply chain interruptions that are not foreseen. This suggests that the surveyed businesses place a premium on being ready for the unexpected. While there is significant variety in replies (as indicated by the moderate standard deviation), most participants appear to have faith in the robustness of their company's contingency preparations.

The mean score of 4.17 on the importance of fulfilling customer expectations and the ability to adjust to their changing requirements quickly demonstrates widespread consensus on the significance of doing so. Participants believe their companies emphasise customer satisfaction and can adapt swiftly to new or changing demands. This points to a customer-focused mentality on the part of the businesses polled.

Participants appear to agree on the responsiveness of their firms' supply chain procedures, as evidenced by high mean scores and low standard deviations across all claims. The result implies that the companies assessed have the resources necessary to respond rapidly to shifts in the market, work productively with their suppliers, and put their customers' needs first.

4.4.3 Descriptives of Process Innovation

Table 4. 5 Process Innovation

Descriptive Statistics						
	Mean	S.D	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Embracing a culture of continuous improvement in processes	4.21	0.678	-1.548	0.178	5.845	0.354
Encouraging cross-functional collaboration	4.06	0.794	-1.810	0.178	5.532	0.354
Allocating resources to research and development for process enhancement	4.19	0.807	-1.296	0.178	2.524	0.354
Actively adopting emerging technologies for process optimization	4.33	0.828	-1.836	0.178	4.943	0.354
Designing processes with flexibility to accommodate change	4.21	0.806	-1.456	0.178	3.081	0.354
Involving employees at all levels in process innovation efforts	4.07	0.652	-1.490	0.178	5.951	0.354

Using metrics and evaluation methods to assess process performance	4.18	0.695	-1.330	0.178	4.516	0.354

Strong agreement with the statement "Embrace a culture of continuous improvement in processes" is shown by the high mean score of 4.2. Participants generally agree that a continuous improvement culture is highly valued in their organisations. Given that a culture of constant improvement is a crucial component of sustainable supply chain management practises, this is relevant to the study. Responses appear closely concentrated around the mean, as indicated by the small standard deviation. This trend shows that employees generally agree that their company places a premium on continuously improving processes.

A mean score of 4.06 suggests widespread support for fostering cooperation between departments. Participants feel that their companies emphasize interdisciplinary teams working together to innovate processes. This is critical since working together along the supply chain is essential to implementing sustainability measures. Participants generally agree their company encourages cross-functional cooperation in process innovation, notwithstanding some variation in replies (as indicated by the modest standard deviation).

With a mean score of 4.19, respondents strongly agree that their companies invest in R&D to improve existing processes. According to those surveyed, their companies invest in R&D to improve internal procedures. This is crucial since R&D spending is directly linked to supply chain innovation and sustainability. The standard deviation is moderate, indicating some variation in answers. However, most participants are confident in their company's dedication to investing in R&D to improve internal processes.

The high mean indicates strong agreement with the assertion that their companies regularly employ new technology to optimise processes. Respondents are confident that their organisations routinely implement cutting-edge tools to improve operational efficiency. This is critically important to the study since technology drives responsive and sustainable supply chains. The standard deviation is moderate, indicating some variation in answers. However, most respondents are confident that their company adopts cutting-edge technologies to improve operational efficiency.

With such a high mean, it's clear that most respondents think their companies' procedures are built to be adaptable to new circumstances. Respondents are confident that their organisations routinely implement cutting-edge tools to improve operational efficiency. This is critically important to the study since technology drives responsive and sustainable supply chains. The standard deviation is moderate, indicating some variation in answers. However, most respondents are confident that their company actively adopts cutting-edge technologies to improve operational efficiency.

With a mean score of 4.07, respondents strongly agree that their company encourages participation from workers at all levels in process innovation activities. Respondents have confidence that their companies promote involvement from all levels of staff in process innovation. It's vital because encouraging innovation among staff members may improve supply chain sustainability and responsiveness. Responses appear tightly concentrated around the mean, as indicated by the small standard deviation. This suggests that respondents generally agree that process innovation is highly valued at their workplace.

A strong agreement that their companies employ measurements and assessment methodologies to monitor process effectiveness is shown in the high mean score of 4.18. Respondents believe their organisations use metrics and evaluation techniques to gauge process effectiveness. This is noteworthy because it points to a data-driven approach to process innovation, which is essential to developing environmentally friendly supply chain procedures. The standard deviation is moderate, indicating some variation in answers. However, most survey respondents said they trusted the measures their company used to evaluate process effectiveness.

The findings show that manufacturers in Ghana place a significant priority on measures to improve their processes. The high means and low to moderate standard deviations show widespread agreement among respondents that process innovation is a priority at their respective companies. Therefore, the studied companies will likely be well-prepared to exploit process innovation and digitalisation in Ghana's manufacturing sector since they are already actively involved in projects promoting sustainable supply chain practises.

4.4.4 Descriptives of Digitilisation

Table 4. 6 Digitilisation Initiatives

Descriptive Statistics

	Mean	S.D	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Integration of Digital Tools in Operations	4.18	0.835	-1.360	0.178	2.424	0.354
Utilization of Data-Driven Insights	4.28	0.868	-1.584	0.178	2.736	0.354
Automation of Routine Tasks and Processes	3.89	0.812	-1.009	0.178	1.536	0.354
Investment in Cybersecurity Measures	4.01	0.796	-0.794	0.178	0.609	0.354
Adoption of Cloud Computing for Scalability and Flexibility	4.29	0.744	-1.170	0.178	2.626	0.354

Implementation of Artificial Intelligence (AI) and Machine Learning (ML)	4.09	0.825	-1.380	0.178	2.596	0.354
Digitalization of Customer Interactions and Experiences	4.26	0.717	-1.132	0.178	3.084	0.354

Source: Field Data, 2023

Respondents indicated that digital tools are commonly utilised in their firms, with a mean score of 4.18. There is a consensus indicating that the businesses surveyed are actively embracing and putting into practise digital solutions to enhance and expedite their internal processes.

Participants also acknowledge that their firms rely heavily on data-driven insights, with a mean score of 4.28. This emphasises the importance of making data-driven decisions for smooth and efficient operations.

Participants decisively acknowledged their companies' high priority on cybersecurity, as evidenced by a mean score of 4.01. This score reflects their deep understanding of the significance of investing in cybersecurity to safeguard their digital operations and assets.

Participants strongly agree that cloud computing greatly benefits their businesses due to its impressive scalability and adaptability, as evidenced by the mean score of 4.29. It appears that the businesses surveyed are utilising internet-based solutions to enhance the scalability and adaptability of their operations. Participants agreed (4.29 average) that their companies utilise automated procedures. It appears that the companies surveyed make active use of technology to improve their internal procedures.

Respondents also agree that their companies prioritise digitally enhanced customer service, as evidenced by the impressive mean score of 4.26 out of 5. The companies assessed place great importance on digital consumer touchpoints and experiences.

Respondents support the adoption of diverse digital technologies and practises by their firms. This aligns with the significance of digitalization in sustainable supply chain management practises in Ghana's manufacturing sector. It appears that the assessed firms are effectively utilising digitalization to improve their operational capabilities.

4.5 Assessment of the Partial Least Square – Structural Equation Model

The study's research objectives were evaluated using Partial Least Squares (PLS), a statistical technique known as structural equation modelling. The first analysis involved assessing key underlying assumptions and model qualities, such as item loadings, indicator reliability (IR), construct reliability (CR), convergent validity (average variance extracted), multicollinearity (VIF), and discriminant validity. This assessment aimed to ensure that the study achieved satisfactory levels of validity and reliability (Hair et al., 2014). Also, these model qualities were tested to make meaning out of the structural model results (Henseler et al., 2009; Ringle et al., 2011).

4.5.1 The structural and metric model specification

This section defined the model's structure by defining the exogenous and endogenous variables and the indicators that go with them. The study's model included one independent variable, one dependent variable, one meditation variable, and one moderating variable. The model’s structure is depicted in Figure 4.1.

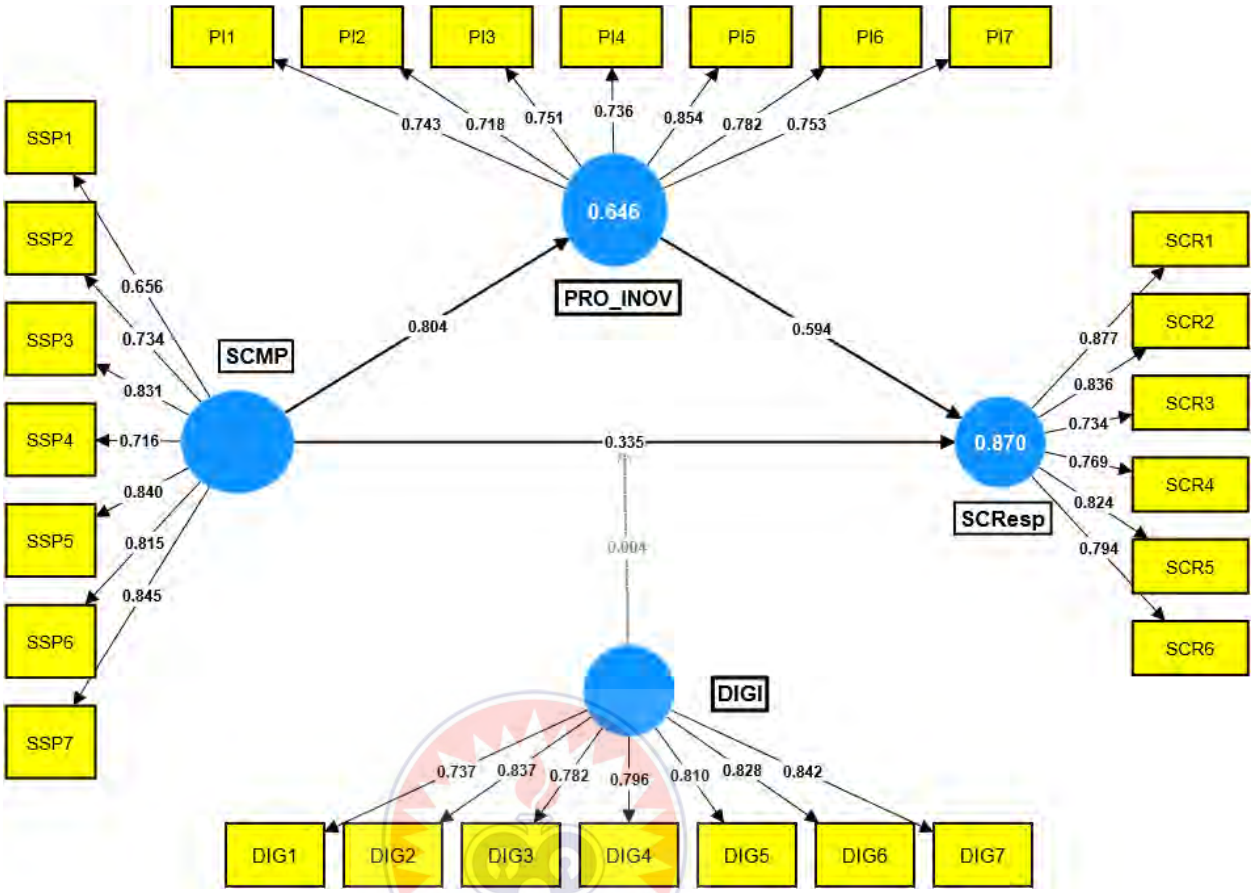

Figure 4. 1 Model Construct

In the model examining sustainable supply chain management, seven indicators (SSP1, SSP2, SSP3, SSP4, SSP5, SSP6, and SSP7) were employed to measure the exogenous variable. Supply chain responsiveness, comprising six indicators (SCR1, SCR2, SCR3, SCR4, SCR5, and SCR6), served as the endogenous variable. Process innovation, functioning as the mediating variable, was represented by seven indicators (PI1, PI2, PI3, PI4, PI5, and PI7). Digitization, the moderating factor in this model, was denoted by seven indicators (DIG1, DIG2, DIG3, DIG4, DIG5, DIG6, and DIG7). Latent variables were utilised to generate three hypotheses for the model's trajectories, as shown in Figure 4.1. Using process innovation as a mediator and digitalisation as a moderator, these hypotheses predict a positive link between the exogenous variable sustainable supply chain

management and the endogenous variable supply chain responsiveness. It predicted a positive relationship between SSCMP and SCRep, SSCMP and SCREP through PRO__INOV, and SSCMP and SCrep moderated by DIGI.

Each construct's item loadings (indicators) were also evaluated to further test the model's structure. This was done to evaluate how well the indicators (item loadings) could measure each construct in the study. An indicator or item with a loading of 0.70 or above is considered a reliable measurement of its construct (Henseler et al., 2009). However, the model does not include a construct quality indicator if its loading is less than 0.70. Figure 4.2 displays the “evaluated” version of the model. Except for one indicator under SSCMP, all item loadings for all constructs were over the 0.70 level recommended by Henseler et al. (2009) (see Figure 4.2). This indicates that such an item (indicator) did not measure the study’s constructs within the firms studied.

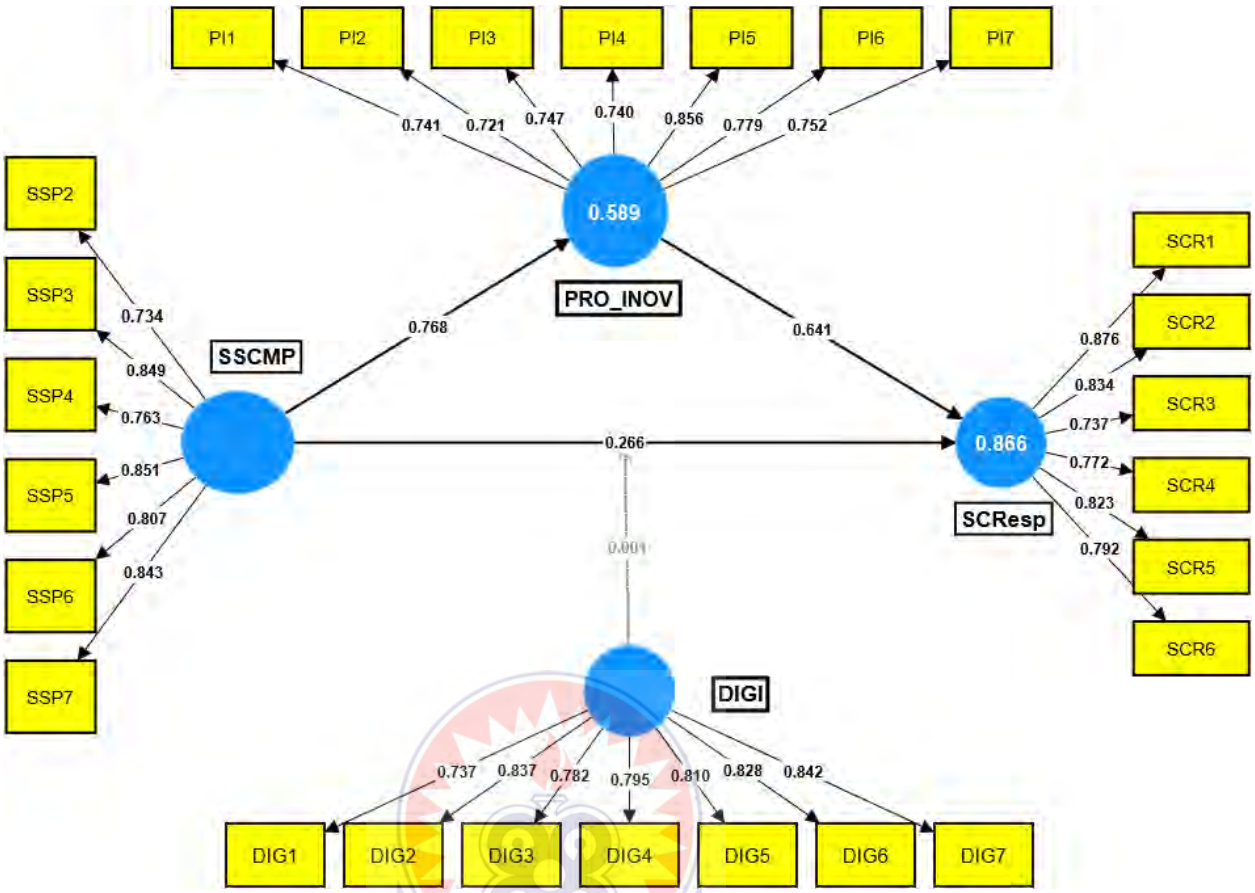

Figure 4. 2 Model Construct (Evaluated)

Examining the item loadings in greater detail in Figure 4.2 demonstrated indicator reliability using the Henseler et al. (2009) minimal cut-off 0.7. Some items were omitted from the model because their loadings on the relevant constructs were below 0.7, indicating that they did not adequately measure that construct. In particular, the exogenous variable sustainable supply chain management practises had a loading of 0.656 on SSMP1 deleted.

4.6 Model Reliability

Internal consistency reliability (IR), construct reliability, convergent validity (average variance extracted), and multicollinearity (Inner VIF values) were reported in Table 12 below.

Table 4. 7 Reliability of Model

Variables	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	(AVE)	VIF
Digitalisation	0.91	0.924	0.928	0.648	3.305
Process innovation	0.88	0.881	0.907	0.583	3.370
Supply chain responsiveness	0.892	0.892	0.918	0.651	
Sustainable supply chain management practices	0.894	0.9	0.919	0.655	3.784

4.6.1 Internal Consistency (Cronbach's alpha and Composite reliability (rho a & c)

The study's indicator and construct reliability are displayed in Table 4.7. Generally, IR indicators should have a threshold value of > 0.7 (Chin, 2010; Hair et al., 2011; Latan & Ghozali, 2013; Wong, 2013). According to Vinzi, Trinchera, and Amato (2010), the threshold value indicates that the shared variation between a construct and its indicator is smaller than the measurement error variance. Thus, indicator reliability (IR) is a useful method for determining whether or not a collection of scale items has a single dimensionality. The data from Cronbach's alpha and rho_A () were used to determine this.

There is a significant degree of internal consistency among the digitalisation-related components. All three reliability indices (Cronbach's alpha, a, and c) are above the generally accepted criterion of 0.70. All of the elements in the digitalisation variable appear to be measuring the same concept.

There is also a significant internal consistency among the process innovation-related variables. Both rho_a and c are quite high, much over the usually recognised threshold of 0.90, indicating a very high level of dependability even though Cronbach's alpha is just below it. All elements in the process innovation variable appear to be measuring the same thing.

There is a great deal of consistency among the supply chain responsiveness variables. All three indices of dependability (Cronbach's alpha, a, and c) are above the generally accepted criterion of 0.70. All of the supply chain responsiveness variable components appear to be measuring the same concept.

There is a significant internal consistency among the variables that measure sustainable supply chain management procedures. All three reliability indices (Cronbach's alpha, a, and c) are above the generally accepted criterion of 0.70. All items in the sustainable supply chain management practises variable appears to be measuring the same concept.

These analyses indicate a significant internal consistency among the four assessed variables (digitalisation, process innovation, supply chain responsiveness, and sustainable supply chain management practises). High levels of reliability in the measurement of these constructs are consistently indicated by the internal consistency measures (Cronbach's alpha, a, and c).

4.6.2 Convergent Validity

Table 4.6 presents the result of the convergent validity (CV) of the study. the Average Variance Extracted (AVE) is commonly used to measure convergent validity (CV) in PLS-SEM models (Hair et al., 2011, 2012). Hair et al. (2011) posits that the AVE explains how the construct captures an indicator’s variance relative to the total variance and the variance resulting from measurement error. The study tested CV by examining the AVEs of all the variables in the SEM model. An AVE with a minimum threshold of 0.5 for a construct to show convergent validity has been recommended by Fornell and Larcker (1981), Bagozzi and Yi (1988) and Hair et al. (2011). The results revealed that the AVEs of all the latent

variables ranged from 0.648 to 0.655, thus > 0.5, indicating that the validity of the measurement scale was convergent.

4.6.3 Multicollinearity among variables under the model

The study further checked multicollinearity using the table's variable inflation factor (VIF) values. Hair et al. (2014) noted that multicollinearity diagnostics is assessed to ensure that the path coefficients are free from bias while minimising the significant levels of

collinearity among the predictor constructs. Pallant and Manuel (2007) stressed that VIF values > 10 indicated multicollinearity among the independent variables, thus affecting the development of a good PLS-SEM model. Hair et al. (2014) suggested that the VIF values of each construct should be less than the cut-off point of 5.0. From the table, the inner VIF values of the exogenous indicators were DIG (3.305), PI (3.3705), and SSP (3.784), respectively. This showed the absence of multicollinearity between the exogenous variables.

Table 4. 8 Multicollinearity Analysis

INDICATOR		VIF
Digitilisation		
	DIG1	3.125
	DIG2	2.811
	DIG3	3.61
	DIG4	3.824
	DIG5	4.427
	DIG6	3.121
	DIG7	4.054
Process Innovation		
	PI1	1.837
	PI2	1.971
	PI3	3.125

PI4	2.751
PI5	3.248
PI6	2.751
PI7	2.322
Supply Chain Responsiveness	
SCR1	4.525
SCR2	3.826
SCR3	3.586
SCR4	3.309
SCR5	2.745
SCR6	3.229
Sustainable Supply Chain Practices	
SSP2	2.382
SSP3	3.117
SSP4	2.052
SSP5	2.936
SSP6	3.916
SSP7	3.364

Table 13 indicated that the outer VIF values of the respective indicators ranged between 1.000 and 4.525. These are clear indications that all the VIF values are less than the cut point of 5 suggested by Hair et al. (2014). This result further indicates the absence of multicollinearity among the indicators measuring the various exogenous variables. The study's result has, therefore, been supported.

4.6.4 Discriminant Validity

Discriminant validity, as defined by Fornell and Larcker (1981), involves assessing the distinctiveness of different constructs or variables in a study. It explores whether a measurement instrument can differentiate between different concepts. Hair et al. (2010) emphasised the importance of ensuring that the latent constructs being measured in a model are distinct and not confounded with each other. This criterion compares the square root of

each construct's Average Variance Extracted (AVE) to the correlations between that construct and all other constructs. Discriminant validity is confirmed when a construct's square root of the average variance extracted (AVE) is higher than its correlations with all other constructs (Fornell & Larcker, 1981). Establishing discriminant validity assures researchers that the measurement model accurately reflects the distinct characteristics of the underlying constructs. It ensures that the variables being measured are distinct and do not overlap, providing assurance. The Heterotrait-Monotrait (HTMT) Ratio of Correlations is a new method for assessing discriminant validity in structural equation modelling (SEM).

Table 4. 9 Discriminant Validity - HTMT RATIO

	DIGI	PRO_IN	SC_RES	SSCM
DIGI				
PRO_IN	0.442			
SC_RES	0.601	1.009		
SSCMP	0.692	0.848	0.929	

The discriminant validity of Digitilisation with other constructs is confirmed, as all HTMT ratios are below the threshold of 0.85. Although the discriminant validity of Sustainable Supply Chain Management Practises has been established, the ratio with Supply Chain Responsiveness slightly exceeds the recommended threshold. Supply Chain Responsiveness differs from Sustainable Supply Chain Management Practises, as the HTMT ratio is below 0.85. The HTMT ratios indicate strong discriminant validity among the constructs.

Table 4. 10 Discriminant Validity – Fornnel Larcker

	DIGI	PRO_IN	SC_RES	SSCMP
DIGI	0.805			
PRO_IN	0.415	0.763		
SC_RES	0.56	0.896	0.807	
SSCMP	0.638	0.768	0.837	0.809

Table 4.9 illustrates the discriminant validity assessment for four constructs: Digitalization, Process Innovation, Supply Chain Responsiveness, and Sustainable Supply Chain management practices. The Fornell-Larcker criterion stipulates that the square root of the average variance extracted by a construct should surpass the correlation between the construct and any other. Based on the presented data, it is evident that all constructs meet this criterion. Specifically, the square root of each construct's average variance extracted exceeds its correlation with any other construct, indicating that they possess discriminant validity.

Table 4. 11 Fornell-Larcker Discriminant Validity Analysis

Construct	AVE (Square Root)	Correlation with Other Constructs	Discriminant Validity
Digitalization (Digi)	≈ 0.897	PRO_IN: 0.415 SC_RES: 0.56 SSCMP: 0.638	Valid
Process innovation (Pro_In)	≈ 0.873	DIGI: 0.415 SC_RES: 0.896 SSCMP: 0.768	Valid
Supply chain responsiveness (Sc_Res)	≈ 0.898	DIGI: 0.56 PRO_IN: 0.896 SSCMP: 0.837	Valid
Sustainable supply chain mgmt practices	≈ 0.899	DIGI: 0.638 PRO_IN: 0.768 SC_RES: 0.837	Valid

4.7 Path Coefficients

After assessing the measurement model to ensure it meets the PLS-SEM criterion, the study continued with answering the three research objectives were To identify the relationship between sustainable supply chain management and supply chain responsiveness, To examine the mediating role of process innovation between sustainable supply chain management and supply chain responsiveness and to examine the moderating effect of digitalisation between sustainable supply chain management and supply chain responsiveness. The objectives were achieved by assessing the path coefficient, specific indirect effects, and significance level with t-statistics obtained through 5000 bootstraps as suggested by Hair et al. (2014). The results were further confirmed with their corresponding confidence intervals.

The results of the bootstrap using PLS-SEM are presented in Table 4.11.

Table 4. 12 Results of Bootstrap and Study Objectives

		Original sample (O)	**Sample mean (M)**	**(STDEV)**	**T statistics**	**P values**	**p<0.05**
OBJ 1 (Path Coefficient)	SSCMP -> SC_RES	0.266	0.261	0.062	4.323	0.000016	Supported
OBJ 2 (Specific Indirect effect)	SSCMP -> PRO_IN -> SC_RES	0.492	0.484	0.065	7.571	p<.0001	Supported
OBJ 3 (Path Coefficient)	DIGI x (SSCMP -> SC_RES)	0.001	-0.002	0.029	0.031	0.975	Not Supported

Note: * = P<0.05
Source: Field survey (2023)

Table 4. 13 Confidence Intervals

	Original sample (O)	Sample mean (M)	2.50%	97.50%
SSCMP -> SC_RES	0.492	0.484	0.346	0.603
SSCMP -> SC_RES	0.266	0.261	0.141	0.382
DIGI x (SSCMP -> SC_RES)	0.001	-0.002	-0.065	0.048

4.8 Relationship between sustainable supply chain management and supply chain responsiveness.

From the Bootstrap Results (Table 4.11), the statistics for the relationship between Sustainable Supply Chain Management Practises (SSCMP) and Supply Chain Responsiveness (SC_RES) were presented. The T statistic measures the standard deviations that separate the original sample (O) from the mean. A T statistic of 4.323 indicates a significant relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness in this instance. The p-value is practically equal to zero ($p<0.0001$). This low p-value indicates that there is substantial evidence of a positive relationship. It supports the conclusion that a significant positive correlation exists between sustainable supply chain management practises and supply chain responsiveness.

According to the analysis, sustainable Supply Chain Management practices and responsiveness have a statistically significant positive relationship. This suggests that companies in Ghana's manufacturing sector implementing sustainable supply chain management practises tend to have a more responsive supply chain. The finding demonstrates a significant positive relationship between Sustainable Supply Chain Management Practises (SSCMP) and Supply Chain Responsiveness (SC_RES). Specifically, it indicates that companies in Ghana's manufacturing sector implementing sustainable supply chain management practises tend to have a more responsive supply chain. This resonates with the emphasis on incorporating economic, environmental, and

social considerations into supply chain operations (Aguado et al., 2018). According to the study, this integration improves supply chain responsiveness.

In addition, it suggests that sustainable supply chain practises seek long-term viability and economic benefits (Aguado et al., 2018; Kazancoglu et al., 2022). This relationship demonstrates that implementing sustainable practises contributes to improved economic outcomes, including a more responsive supply chain. According to the literature by (Kazancoglu et al., 2022), aligning operations with sustainability principles enhances competitiveness and resilience. This is consistent with the finding that companies implementing sustainable practises have more responsive supply chains. Regarding the claim that sustainable practises benefit the company and contribute to broader environmental and societal objectives (Kazancoglu et al., 2021). This is accomplished by minimising environmental impacts and encouraging social responsibility, as this positive correlation indicates.

4.9 The mediating role of process innovation between sustainable supply chain management and supply chain responsiveness.

To assess the second objective, the path coefficients of a bootstrap analysis were conducted and presented under table 4.11 and subsequently supported with its confidence intervals under table 4.12. The T statistic of 7.571 is significantly high, suggesting a strong connection between Sustainable Supply Chain Management Practises and the mediating factor, Process Innovation, which subsequently impacts Supply Chain Responsiveness. The p-value is very low ($p<0.000$), which strongly indicates a mediating role of process innovation. The results suggest a strong association between Sustainable Supply Chain Management Practises, Process Innovation, and Supply Chain Responsiveness. The

analysis indicates that Sustainable Supply Chain Management Practises substantially positively affect Process Innovation, resulting in enhanced Supply Chain Responsiveness. This suggests that by investing in sustainable practises, the manufacturing industry of Ghana can experience increased innovation, leading to improved responsiveness in the supply chain.

Research conducted by Helmer in 2022 supports this discovery, emphasising the importance of process innovation in supply chains. The focus is on process innovation, which entails the introduction of new methods, tools, or technologies to improve the efficiency, effectiveness, and quality of supply chain processes (Helmer et al., 2022). Through the implementation of process innovations, companies can optimise their operations, cut down on expenses, and boost productivity. This, in turn, leads to a more agile and responsive supply chain. Additionally, it highlights the importance of process innovation in identifying and implementing more efficient methods for managing procurement processes, encompassing everything from purchase requests to the delivery of goods and services (Laubengaier et al., 2022). This finding aligns with the prior studies that integrating Sustainable Supply Chain Management Practises with Process Innovation positively impacts Supply Chain Responsiveness.

Through the implementation of process innovations, companies can optimise their operations, cut down on expenses, and boost productivity, resulting in a more agile and responsive supply chain. Furthermore, the results highlight the importance of combining Sustainable Supply Chain Management Practises with Process Innovation. The positive impact of this synergy on Supply Chain Responsiveness is evident, emphasising the close

relationship between sustainable practises and innovative process improvement (Laubengaier et al., 2022).

The finding supports the theory that process innovation requires technological advancements, a culture of innovation, and continuous improvement. This culture promotes a collaborative environment where employees are encouraged to freely exchange ideas, explore innovative approaches, and question traditional methods (Helmer et al., 2022). In addition, process innovation involves restructuring current processes to eliminate inefficiencies and improve quality. This is reflected in the study's focus on methods such as lean manufacturing and continuous improvement (Helmer et al., 2022).

4.10 Moderating effect of digitalisation between sustainable supply chain management and supply chain responsiveness

The interaction between Digitalization (DIGI), Sustainable Supply Chain Management Practises (SSCMP), and Supply Chain Responsiveness (SC_RES) was evaluated based on the path coefficient under the bootstrapping analysis. The T statistic of 0.031 indicates that the interaction term between Digitalization, Sustainable Supply Chain Management Practises, and Supply Chain Responsiveness has a very low effect. The high p-value of 0.97 ($p>0.05$) indicates that the moderating effect is statistically insignificant. This means that Digitalization does not significantly moderate the relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness.

The analysis reveals that Digitalization does not moderate the relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness in the Ghanaian manufacturing industry. This suggests that the influence of Digitalization on the relationship between Sustainable Supply Chain Management Practises and Supply Chain

Responsiveness is negligible. The existing literature has extensively discussed the transformative potential of digitalisation in supply chain management (Ageron et al., 2020; Deepu & Ravi, 2023a; Shmatko et al., 2021a). However, the findings of this study offer a varied perspective. The observed results indicate a significant difference.

The expected moderating effect of digitalisation on the relationship between Sustainable Supply Chain Management Practises (SSCMP) and Supply Chain Responsiveness (SC_RES) did not occur. In contrast to previous studies that emphasised the importance of digital integration in improving interaction and responsiveness in supply chains (Ageron et al., 2020), the analysis did not find a significant moderating effect.

In addition, the study's analysis of Process Innovation as a mediator between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness produced noteworthy findings. The literature indicated that Process Innovation plays a significant role in mediating relationships (Deepu & Ravi, 2023a; Shcherbakov & Silkina, 2021b). However, the findings under the moderating effect of digitalisation revealed a more complex relationship, suggesting that digitalisation within the Ghanaian manufacturing industry has not reached the level where it significantly moderates sustainability practices on supply chain responsiveness. These differing outcomes may be influenced by factors such as industry-specific practises and technological adoption patterns. Furthermore, it's important to recognise that the fast-paced advancements in digital technologies and their implementation in manufacturing firms may have introduced new dynamics that haven't been fully explored in the current literature (Helmer et al., 2022).

4.11 Explanatory and Predictive Power Analysis

To assess the predictive power of the exogenous variables on the endogenous variables, the coefficient of determination, presented in Table 4.13, was employed. The R-squared, also known as the coefficient of determination, measures the degree to which the regression model can explain a relationship among variables. Root Mean Squared Error (RMSE)and Mean Absolute Error (MAE) are metrics used to evaluate the Model. These metrics indicate the accuracy of the predictions and the deviation from the actual values. This statistical metric evaluates how closely the data aligns with the fitted regression line. It signifies the variance ratio for a dependent variable, offering insight into its regression effectiveness. In simple terms, it quantifies the extent to which the independent variables contribute to the variation in the dependent variable. A 100% R-squared indicates that the independent variables entirely explain the dependent variable.

Table 4. 14 Coefficient of determination

	R-square	R-square adjusted	Q^2predict	RMSE	MAE
Process innovation	0.589	0.587	0.585	0.688	0.468
supply chain responsiveness	0.866	0.863	0.696	0.581	0.446

Table 4.13 provides the R-square, adjusted R-square, and Q^2predict values for the Process Innovation and Supply Chain Responsiveness variables. For Process Innovation, the R-square value is 0.589, indicating that approximately 58.9% of the variance in this variable can be explained by the independent variable sustainable supply chain management practices. The adjusted R-square, which accounts for the number of predictors in the model, is 0.587. Additionally, the Q^2predict value, which assesses the model's ability to predict new data, is 0.585, indicating a significant predictive ability.

For Supply Chain Responsiveness, the R-square value is notably higher at 0.866, indicating that the independent sustainable supply chain management practices account for around 86.6% of the variance in this variable. The adjusted R-square is 0.863, and the Q^2predict value is 0.696. These results suggest that the model is relatively effective in explaining the variance in both Process Innovation and Supply Chain Responsiveness. The higher R-square values for Supply Chain Responsiveness indicate a stronger relationship with the independent variables compared to Process Innovation. The R-square value for Supply Chain Responsiveness is high (0.866), indicating a strong relationship with the independent variables, including sustainable supply chain management. This suggests that sustainable supply chain management significantly contributes to enhancing supply chain responsiveness.

The presence of a mediating role was assessed by examining the significance of the indirect effect through process innovation. The coefficient associated with the indirect effect was statistically significant, thus the earlier findings indicated that process innovation plays a mediating role. Additionally, the adjusted R-square value for Supply Chain Responsiveness (0.863) indicates that process innovation contributes to explaining a substantial portion of the variance, supporting its mediating role. The RMSE of 0.581 and MAE of 0.446 are fairly low, suggesting that the models fit the data well. These results indicate that the predicted values closely align with the actual values, reinforcing the models' reliability.

4.12 Chapter Summary

In this chapter, the study's research objectives were presented and discussed through analysis with PLS SEM. The analysis revealed that sustainable supply chain management

practises significantly impact supply chain responsiveness, with process innovation playing a significant role in mediating this relationship. However, digitilization did not have a moderating effect on the relationship. It can be inferred that sustainable procurement practises alone can predict a positive supply chain responsiveness and promote process innovation. Contrary to the literature on the moderating role of digitilisation, the findings indicate that digitilisation in the Ghanaian context has not yet reached a level where it can effectively moderate the relationship between sustainable supply chain practises and supply chain responsiveness.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarises the findings regarding the study's research objectives and then draws conclusions and makes recommendations based on those findings. The chapter concludes with other areas for research recommendations.

5.2 Summary of Findings

The study aligned with empirical reviews examining the relationship between sustainable supply chain management and supply chain responsiveness. It also investigated the mediating and moderating roles of process innovation and digitization. The study adopted a quantitative approach and employed an explanatory research design. Data was collected from 187 respondents in Ghana's manufacturing sector through a structured questionnaire based on the review of previous studies. A 100% response rate was achieved, yielding 187 valid responses for analysis. The collected data was processed using IBM SPSS Statistics 27 and SmartPLS 4 software to ensure a seamless and efficient analysis. The study's objectives were addressed through both descriptive and inferential statistics. The socio-demographic information of the respondents was analysed using frequencies and percentages. The study's variables were described using statistical measures such as means, standard deviations, skewness, and kurtosis.

The partial least squares structural equation modelling technique assessed the study's objectives. Significance testing was based on the criterion that t-statistics should exceed

1.96, resulting in a p-value of less than 0.05 ($p < 0.05$). This section presents the major findings of the study in relation to the research objectives.

The study's first objective focused on analysing the relationship between Sustainable Supply Chain Management Practises (SSCMP) and Supply Chain Responsiveness (SC_RES). The analysis uncovered a significant positive relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. Firms that adopt sustainable supply chain practises in the Ghanaian manufacturing sector often experience more responsive and efficient supply chains. The significance of incorporating economic, environmental, and social factors into supply chain operations cannot be overemphasised. This integration not only ensures long-term sustainability and economic advantages but also aligns with broader environmental and societal goals.

The study's second objective examined the role of Process Innovation as a mediator between Sustainable Supply Chain Management Practises (SSCMP) and Supply Chain Responsiveness (SC_RES). The analysis revealed a positive connection between SSCMP and Process Innovation, resulting in improved Supply Chain Responsiveness. Investing in sustainable practises in the Ghanaian manufacturing sector can lead to enhanced innovation and greater responsiveness in the supply chain. The effective integration of Sustainable Supply Chain Management Practises and Process Innovation demonstrates a favourable influence on Supply Chain Responsiveness. This highlights the important connection between sustainable practises and innovative process improvement. In addition, the study emphasises the importance of cultivating an innovative culture and continuously improving processes for successful process innovation. This fosters an atmosphere where employees feel empowered to share ideas and explore innovative approaches. In addition,

it is important to restructure current processes in order to eliminate inefficiencies and improve quality. This can be achieved by adopting methods such as lean manufacturing and continuous improvement. The findings highlight the important role of Process Innovation in improving Supply Chain Responsiveness by integrating Sustainable Supply Chain Management Practises.

The study's third objective examines how Digitalization affects the relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. The analysis showed that Digitalization has a minimal impact and is statistically insignificant in changing this relationship. It appears that the connection between sustainable practises and supply chain responsiveness in the Ghanaian manufacturing industry is not significantly affected by digitalisation. The findings offer a fresh perspective in comparison to previous literature, which has extensively explored the transformative power of digitalisation in supply chain management. The observed results indicate a notable disparity from the anticipated moderating effect of digitalisation on the relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. The analysis also uncovers a more intricate connection when considering the impact of Digitalization. This suggests that the level of digitization in the Ghanaian manufacturing industry might not currently have a significant influence on the relationship between sustainability practises and supply chain responsiveness.

The differences in findings could be due to specific practises within different industries and varying levels of technological adoption. Moreover, the swift progress in digital technologies within manufacturing firms may bring about new dynamics that need to be

explored beyond the current literature's scope. This highlights the ever-changing nature of the digitalisation landscape in supply chain management.

5.3 Conclusions

The study investigated sustainable supply chain management practises, process innovation, and digitalisation in the manufacturing industry of Ghana. The study found a strong relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. This emphasised the importance of incorporating economic, environmental, and social factors into supply chain operations, promoting a more responsive supply chain.

The emergence of Process Innovation played a crucial role in bridging the gap between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. The positive impact of sustainable practises on Process Innovation has led to an improvement in supply chain responsiveness. This highlighted the significance of fostering an environment of innovation and ongoing enhancement within supply chain operations.

In juxtaposition to what is commonly found in the literature review, the study identified that Digitalization didn't moderate the relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. It seems that the current level of digitization in the Ghanaian manufacturing industry may not have had a significant impact on the relationship between sustainability practises and supply chain responsiveness.

5.4 Recommendation

Based on the findings, it is highly recommended to prioritise the continuous implementation of sustainable practises. The study's findings demonstrate a strong relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. It is crucial to incorporate economic, environmental, and social factors into supply chain operations. By adopting this approach, companies can create a supply chain that is more agile and responsive than ever before, in line with the changing demands of the industry.

In addition, it is crucial to foster an innovative culture within supply chain operations. According to the study, Process Innovation plays a crucial role in the relationship between Sustainable Supply Chain Management Practises and Supply Chain Responsiveness. It is crucial to foster a culture that motivates employees to explore and implement creative solutions. Companies can optimise processes, reduce expenses, and enhance the responsiveness of their supply chain by fostering an environment that encourages continuous improvement and creative problem-solving.

While the study indicates a limited moderating effect of Digitalization, it remains a significant aspect of supply chain management. Therefore, it is advisable to strategically utilise digital technologies. Efficiently addressing operational needs requires strategic investments in technologies that are tailored to those needs. Emphasise solutions that improve connectivity, visibility, and efficiency in supply chain processes. Through the utilisation of digitalisation, companies can remain at the forefront of technological advancements and sustain a competitive advantage in the market. With the ever-changing landscape of digital technologies, it is crucial to consistently assess new trends. The study

emphasises that the effects of digitalisation can change as time goes on. It is essential to remain attentive to new technologies and evaluate their potential for seamless integration into supply chain operations. This approach helps companies stay adaptable and quickly respond to market changes. These recommendations provide practical and actionable strategies to improve supply chain performance in the Ghanaian manufacturing industry. Companies can achieve sustained success in a rapidly evolving industry landscape by prioritising sustainability, fostering innovation, strategically leveraging digitalisation, and staying attuned to technological trends. This allows them to navigate the complexities of modern supply chain management.

5.5 Areas for Future Studies

Digitalization is rapidly transforming industries, including supply chain management. Thus, it is crucial for future studies to thoroughly explore the complex role of digitalisation in supply chains and the associated challenges. Further research is needed to explore the impact of digitalisation on conventional supply chain operations. This involves analysing the integration of various technologies such as IoT devices, blockchain and cloud-based platforms. It is essential to understand the ways in which these technologies improve interaction, visibility, and performance across the supply chain.

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APPENDIX A

QUESTIONNAIRE

EXAMINING SUSTAINABLE SUPPLY CHAIN MANAGEMENT AND SUPPLY CHAIN RESPONSIVENESS: THE ROLES OF PROCESS INNOVATION AND DIGITALISATION IN THE MANUFACTURING INDUSTRY OF GHANA

Please take a few moments to complete the following questionnaire. Your responses will only be used for research purposes and remain entirely confidential. I kindly request that you provide honest and accurate information based on your experiences and opinions. Thank you for your time and valuable contribution to this study.

SECTION A: DEMOGRAPHICS

1. Gender
   - ☐ Male
   - ☐ Female
2. What is your age group?
   - ☐ 18-30 Years
   - ☐ 31-40 Years
   - ☐ 41-50 Years
   - ☐ Above 50 Years
3. Educational Qualification
   - ☐ HND or Equivalent
   - ☐ Bachelor's degree
   - ☐ Master's degree
   - ☐ Doctorate
4. How long have you been working in the Manufacturing Industry?
   - ☐ Under a Year
   - ☐ 2 to 5 years
   - ☐ Above five years
5. Which department/division are you currently working in? (Please select the appropriate option.)
   - ☐ Procurement
   - ☐ Stores/Finance
   - ☐ Operations
   - ☐ Logistics
6. Do you have formal training or education in supply chain management, sustainability, or digitalisation?
   - ☐ Yes

☐ No

7. How familiar are you with sustainable supply chain management practices, process innovation, and digitalisation in the manufacturing industry?
   ☐ Very Unfamiliar
   ☐ Somewhat Unfamiliar
   ☐ Neutral
   ☐ Somewhat Familiar
   ☐ Very Familiar

Please indicate your level of agreement or disagreement with the following statements using a 5-point Likert scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

A: SUSTAINABLE SUPPLY CHAIN MANAGEMENT PRACTICES

Please indicate your agreement or disagreement with each statement on your firm's Sustainable Supply Chain Management Practices	**1**	**2**	**3**	**4**	**5**
1. Using Renewable Energy Sources	☐	☐	☐	☐	☐
2. Supplier Audits for Environmental Compliance	☐	☐	☐	☐	☐
3. Implementing Waste Reduction Strategies	☐	☐	☐	☐	☐
4. Promoting Ethical Labour Practices in the Supply Chain	☐	☐	☐	☐	☐
5. Optimizing Transportation for Reduced Emissions	☐	☐	☐	☐	☐
6. Investing in Eco-Friendly Packaging Materials	☐	☐	☐	☐	☐
7. Tracking and Reporting Sustainability Metrics	☐	☐	☐	☐	☐

B: SUPPLY CHAIN RESPONSIVENESS

Please indicate your agreement or disagreement with each statement on your firm's Supply Chain Responsiveness	**1**	**2**	**3**	**4**	**5**
8. My organization is able to quickly adjust its supply chain processes in response to changes in market demand or conditions.	☐	☐	☐	☐	☐
9. My organization has real-time visibility into inventory levels across the supply chain, enabling swift decision-making.	☐	☐	☐	☐	☐
10. My organization collaborates closely with suppliers to ensure quick response times in case of disruptions or changes.	☐	☐	☐	☐	☐
11. My organization has the capability to swiftly adjust production and manufacturing processes to meet changing demand.	☐	☐	☐	☐	☐

12. My organization has well-defined contingency plans in place to handle unexpected disruptions in the supply chain.	☐	☐	☐	☐	☐
13. My organization places a high priority on meeting customer demands and is able to respond quickly to their changing needs.	☐	☐	☐	☐	☐
C: PROCESS INNOVATION					
Please indicate your agreement or disagreement with each statement on your firm's Process Innovation initiatives	**1**	**2**	**3**	**4**	**5**
14. Embracing a culture of continuous improvement in processes	☐	☐	☐	☐	☐
15. Encouraging cross-functional collaboration	☐	☐	☐	☐	☐
16. Allocating resources to research and development for process enhancement	☐	☐	☐	☐	☐
17. Actively adopting emerging technologies for process optimization	☐	☐	☐	☐	☐
18. Designing processes with flexibility to accommodate change	☐	☐	☐	☐	☐
19. Involving employees at all levels in process innovation efforts	☐	☐	☐	☐	☐
20. Using metrics and evaluation methods to assess process performance	☐	☐	☐	☐	☐
D: DIGITALIZATION					
Please indicate your agreement or disagreement with each statement on your firm's Digitalization Initiatives	**1**	**2**	**3**	**4**	**5**
21. Integration of Digital Tools in Operations	☐	☐	☐	☐	☐
22. Utilization of Data-Driven Insights	☐	☐	☐	☐	☐
23. Automation of Routine Tasks and Processes	☐	☐	☐	☐	☐
24. Investment in Cybersecurity Measures	☐	☐	☐	☐	☐
25. Adoption of Cloud Computing for Scalability and Flexibility	☐	☐	☐	☐	☐
26. Implementation of Artificial Intelligence (AI) and Machine Learning (ML)	☐	☐	☐	☐	☐
27. Digitalization of Customer Interactions and Experiences	☐	☐	☐	☐	☐

Your response is greatly appreciated. Thank you.