SUPPLY CHAIN INTEGRATION AND PERFORMANCE OF MANUFACTURING SMES IN RWANDA

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Supply Chain Integration and Performance of Manufacturing SMES in Rwanda

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

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DEDICATION

This thesis work is dedicated to my wife, Triphonie Uwimana, and children, for their sincere love and support as I pursued this program. They supported me even when I felt like giving up, and I appreciate the assistance extended to me by the colleagues and staff of JKUAT in one way or another.

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God bless you all!

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ABBREVIATIONS AND ACRONYMS

%	Percentages
AfDB	African Development Bank Group
ANOVA	Analysis of Variance
ASEAN	Association of Southeast Asian Nations
CBE	College of Business and Economics
CRM	Customer Relationship Management
CVI	Content Validity Index
DRC	Democratic republic of Congo
EDI	Electronic Data Interchange
EFA	Exploratory factor Analysis
ERP	Enterprise resource planning
FCPA	Foreign Corrupt Practice Act
GDP	Gross Domestic Product
ICT	Information Communication Technology
IMF	International Monetary Fund
IOT	Internet of Things
KPIs	Key Performance Indicators
LVAC	Transforming local value-added content

MBO	Management by Objectives
MDG	Millennium Development Goals
MFEP	Ministry of Finance and Economic Planning
MINECOFIN	Ministry of Finance and Economic Planning
MINICOM	Ministry of Commerce
MSMEs	Micro Small and Medium Enterprises
NIRDA	National Industrial Research and Development Agency
NISR	National Institute of Statistics of Rwanda
OEE	Overall Equipment Effectiveness,
OOE	Overall Operations Effectiveness:
PSF	Private Sector Federation
RBV	Resource-Based View
RDB	Rwanda Development Board
RECs	Regional Economic Communities
RFID	Radio Frequency Identification
RFP	Request for Proposal
ROI	Return on Investments
RV	Relational View
RWF	Rwandan Francs

SADC	Southern African Development Community
SC	Supply Chain
SCI	Supply chain incorporation
SCI	Supply Chain Integration
SCM	Supply Chain Management
SCOR	Supply Chain Operational Reference
SCR	Supply Chain Risk
SD	Standard Deviations
SPSS	Software Package for Social Sciences
TEEP	Total Effective Equipment Performance
UR	University of Rwanda
US	United States
VMI	Vendor Management Inventory
WTO	World Trade Organization

DEFINITION OF OPERATIONAL TERMS

Capacity Integration In supply chain management, *capacity integration* refers to the alignment and coordination of production, logistics, and resource capacities across supply chain partners to ensure efficiency, responsiveness, and adaptability. It involves integrating internal and external capabilities, such as manufacturing capacity, transportation, and warehousing, into a cohesive system that enables SMEs to meet customer demand while minimizing costs and disruptions (Zhao, Huo, Sun, & Zhao, 2013).

Collaboration Integration The Collaborative Integration Paradigm describes the relationships among purposes for collaboration, types of partners, and degrees of integration from diverse individual, organizational, or disciplinary partners into the processes and outcomes of the collaboration (Djiofack & Niyibizi, 2021).

Communication Integration The process of strategically controlling or influencing all messages and encouraging purposeful dialogue to create and nourish profitable relationships with customers and other stakeholders" (Djiofack & Niyibizi, 2021).

Customer Integration This is the component of customer relationship management that puts technology that allows customers to process their transactions and to have direct contact with the organization (Djiofack & Niyibizi, 2021).

Information Sharing Information sharing refers to distributing useful information for systems, people, or organizational units. An organization, to enhance the results of information sharing, should answer four main questions: what to share, With whom to share, how to share, and finally, when to share (Betti & Basso, 2019).

Firm's Performance it refers to the overall outcomes achieved through the coordination and collaboration of supply chain partners, measured in terms of efficiency, responsiveness, customer satisfaction, cost reduction, and competitive advantage (Flynn, Huo, & Zhao, 2010).

Supply Chain Integration In supply chain management, supply chain integration is defined as the alignment of internal and external processes within a firm and with value chain partners. It focuses on strategic and operational linkages with suppliers and customers. Supply chain integration aims to enhance supply chain performance and gain a competitive advantage (Flynn, Huo, & Zhao, 2010).

Performance measurement integration In supply chain management, performance measurement integration refers to the systematic alignment and coordination of metrics, methods, and systems across functions and strategies, such as lean and agile approaches, to create a unified, coherent system that enhances decision-making, operational alignment, and strategic effectiveness. It ensures the integration of financial, efficiency, flexibility, and customer-oriented metrics, thereby enabling organizations to monitor, assess, and continuously improve performance holistically (Dahinine et al., 2024).

ABSTRACT

This study aimed to determine the relationship between Supply Chain integration and the performance of manufacturing SMEs in Rwanda. This is to address how Manufacturing SMEs in Rwanda struggle with supply chain performance due to limited integration with suppliers and customers because of weak supplier-customer integration, limited strategic partnership, poor internal coordination and data sharing, and low adoption of ICT and logistics solutions, and address the gap of limited empirical evidence on SCI practices. The study was guided by the following objectives: SC communication integration, SC Customer integration, SC Collaboration integration, and performance measurement integration, respectively. This study used the Resource-Based View theory, network Theory, and Supply Chain Operational Reference (SCOR) Model. The study adopted a cross-sectional research design and a positivist research philosophy. The study population was 682 manufacturing SMEs. A stratified random sampling technique was used to select the required sample. The pilot study was carried out in twelve (12) manufacturing SMEs, where 25 questionnaires were distributed. All the variables tested in the pilot study had a Cronbach's alpha value greater than 0.7. This suggests that all the questionnaires used in the study were reliable. Therefore, the questionnaire was both valid and reliable, and it was used to collect data for this study. Inferential statistics were employed to examine the relationship between study variables, utilizing both Pearson correlation and multiple regression analysis models. The significance of the model was tested at a 5% significance level. Data was collected through the questionnaires and the interview guide. The qualitative data were presented using descriptive statistical techniques, including frequency, mean, and standard deviation. Data were analyzed using the Statistical Package for the Social Sciences version 26, and the results were presented in the form of tables, figures, and histograms. The study likely employed tables (descriptive, correlation, regression, and factor analysis) and graphs as its primary data presentation techniques. The key findings indicate that SC communication, SC customer, SC collaboration, and performance measurement integration collectively explained 71.9% of the performance of manufacturing SMEs in Rwanda. The study offers managers actionable insights into key factors influencing SME manufacturing performance, enabling improved resource utilization and sustainable competitiveness. The study informs policy decisions aimed at addressing performance challenges, enhancing productivity, and strengthening the competitiveness of manufacturing SMEs in Rwanda. It expands the body of knowledge on supply chain integration and SME performance, identifies research gaps, and offers a foundation for future theoretical and empirical studies. The study concludes that communication integration is the strongest predictor of performance of SMEs, while information sharing shows the weakest effect, with other factors (customer, performance measurement, and collaboration integration) having a moderate influence. It recommends enhancing real-time communication, customer involvement, KPI alignment, collaborative partnerships, and cloud-based data sharing to strengthen supply chain performance.

CHAPTER ONE

INTRODUCTION

This chapter introduces the background of the study, the statement of the problem, the research objectives, the research questions, the research hypothesis, the significance of the study, and the scope and limitations of the study.

1.1 Background of the Study

Since its introduction in the early 1980s, supply chain management (SCM) has garnered increasing interest from the management and operations research fields. Authors like Ali et al., (2023); Ghariani & Boujelbene (2024); Suryanto & Mukhsin (2020) highlight how crucial supply chain management (SCM) is, especially for supply chain integration (SCI), which enables supplier network and business performance. Supply chain integration provides businesses with a competitive advantage as a key to achieving optimal supply chain performance. The term supply chain integration refers to the degree to which strategic manufacturers cooperate with their supply chain partners and the efficient administration of intra- and inter-organizational processes that result in successful flows of money, decisions, information, goods, and services, all to optimize value to the customer (Flynn et al., 2010). Integrating supply chain processes with suppliers and customers enables companies to enhance their product and material flows throughout the supply chain. It also helps companies reach various resources and capabilities within other supply chains, thereby stimulating their innovativeness. In the supply chain, the extent to which collaboration with suppliers and customers allows companies to achieve their internal business processes is (Zhong et al., 2023).

In today's global high competition and increasing costs of natural resources, as well as the growing needs of customers for higher-quality manufactured goods, better product selection, and improved client service, new challenges have arisen for manufacturing SMEs (Ghariani & Boujelbene, 2024). The competitive market requires SMEs to produce value-added, high-quality, and innovative products or services as a fundamental tactic for staying alive. Manufacturing SMEs are now outsourcing activities they cannot perform in-house, seeking a third-party specialist to handle tasks that are not part of their core competencies, in order to stay alive and competitive. Therefore, businesses require an integrated supply chain framework to link the entire network and mitigate persistent supply chain issues, such as functional silos, a lack of knowledge and information transparency, and inadequate development of appropriate relationships with suppliers and customers (Zhong et al., 2023).

Supply chain management involves the planning and supervision of all sourcing and procurement, conversion, and logistics management activities. For supply chain integration to succeed, all nodes in the network - internal or external to the business must interact, exchange, and share accurate, timely information (Akhtar et al., 2023; Shah & Soomro, 2021). Many cross-functional teams, external supply chain partners, and cooperative internal business processes are all involved in supply chain integration. Producers, suppliers, distributors, and retailers work together in a supply chain to promptly fulfill client requirements.

The concept of supply chain acknowledges that by integrating suppliers and customers in the value-creation process, integrated business operations benefit the company's customers and extend beyond the company's boundaries. Supply chain integration was theoretically traced back to the value chain model of competitive advantages (Porter, 1985). Porter argues that the main objective of supply chain management is to maximize vertical and horizontal networks between suppliers and customers. The main objective of supply chain management is to maximize these vertical connections between suppliers and customers. Optimizing these linkages horizontally and vertically is the core of supply chain management.

In supply chain management, supply chain integration (SCI) can be divided into two interrelated ways. The first type of integration refers to the cooperation between manufacturers, suppliers, and consumers in the forward physical movement of products. The second is supplier integration, which refers to the backward flow of information from customers to suppliers. Many SMEs can improve supply chain management by using these information flows to coordinate their physical and operational processes (Zhong et al., 2023). Supply chain integration handles activities related to the physical distribution and handling of goods, including shipment and storage of items for customers. Suryanto & Mukhsin, (2020) asserted that, to exchange and share complete, up-to-date information, every node in the supply chain integration network whether internal or external needs to be connected.

An organization's performance is determined by how well it executes its overall strategy, the results of its operations, and the extent to which it meets its market goals and financial objectives. Good operational coordination is essential for manufacturing SMEs to establish and maintain a competitive advantage in their products and services. Manufacturing SMEs need strong operational coordination to establish and maintain a competitive advantage in goods and services. In this context, monitoring and integrating key components, such as overall quality management and information, into their supply chain significantly impacts supply chain performance. Information sharing does not directly impact business performance; instead, it affects operational performance.

In Rwanda, over 70% of registered SMEs in developing countries, including Rwanda, fail within their first two years, often due to supply chain challenges (IMF, 2024). Rwanda’s manufacturing sector contributes just under 10% of GDP, with modest growth of around 7–10% in recent years. Rwanda's broader industry sector, including manufacturing SMEs, accounts for approximately 21% of the national GDP (NISR, 2024). The average delivery lead times in Rwandan manufacturing SMEs often exceed regional benchmarks, though specific quantitative data remains limited; delays are widely reported as a significant operational issue (e.g., logistical constraints due to infrastructure and landlocked geography). As Rwanda advances its industrialization, manufacturing remains a relatively small yet high-growth segment, signaling both opportunities and ongoing challenges for SMEs in meeting delivery expectations and sustaining performance.

1.1.1 Global Perspective on Supply Chain Integration

Supply chain integration (SCI) has emerged as a critical driver of competitiveness worldwide, enabling SMEs to improve efficiency, responsiveness, and resilience in dynamic markets. Globally, SCI emphasizes the alignment of internal processes (production, logistics, and information systems) with external partnerships (suppliers, distributors, and customers) through collaboration, trust, and information sharing (Flynn, Huo, & Zhao, 2010).

In developed economies, SCI often leverages advanced technologies such as AI, blockchain, and IoT to achieve real-time visibility, traceability, and data-driven decision-making (Wamba & Queiroz, 2020). In contrast, many developing economies, including those in Sub-Saharan Africa, struggle with fragmented supply chains, infrastructure gaps, and limited digital adoption, which hinder seamless integration (Ghariani & Boujelbene, 2024).

At a global level, SCI is also viewed through the lens of resilience and risk management, particularly in the aftermath of COVID-19 disruptions, when SMEs worldwide recognized the need for stronger collaboration, diversified sourcing, and digital platforms to mitigate vulnerabilities (Ivanov & Dolgui, 2020).

Thus, while high-income regions strive for digitally enabled, sustainable, and resilient integration, lower-income regions prioritize building foundational capacity in information sharing, process coordination, and customer-supplier collaboration to enhance competitiveness and survival.

1.1.2. State of the Regional Supply Chain Integration

In Africa, the concept of supply chain integration dates back to the colonial era, when traditional handicrafts were manufactured by individuals organized into known performance associations and cooperatives (MINICOFIN, 2020). Around the beginning of the twentieth century, particularly the British policy of colonial development partnerships that emerged during that period, when access to production was available to the small manufactured industries, which were marred by substantial issues of surplus liquidity (Mangla et al., 2018). The supply chain in the region has been substantially constrained by a multitude of factors that limit, among other things, eligibility, physical access, and affordability. It is also based on the performance of the traditional handicraft-manufactured individuals, with the free market for goods and services dictating the social and economic development role that colonies played in the British Empire. For the past five years, integrating the supply chain has been a hot topic at specialist conferences for logistics, Information Technology, and procurement.

The concepts were straightforward: use the immediacy and error-free nature of direct electronic driving innovation through Information Technology (Mangla et al., 2018). In South Africa, Sqwidnet, as the premier network provider for the Internet of Things (IoT), enables a multitude of low-cost, low-power devices to monitor or respond to events in the environment or exchange data with each other and with operators and users, all to make life easier, safer, and more convenient, more streamlined. Real-time communication and information sharing are vital to reducing the costs and delays in moving stock from point A to point B (Nkwabi & Fallon, 2020). The primary issues impacting the supply chain within these organizations are low production capabilities, inadequate storage facilities, poor transportation, and poor relationship management.

Today's manufacturers must not only manage their organizations but also be involved in managing the network of upstream and downstream firms. Increasing global competition has caused organizations to rethink the need for cooperative, mutually beneficial. (Asamoah et al., 2020). Supply Chain partnerships and the joint improvement of inter-organizational processes have become a high priority (Dametew et al., 2020). In recent years, the supply chain has become a rapidly growing topic of importance on the agenda. Supply chain management (SCM) can provide a competitive advantage from a business perspective. Managing SC effectively has become critical for the survival and growth of organizations. Ideally, the entire SC process must be designed, managed, and coordinated as a unit. Accordingly, the integration of the SC is a critical element of the SCM strategy (Asamoah et al., 2020).

Previous studies, both empirically and theoretically, agree that the higher the level of integration with suppliers and customers, the greater the potential benefits. (Dubey et al., 2020; Nguyen Thi & Nguyen Thi Thu, 2022). However, studies have not always found a clear relation between the level of SCI and performance improvement. A wide range of studies on SCI have been conducted. (Asamoah et al., 2020; Miller, 2021; Nkwabi & Fallon, 2020). Many of them focus on the relationship between SCI and performance. Analysis of these papers reveals that various dimensions and variables, along with a broad spectrum of scales, have been used to measure SCI. Many authors develop new models with new constructs and new measurement scales. While a few authors consider SCI through unidimensional constructs, others use multi-dimensional constructs for measuring. (Mangla et al., 2018). Few papers employ the exact SCI dimensions and variables for specific regions, countries, or industries. There is, therefore, a lack of clear definitions and understanding of the concept of the Supply chain (SC).

Over the last few years, the supply chain has rapidly risen to the top of the agenda in the South African region, and many technology SMEs have emerged with innovative supply chain solutions (Luthra & Mangla, 2018). The supply chain is in place to move physical objects, so the technology and information aspects are only part of the puzzle for the success of manufacturing firms. Technology and information also manage the flow of goods and information from raw material to final sale, known as a "supply chain," which affects everything in Africa. Information must be exchanged, which means that technology systems must be integrated between the supplier and customer to allow pricing, ordering, and fulfillment information to be transmitted and received securely, accurately, and reliably. Today, supply chain integration in the African continent aims to reduce inefficiency through basic operational improvements, such as reducing lead times and delivering only what the retailer or distributor needs when needed. This means the retailer shares inventory, sales, and forecast information with the supplier, who, in turn, shares capacity and planning data, providing transparency on its ability to deliver. This aligns with the industry standard model for collaborative planning, forecasting, and replenishment, pioneered by Walmart as C-FAR (Nkwabi & Fallon, 2020).

1.1.3 Local Perspective of Supply Chain Integration

One of the significant transformations in the rapidly evolving digital economy occurs in the SCs of both traditional and e-commerce companies (African Development Bank Group, 2019). Information technology has enabled channel partners to trade goods, share information, and integrate their processes, reshaping inter-organizational dynamics and resulting in more efficient channels. The power of inter-organizational information systems (IOIS) is well known (Mangla et al., 2018). It has proven to be effective in reducing transaction costs. Effective integration, including information sharing and stakeholder collaboration, is crucial for meeting customer demands and optimizing internal processes (Uwamahoro et al., 2024).

In Rwanda, supply chain integration (SCI) is increasingly recognized as a cornerstone for enhancing the performance and competitiveness of manufacturing SMEs. The country's industrial sector, which contributes approximately 21% to the national GDP, with manufacturing accounting for nearly 10%, is expanding under Rwanda's Vision 2050 and industrialization strategies (National Institute of Statistics of Rwanda [NISR], 2024). However, integration across supply chains remains limited due to fragmented logistics systems, high transport costs linked to Rwanda's landlocked geography, and inadequate digital infrastructure (Lloyds Bank, 2024).

Rwandan SMEs frequently encounter difficulties in meeting delivery deadlines, coordinating with suppliers, and providing consistent customer service, which reflects the weakness of their communication and collaboration mechanisms. Nevertheless, government initiatives, such as the Made in Rwanda policy and investments in regional trade facilitation under the East African Community (EAC), are encouraging SMEs to share information more effectively, form collaborative partnerships, and adopt technology (Rwanda Development Board [RDB], 2023). Thus, while Rwanda's SCI perspective is still developing, there is a strong policy and strategic emphasis on building integrated, resilient, and competitive supply chains that can enhance SME operational performance and position Rwanda as a regional manufacturing hub.

1.1.4 Performance of Manufacturing SMEs in Rwanda

The manufacturing sector in Rwanda has undergone significant changes in the past ten years, owing to increased industrialization and government involvement in manufacturing industries (International Monetary Fund (IMF), 2022). These changes have generated new implications for the country's industrial sector, necessitating reevaluation of industrial policies, especially regarding government involvement. Given the disappointing results in public industrial investments, the government should abstain from further direct investment in industry and concentrate on consolidating past investments (Omwoyo et al., 2020a). The government intends to prioritize the growth of small and medium-sized businesses and give the private sector a priority in manufacturing through its Third Development Plan.

Within the next five years, it should establish an improved institutional and policy framework for the development of small-scale enterprises. In addition, it should improve existing firms' operations by rehabilitating viable public enterprises and reforming the incentives system to allow more competition and encourage economic efficiency (National Bank of Rwanda et al., 2024). Manufacturing SMEs account for over 75% of Rwanda's industrial sector and are major drivers of employment, maintaining an average return on investment (ROI) of approximately 20%, which reflects strong operational efficiency and favorable business conditions in Rwanda (NISR, 2023). Despite a positive ROI, the sector is marred by widespread fragility: more than 70% of registered SMEs across developing economies, including Rwanda, exit within their first two years, often due to supply chain vulnerabilities and structural obstacles.

Research findings from Kigali-based manufacturing SMEs indicate that excellence in manufacturing capabilities has a positive and significant impact on firm performance, validating the resource-based view in the Rwandan SME context. These results provide empirical support for the applicability of the Resources-Based View (RBV) theory within the manufacturing SMEs in Rwanda. Additionally, the manufacturing sector's share of total merchandise exports in Rwanda remains relatively low, only about 10.4% in 2022, compared to notably higher levels in neighboring Uganda and

Tanzania (around 25%). Despite this modest export share, manufacturing plays a critical role due to its strong interconnections with the broader industrial and services sectors (Rwanda Export Sector Overview, 2023).

1.2 Statement of the Problem

The manufacturing sector in Rwanda has been recognized as a critical driver of economic transformation, industrialization, and job creation (NISR, 2023). Despite its potential, its overall contribution to national output remains relatively small. For instance, the sector accounted for only 0.8% of total merchandise exports in 2022, compared to approximately 1.9% in Uganda and 3.1% in Tanzania (World Bank, 2023). More recently, while Small and Medium Enterprises (SMEs) account for over 75% of Rwanda's manufacturing sector and provide the majority of jobs within it (NISR, 2022), their economic impact remains limited. The International Finance Corporation (IFC, 2022) highlighted that although Rwandan SMEs achieve an average return on investment (ROI) of approximately 20%, a figure higher than that of many African peers due to government support and a favorable business environment, their survival rates remain precarious. Globally, more than 70% of SMEs in developing countries shut down within their first two years of operations, and Rwanda is not immune to this trend.

A major challenge undermining the performance of manufacturing SMEs in Rwanda is the lack of effective supply chain integration (SCI). Rwanda's manufacturing SMEs face logistical constraints due to its landlocked status, high transportation costs, and weak infrastructure, which further increase the need for coordinated supply chain strategies. However, existing evidence suggests that SMEs are often reluctant to collaborate with other businesses and adopt modern supply chain practices (Fernando & Wulansari, 2020; Omwoyo et al., 2020a). This reluctance hampers knowledge sharing, technological adoption, and resource pooling, leaving SMEs vulnerable to inefficiencies, high operational costs, and weak competitiveness.

Although current studies have demonstrated that SCI enhances organizational performance by improving collaboration, communication, and efficiency (Min et al., 2005; Mofokeng & Chinomona, 2019; Ali et al., 2023). The relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda remains underexplored, with limited studies focusing on this context. Existing studies concentrated on developed countries, creating a contextual gap in understanding integration within Rwanda's context. Moreover, previous studies have presented inconsistent findings, indicating conceptual gaps in the supply chain integration dimensions that drive performance. Finally, most studies rely on qualitative case studies, with limited use of quantitative, large-sample, and mixed-method approaches to provide generalizable evidence, indicating methodological gaps.

Therefore, a clear research gap exists in understanding the role of SCI in enhancing the performance of Rwandan manufacturing SMEs. Addressing these gaps is crucial for policymakers, practitioners, and entrepreneurs to design strategies that foster collaboration, digital integration, and competitiveness. This study aims to investigate the relationship between supply chain integration and SME performance in Rwanda's manufacturing sector, with the ultimate goal of providing actionable insights to enhance industrial growth and sustainability.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective was to establish the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda.

1.3.2 Specific Objectives

The specific objectives of this study were:

i. To determine the relationship between Supply Chain communication integration and the performance of manufacturing SMEs in Rwanda.
ii. To examine the relationship between Supply chain customer integration and the performance of manufacturing SMEs in Rwanda.
iii. To assess the relationship between Supply chain collaboration integration and the performance of manufacturing SMEs in Rwanda.

iv. To evaluate the relationship between Supply Chain Performance measurement integration and the performance of manufacturing SMEs in Rwanda.

v. To assess how information sharing moderates the relationship between supply chain integration dimensions (communication, collaboration, customer, and performance) and performance of manufacturing SMEs in Rwanda.

1.4 Research Hypothesis

Ho_1: There is no significant relationship between communication integration and the performance of manufacturing SMEs in Rwanda.

Ho_2: There is no significant relationship between customer integration and the performance of manufacturing SMEs in Rwanda.

Ho_3: There is no significant relationship between collaboration integration and the performance of manufacturing SMEs in Rwanda.

Ho_4: There is no significant relationship between performance Measurement integration and the performance of manufacturing SMEs in Rwanda.

Ho_5: Information sharing does not significantly moderate the relationship between supply chain integration dimensions and the performance of manufacturing SMEs in Rwanda.

1.5 Significance of the Study

This study would be significant to various stakeholders as it could provide insights into how SMEs in the manufacturing sector can enhance their performance by integrating their supply chain activities. The study's conclusions can be applied by manufacturing SMEs to identify the critical elements affecting their performance and develop plans for improving supply chain integration. The industrial sector relies heavily on small and medium-sized enterprises (SMEs) due to their capacity to drive economic growth. In this context, they are improving the competitiveness of

Rwanda's manufacturing sector, which is a significant driver of the country's GDP and economy.

1.5.1 Management of Manufacturing SMEs

The study provides insight for industry owners and policymakers on the factors that determine the performance of the manufacturing SMEs and the efficient utilization of resources for sustainable competitiveness. Thus, this study provides a comprehensive understanding of the factors that influence the performance of manufacturing SMEs in Rwanda. The results can also serve as a basis for future policy development and provide guidance for practitioners.

1.5.2 Policy Makers

The study's findings may influence government policymakers, enabling them to better understand the factors affecting the performance of manufacturing SMEs and develop solutions for the primary issues. The study's findings can strengthen Rwanda's economy by helping the country's small and medium-sized manufacturing enterprises (SMEs) become more productive and competitive.

1.5.3 Scholars

The study can help future academics develop more comprehensive theories and models that can be used to enhance the productivity of small and medium-sized manufacturing enterprises by contributing to the existing body of knowledge. The study may also help identify information gaps in the supply chain's performance and integration, which can inform future research and studies in this area. The research will identify areas for further research that would be helpful to supply chain management students. Hopefully, this study will make a positive contribution to the advancement of further scientific research.

1.6 Scope of the Study

This study aimed to determine the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda. It focused on supply chain communication, collaboration, customer integration, and the integration of supply chain performance measurement. The study also focused on the manufacturing SMEs in Rwanda as one of the pillars of national development. It promotes socio-economic growth to achieve the high economic growth of Vision 2050, through employment and poverty reduction. The study covered the period from 2020 to 2024.

The study concentrated on seven (7) dominating clusters, giving a total of six hundred eighty-two (682) registered SMEs in Rwanda. The seven (7) dominating clusters are food and beverage, textile, clothing and leather goods, wood, paper and printing, chemical, rubber and plastics, non-metallic mineral products, metal products, machinery and equipment, furniture and other manufacturing in Kigali City, Musanze, Rwamagana, and Muhanga Town. The study targets Kigali, Musanze, Muhanga, and Rwamagana. This is because Kigali is the capital city, where the majority of SMEs are concentrated, due to its large population and good infrastructure. Musanze town, located in the Northern Province, is the second-largest town after Kigali, the capital city. It experiences heavy rainfall throughout the year and is highly productive in agriculture. It also borders Uganda and the DRC, hence a high influx of immigrants. Muhanga town is closer to Kigali, and due to the excellent road network and land availability, many investors are establishing manufacturing SMEs in the area. Rwamagana town is located closer to the Tanzania border, and due to its land availability, good road network, and high population density.

1.7 Limitations of the Study

First, the study was conducted within the Rwandan manufacturing SME sector, which may limit the generalizability of findings to other industries or countries with different economic, cultural, and institutional contexts. Second, Unpredictable external factors, such as inflation, global supply chain disruptions, or policy changes in Rwanda during the study period, may affect the performance of manufacturing SMEs, making it difficult to isolate the influence of supply chain integration. Third, the study relies on self-reported data from SMEs, which may be erroneous or biased. Fourth, the study only examines the elements of supply chain integration; other factors that can impact the performance of manufacturing SMEs were not considered. Finally, because the study is cross-sectional, it is challenging to determine a causal relationship between supply chain integration and the performance of SMEs. However, the research must restrict the discussion to limitations related to the research problem under investigation.

The strategies to overcome all these challenges include combining multiple data sources, such as interviews, document reviews, and secondary data from government institutions and the private sector, to reduce bias. The strategy strengthened the validity and reliability of the findings. The study used a stratified random sampling technique to ensure coverage of small, medium, and different subsectors. This strategy helped to minimize the risk of underrepresentation and enhanced the generalizability of the results.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature related to the subject under study. It consists of a theoretical review and conceptual framework, and it also presents key findings of past similar studies, a critique of existing literature, research gaps, and a summary.

2.2 Theoretical Framework

A theory is a set of related constructs (concepts), definitions, and propositions that logically explain events by constructing correlations between variables to predict and explain the phenomena (Van der Waldt, 2021). Theories serve as analytical tools for understanding, clarifying, and predicting specific topics. Formal theories, being syntactic, only apply to data containing a semantic component, such as the relationships and specifics of the actual historical world in motion. It guides the choice of the measuring items and the statistical correlations that the research will examine. Consequently, the theoretical literature helps in selecting a viable research design, provides a thorough framework for data analysis, and helps the researcher's understanding of the variables of the study (Van der Waldt, 2021). The current study adopts the Resource-Based View (RBV) theory, Network Theory, and Supply Chain Operations Reference (SCOR) Model. Thus, it is a collection of interrelated statements or principles that explain the major theories about supply chain integration and the performance of manufacturing SMEs in Rwanda.

2.2.1 Resource-Based View Theory (RBV)

The study aims to investigate the relationship between supply chain integration and the performance of manufacturing SMEs using the resource-based view (RBV). The fundamental idea of RBV theory is that companies have access to various resources that give them a competitive advantage (Barney, 1991). Accordingly, an organization's internal resources and competencies can directly promote enhanced performance and long-term competitive advantage. A sustainable competitive advantage also develops when a firm's resources satisfy the four (4) criteria of valuable, rare, non-substitutability, and inimitability (VRIN).

Resources must be valuable before utilizing opportunities or lowering hazards in their external environment (Thoo et al., 2017). The main objective of RBV is to explain why some organizations outperform others. To achieve this, it is essential to emphasize the impact of unique, invaluable, and exceptional resources on profitability and organizational performance. These tactics encompass increasing resource levels, procuring internal and external sources, and offloading excess resources (Barney, 1991).

RBV argues that a firm's competitive advantage and performance are driven by its unique resources and capabilities (Barney, 1991). In this context, supply chain integration through communication, collaboration, customer, and performance integration can be considered valuable, rare, inimitable, and non-substitutable (VRIN) resources that enhance firm performance (Barney, 1991; Wernerfelt, 1984). On the other hand, the moderating variable of information sharing strengthens the value of these resources by enabling better coordination, reducing uncertainty, and fostering trust among supply chain partners (Zhou & Benton, 2007; Flynn, Huo, & Zhao, 2010).

First, a firm can benefit from opportunities or reduce risks in its external environment; its resources must be valuable. Second, the resources must be rare for competitors to acquire. Thirdly, the resources must be limited and challenging for other businesses to imitate. The company's assets have been classified into three groups: physical, human, and investment capital. Physical capital resources include a firm's plant, location, assets, technology, equipment, and capacity to purchase raw materials. Human capital resources encompass the abilities of managers and employees, including experience, judgment, intelligence, interpersonal skills, and training. Other organizational capital resources include a company's official reporting structure, coordinating mechanisms, unofficial intra- and inter-organizational linkages, and formal and informal planning (Barney (1991). A particular set of organizational, human, and material capital resources is usually required to accomplish a given plan.

The Resource-Based View (RBV) logic distinguishes between three types of resources: organizational, human, and physical capital. Other resources, including cash, technology, and reputational capital, can enhance it (Barney, 1991). Resources are items that are either owned or controlled by the organization. These resources can be tangible, like infrastructure, or intangible, like information sharing. For this study, the RBV theory primarily focuses on the significance of managerial activities in managing the internal resources provided by various functional divisions and the external resources offered by suppliers and customers to improve firm performance. Accordingly, for strategic supply chain integration (SCI) to be successful, practitioners should not focus on a single inhibitor, but rather consider internal functions, supplier integration, and customer integration. Interdependence is then seen as a crucial component of SCI (Thoo et al., 2017).

According to a study by Grant (1991), businesses need new management skills to meet the demands of the data-driven world. For example, working with big data requires the application of predictive analytics, as well as specific, essential competencies from fields such as finance, accounting, statistics, discrete event simulation, forecasting, and applied mathematics. Employing and training its present staff members is one way a business might generate competent, qualified workers. Moreover, trained and motivated employees enhance mutual trust, facilitate the sharing of practical information and knowledge, and foster teamwork that will likely be difficult for other organizations to imitate.

The RBV can serve as the basis for developing the supply chain strategy taxonomy. To attain SCI, a manufacturer's suppliers and customers must collaborate (L. Luo & Flynn, 2023). If a firm is vertically integrated, its internal operations supply most of the materials for which it is well-known. Vendors and customers are the two additional external sources from which organizations receive resources. According to Amsterdam (2020) distributing a company's limited resources domestically is not as critical as controlling inter-organizational resources to achieve outstanding performance. Partners in the supply chain often provide critical resources. Suppliers are especially crucial to the focus of the firm's execution plans and the availability of resources (Schoenherr & Swink, 2012; Thoo et al., 2017). For this study, RBV theory helped to explain how an organization's resources can be integrated across the supply chain to improve the performance of manufacturing SMEs.

2.2.2. Network Theory

Network theory stresses the mechanisms and processes by which individuals, groups, and SMEs interact with the networks (Daft, 1983). The methods and procedures that people, organizations, and businesses employ to interact with networks are the main emphasis of network theory (Daft, 1983). The theory states three concepts of a network: actors, resources, and activities. Understanding the integration requires an understanding of the relationships between the many actors. Each actor depends on the others, even if they create their own network. Understanding the relationship between the partners is necessary to comprehend the network (Thoo et al., 2017). The correlations are distinct, varied, and consistent. With mutual respect and trust, the actors in the network progressively build a strong foundation for future economic dealings. The actors can be connected through technical, social, cognitive, legal, economic, and other ties (Birkel & Hartmann, 2020). Nowadays, the Internet of Things (IoT) helps organizations connect objects and devices through the Internet. The networks of objects (e.g., devices, vehicles, machines, containers) are embedded with sensors and software that have the potential to collect and share data over the Internet (de Vass et al., 2018; Mostafa et al., 2019).

The Network theory states that information and communication technology (ICT) serves three primary purposes. First, it enables businesses to share large and more complex data sets with their commercial partners. Second, it provides access to real-time supply chain data, including scheduling, production planning, delivery status, and inventory counts. These days, manufacturing SMEs can use information and communication technology (ICT) to monitor and manage every aspect of their supply chain, including purchasing, shipping, storing, distributing, selling, and taking returns (Reiman et al., 2023). Third, ICT makes it easier for businesses and suppliers to coordinate their forecasting and scheduling, which improves inter-firm collaboration (Ju & Wang, 2023). It makes it easier to coordinate supply chain operations, which can occasionally prevent issues related to temporal and geographic distance. Information technology enables seamless integration of systems and facilitates easier access to data across the supply chain for partners. In this context, the theory focuses on the relationships within a network between people, items, and activities (Chatha & Jalil, 2022).

As the literature has adequately demonstrated, the use of ICT has made it easier to reduce coordination costs. For instance, electronic markets with ICT skills cut down on the cost of locating information about prices and product options (Hamann-Lohmer et al., 2023; Reiman et al., 2023). Additionally, because data sharing fosters collaboration and lowers transaction costs, particularly coordination costs, businesses may be able to reduce supply chain uncertainty and contracting costs (Hald & Spring, 2023). If a supplier cannot precisely anticipate the cost of the product components, it will be reluctant to accept a contract that locks it into a fixed price for a lengthy period. By combining technology and business process integration, it is possible to significantly increase the productivity of producing exceedingly complex commodities (Chatha & Jalil, 2022).

Using the network theory, SMEs need to understand the connections among supply chain players to become more effective. With network theory, small and medium-sized manufacturing firms can identify key supply chain participants, understand their interactions, and leverage these networks to enhance productivity. The network theory emphasizes inter-firm relationships and information exchange across the supply chain. It highlights the role of trust, coordination, and shared goals in improving performance.

In the context of this study, the network theory emphasizes inter-firm relationships and information exchange across the supply chain. It highlights the role of trust, coordination, and shared goals in improving performance. Understanding how supply chain integration with suppliers and customers reduces costs, facilitates the acquisition of resources that SMEs need, and enhances the quality of their products is crucial. They can expand their customer base, develop new products, and open new markets. Network theory can also be crucial for SMEs in the manufacturing industrial sector to identify potential supply chain risks, such as interruptions in the flow of goods or information (Hamann-Lohmer et al., 2023; K. et al., 2023). By developing contingency plans based on their understanding of the relationships between the many actors in the chain, small and medium-sized manufacturing SMEs can lower risks and ensure the smooth operation of their supply chain (Chatha & Jalil, 2022).

2.2.3 Supply Chain Operations Reference Model (SCOR Model)

The Supply Chain Operations Reference (SCOR) model was developed by the Supply Chain Council (SCC) in the late 1990s with an emphasis on the operational aspects of supply chain management (SCM). The SCOR model aims to address, improve, and communicate supply chain decisions within a company and with its suppliers and customers (Nguyen et al., 2023). Today, the SCOR model is the most widely adopted and consistent supply chain management (SCM) framework, featuring best practices, performance assessments, and seven key business processes (Ikeanyibe et al., 2023). The model outlines the business processes necessary to meet customers' demands. The model can enhance an organization's performance through supply chain antecedents, such as business analytics, as it becomes a potentially valuable way to secure a competitive advantage and improve supply chain performance (Girjatovičs et al., 2018; Kottala & Herbert, 2020; Nguyen et al., 2023). The SCOR model comprises six strategic processes, covering the central activities relating to production, logistics, and supply chain management, which include plan analysis (PA), source analysis (SA), make analysis (MA), delivery analysis (DA), return analysis (RA), and enablement. Each of these processes is considered both a crucial intra-organizational function and a critical inter-organizational process (Nguyen et al., 2023). The measurement of each component has its own criteria: Reliability, Responsiveness/flexibility, Costs, and Assets.

Many companies, over the last few years, including Intel, General Electric (GE), Airbus, DuPont, and IBM, have widely adopted the model to measure supply chain improvements in global projects (Grant, 1991). The model proved to be a powerful and robust toolset for describing, analyzing, and improving the supply chain performance. Implementing the SCOR requires a clear understanding of how steps are applied from one company to another. It is a model designed for use in any supply chain and is employed worldwide. It is essential to note that not everything described in the SCOR applies to all companies, and not all aspects of the SCOR are present in every company.

The Supply Chain Operations Reference Model (SCOR) describes high-level business processes related to satisfying customer demand (Conner & Prahalad, 1996). This study organizes the model into four process types: Plan, Source, Make, Deliver, Return, and Enable. These processes include the vertical neutral abstractions from demand forecasting/supply planning, procurement, manufacturing processes, order entry, outbound logistics, and returns processing activities. It informs your variable of supply chain communication integration since effective planning requires shared forecasts, demand information, and strategic alignment.

In the planning processes, the SCOR model aligns with supply chain communication and coordination. It informs the variable of supply chain communication integration since effective planning requires shared forecasts, demand information, and strategic alignment. In this context, customers can be involved in the planning process, allowing for more customization, individually tailored products, and greater efficiency (Dicksen, 1996). In the supply chain, transparency allows for better information sharing between suppliers and customers. Demand forecasting capacities can easily be shared and coordinated. As a result, the bullwhip effect is reduced. For example, storage costs are reduced, transport costs are balanced, and synchronized along the supply chain. This also reduces the time to market, enables a faster reaction to customer demand, and decreases lead times.

Regarding the source processes, the SCOR model links to supplier collaboration. It informs supply chain collaboration integration, as sourcing efficiency depends on strong supplier partnerships, trust, and joint problem-solving. It can be implemented with a higher degree of autonomy and speed. The use of the Internet of Things in sharing data increases transparency (Grant, 1991). This enables faster response times and ensures resilience in supplier selection using appropriate standards and certificates. This ensures the fulfillment of requirements regarding ecological and social concerns along the supply chain without requiring extensive administrative procedures.

For making processes, a reduced scrap rate or fewer raw materials leads to lower costs and improves the firm's performance (Dicksen, 1996). It supports the integration of performance measurement variables, as streamlined production and quality management practices directly impact the competitiveness of manufacturing SMEs. Furthermore, enhanced product design, manufacturing processes, and production facilities increase quality and reduce waste during the manufacturing processes. Transparency in the supply chain enables the flexible exploitation of available resources, potentially decreasing energy prices and accelerating production and energy consumption.

The delivery process is closely tied to customer integration. It informs the customer integration variable, as it captures order fulfillment, delivery reliability, and responsiveness to customer needs. It is also influenced by information sharing in terms of optimizing transport routes and scheduling. The use of real-time information in the supply chain enables improvement in quality, and unnecessary steps can be avoided. At the same time, the availability of information impacts the design of lean processes as the quality controls are integrated and damages are reduced (Grant, 1991).

The return process involves repairing or replacing products and can be handled more quickly, flexibly, and cost-effectively. This also includes recycling decisions, such as the use of plastics that need to be handled at the end of the life cycle to protect the environment (Dicksen, 1996). Knowledge sharing can also be used to track materials and their usage throughout the entire lifecycle, as it contributes to a circular economy through Industrial 4.0 and affects customers and other supply chain stakeholders. Regarding the enabling process, transparency is critical to the success of the supply chains and facilitates compliance with rules, agreements, and contracts. As a result, less effort is required in monitoring and control. Thus, design and planning processes can be conducted with the help of information systems, and unnecessary tasks can be reduced (Grant, 1991).

In the context of manufacturing SMEs, businesses can use the SCOR model to optimize their supply chain operations. They can evaluate and enhance the effectiveness of their supply chains by utilizing a range of indicators and a common language provided by the SCOR model (Zhou et al., 2011). Manufacturing SMEs can utilize the SCOR model to pinpoint areas like order fulfillment, demand scheduling, and inventory control in their supply chain that require improvement (Girjatovičs et al., 2018; Müller & Birkel, 2020). Manufacturing SMEs that adopt this strategy may also find ways to enhance customer service, reduce expenses, and increase productivity. The SCOR model can help manufacturing SMEs by promoting the growth of a more cohesive and connected supply chain network.

Manufacturing SMEs can shorten lead times and increase responsiveness by coordinating their operations with suppliers and customers (Girjatovičs et al., 2018; Müller & Birkel, 2020). Utilizing the SCOR model enables manufacturing SMEs to become more profitable, competitive, and customer-focused. It provides manufacturing SMEs with a technical approach to supply chain integration, enabling them to overcome obstacles such as a lack of capital, insufficient experience, and disjointed supply networks.

2.3 Conceptual Framework

A conceptual structure is a hypothesized model that describes the principles under investigation and graphically explains the general structures of the variable under investigation and their relationships. The primary goal of this study is to investigate the relationship between the SCI parameters and the performance of manufacturing firms in Rwanda. The literature informs the proposed conceptual framework for this study within the context of the SCI and organizational performance (Grant, 1991). The study employed the Supply Chain Operational Reference (SCOR) model, the Resource-Based View (RBV), and Network theories, which describe how the various SCI elements interact with performance under different interconnections Figure 2.1.

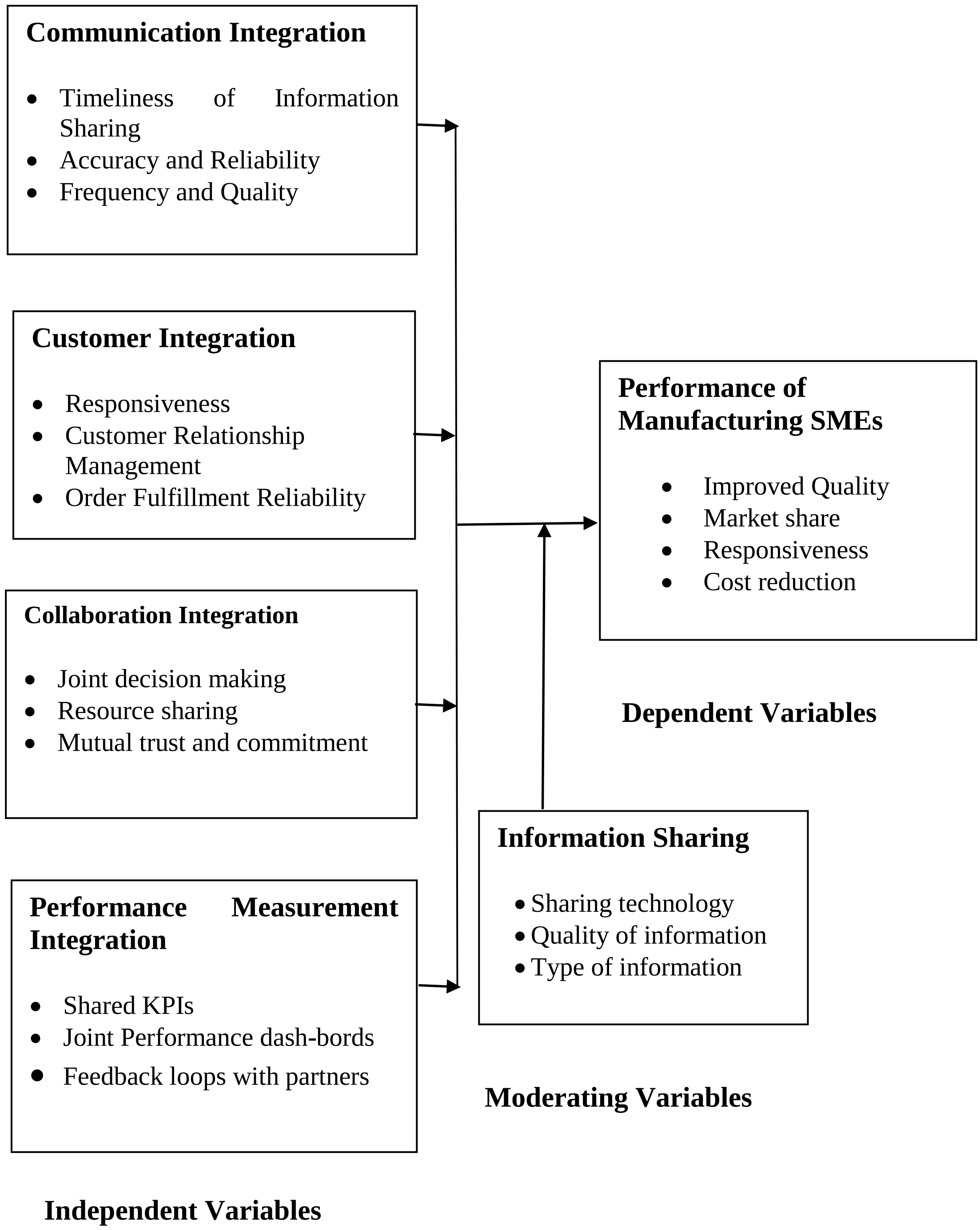

Figure 2.1: Conceptual Framework

2.3.1 Communication Integration

The term "supply chain communication " in supply chain management describes the efficient and well-coordinated information exchange among the different internal and external supply chain partners (Shi et al., 2023). Supply chain communication helps manufacturing SMEs exchange accurate, timely, and reliable information. This enhances coordination, reduces uncertainty, and supports joint decision making (Zhou & Benton, 2007; Flynn, Huo, & Zhao, 2010). In supply chain management, timely information sharing is a crucial component that enables partners to make informed decisions and minimize delays and disruptions (Zhou & Benton, 2007).

Communication integration involves the use of digital platforms, software systems, and communication networks to streamline communication processes, share real-time data, and collaborate on various activities such as inventory management, order processing, and logistics coordination (Zsidisin et al., 2024). These technologies enable supply chain partners to communicate more effectively, make informed decisions, and respond quickly to changes in demand or supply (Ruel et al., 2018). Examples of integrated communication technology in the supply chain include using digital platforms, software, and communication networks to share real-time data and speed up communication processes (Sundram et al., 2020). It also helps to collaborate on a variety of tasks, like order processing, inventory management, and logistics planning (Sundram et al., 2020). Due to these technologies, supply chain actors can now make better-informed decisions, communicate more effectively, and respond quickly to changes in supply or demand (Porcu et al., 2019).

Communication integration comprises making use of systems and communication technologies to ensure that relevant data and insights are effectively shared among different supply chain activities and stages (Tan & Sidhu, 2022). Communication integration links the systems and technologies used in the supply chain, including enterprise resource planning (ERP), logistics, and customer relationship management (CRM) (Asamoah et al., 2015). Because of this interaction, there are no information silos, and a constant flow of information is maintained. This reduces uncertainty and strengthens trust between supply chain partners. It enables the real-time exchange of critical data, such as production schedules, demand forecasts, inventory levels, and shipment tracking (Can Saglam et al., 2022). Real-time supply chain visibility enables informed decision-making and facilitates prompt adaptation to changes.

Song et al. (2024) asserted that with good communication integration between departments within a firm, such as sales, production, logistics, and procurement, they may collaborate more readily. The total efficiency of the supply chain increases when these processes are well coordinated. Other parties involved in the supply chain integration process are manufacturers, distributors, suppliers, retailers, and logistics companies. García-Alcaraz et al., (2020) argued that supply chain communication with the partners is essential for demand forecasts, order status, inventory levels, planning events, and responding to changes in the market. Frequency and Quality of Communication enhance collaboration and supply chain alignment (Flynn, Huo, & Zhao, 2010).

Communication integration is evaluated using indicators such as the timeliness of information sharing, the accuracy and reliability of exchanged information, and the frequency and quality of communication between supply chain partners (Zhou & Benton, 2007; Flynn, Huo, & Zhao, 2010; Cao & Zhang, 2011). Supply chain Communication systems can be used to track key performance indicators (KPIs) related to supply chain performance (Porcu et al., 2019). Integrated communication in supply chain management, which promotes effectiveness, transparency, and teamwork, results in a more flexible and responsive supply chain (Fernando & Wulansari, 2020). Ultimately, it helps organizations gain a competitive advantage in the market by helping them reduce costs, increase customer loyalty, and adjust to changing market conditions (Porcu et al., 2019).

Communication using software applications makes it easier to integrate several sources of communication in a working setting. It covers information sent between devices, departments, and even manufacturing facilities (Can Saglam et al., 2022). Software applications enable various systems and devices to cooperate effectively, ensuring that data can be utilized and shared throughout the supply chain. This combination reduces the likelihood of errors and increases overall efficiency. The software enables real-time observation of production processes. It enables the quick identification of inefficiencies, bottlenecks, or production standard violations and the quick implementation of corrective measures. Software-enabled communication integration enables the real-time application of quality control procedures (Jacobs et al., 2016).

Porcu et al. (2019) asserted that in supply chain management, strong relationships with suppliers are essential for a successful production process. The software facilitates easier communication between suppliers and producers, ensuring the timely delivery of components and raw materials (Asamoah et al., 2015; Sundaram et al., 2020). It improves overall manufacturing performance by decreasing the possibility of overstock or stock-out issues. The software enhances collaboration and correspondence in improved project management and manufacturing process synchronization. Automating tasks and processes with software assistance boosts productivity and lowers the likelihood of errors (Fernando & Wulansari, 2020). Faster manufacturing cycles and more industrial efficiency could result from this.

Software-enabled communication integration and be used to construct predictive maintenance solutions (García-Alcaraz et al., 2020). Manufacturers can lower downtime and boost production efficiency by planning maintenance tasks and analyzing equipment data. The software helps ensure adherence to industry standards and laws (Tan & Sidhu, 2022). Can Saglam et al., (2022) asserted that automated reporting features facilitate the provision of required paperwork, reducing the likelihood of non-compliance issues. The request for goods or services indicates the beginning of the payment and purchase procedure. Purchase to pay to seek effective channels of communication to convey supplier expectations. Communication integration facilitates the proper forwarding of the requests to the relevant departments or individuals for approval (Can Saglam et al., 2022).

García-Alcaraz et al. (2020); Song et al. (2024) asserted that automation systems in manufacturing SMEs are essential for communication integration in the supply chain management (SCM) since they enhance production performance. They also argued that automation systems increase overall productivity in manufacturing activities by simplifying procedures, enhancing efficiency, and reducing errors. While the organization is automated, it enhances coordination and communication across the different production stages. It also facilitates the smooth integration of data from several sources, including logistics platforms, production planning software, and inventory management systems (Tan & Sidhu, 2022). They also argued that making better decisions is made possible by the real-time insights that these integrated data offer into the state of various industrial processes.

In manufacturing firms, automated systems use Networked and interconnected machinery and equipment (García-Alcaraz et al., 2020). It facilitates the coordination and optimization of industrial operations, thereby reducing downtime and increasing overall production (Tan & Sidhu, 2022). Automation systems in manufacturing enhance supply chain visibility by tracking items, production processes, finished goods, and raw materials throughout the manufacturing cycle. This visibility supports resource efficiency, bottleneck prediction, and inventory management (García-Alcaraz et al., 2020). It integrates with modern enterprise resource planning (ERP) systems (Tan & Sidhu, 2022). This integration facilitates information sharing across the manufacturing, finance, sales, and other departments, improving overall coordination and alignment with business objectives (Can Saglam et al., 2022). To summarize, supply chain manufacturers can ensure the effective implementation of automation systems and seamless communication integration to boost operational efficiency, reduce costs, enhance product quality, and improve overall performance (Shi et al., 2023).

2.3.2 Customer Integration

In the manufacturing sector, supply chain customer integration is defined as the ability to rapidly adapt production and delivery in response to evolving customer demands. Customer integration is evaluated through indicators such as responsiveness to customer demand, order fulfillment reliability, feedback loops, and co-development. These indicators collectively drive the performance of manufacturing SMEs. An effective customer integration enhances demand forecasting, improves inventory management, and shortens order fulfillment cycles, ultimately boosting supply chain performance (Dzogbewu et al., 2021). Customer integration involves order fulfillment reliability, which indicates how consistently customer orders are delivered correctly, completely, and according to schedule. High reliability demonstrates strong customer integration and effective coordination with external partners. Customers are integrated into value co-creation, but they must also be involved in the development of services (Ominde et al., 2022).

Scholars and Flynn et al. (2010) defined customer integration as the extent to which a business proactively engages a customer as a partner in managing supply chain resources, information flow, coordinated product and service development, and expectations in a seamless way. Supply chain management categorizes integration as integrating the customer, internal, and supply (Aslam et al., 2023; Flynn et al., 2010). Businesses can better anticipate and understand their customers' demands when they are involved in creating goods and services that better suit those needs. From this literature, customer integration refers to building and maintaining a solid relationship and partnership with major customers (Nguyen Thi & Nguyen Thi Thu, 2022).

Customer involvement in determining best practices helps manufacturers gain valuable insight into customer preferences, needs, and expectations (Dzogbewu et al., 2021). It also leads to business and product development aligned with market demand. Involving the customer in product design enables the company to understand their needs and create products tailored to meet those needs in the market. It also increases customer satisfaction and loyalty, as customers receive products that meet their needs. These concepts accelerate product development, reducing lead times and time-to-market for new products. Close customer collaboration allows manufacturers to receive prompt requests (Agag et al., 2023). It also helps coordinate inventory, production planning, and supply chain management.

According to Fourie (2015), customer integration can enhance the competitiveness of manufacturing firms. It enhances product development and improves customer satisfaction simultaneously. Therefore, researchers stressed the linkage between customer integration and customer value (Fianko et al., 2023; Flynn et al., 2010). In this context, they provide three parameters: understanding the customer needs, expectations, preferences, and purchasing power, which is essential before trying to increase customer value. When developing a product or service for the market, it is simpler to understand and consider client needs by designing with a customer-centric knowledge base, such as this one.

Flynn et al. (2010) argued that real-time customer feedback helps manufacturers make the necessary improvements. It also helps to incorporate customer feedback, thereby reducing the likelihood of costly redesigns after launch. By carefully examining the needs and expectations of their customers, manufacturers can tailor their products and services to meet or exceed their expectations (Yang et al., 2023). High customer satisfaction is closely tied to positive word-of-mouth, repeat business, and, potentially, an increase in market share. Customer integration promotes production flexibility, enabling companies to respond quickly to changing client demands (Yang et al., 2023).

On the other hand, Ominde et al. (2022) found that 40–75% of newly launched services fail due to poor customer relationship management. Customer relationship management involves proactive engagement with customers, such as sharing order status updates, joint product development collaborations, and feedback mechanisms to build trust and align offerings with customer needs. Effective CRM enables SMEs to better understand markets, personalize solutions, and foster loyalty, thereby enhancing performance (Reaidy et al., 2021). The success of manufacturing SMEs depends on their ability to deliver value to customers (Fianko et al., 2023).

Manufacturers can differentiate themselves from competitors by creating products that better meet the requirements and needs of consumers (Agyei-Owusu et al., 2022). Achieving this requires manufacturing forms that incorporate consumer feedback into production processes. This difference may lead to a market share and a competitive advantage. A strong relationship with customers leads to loyal customers and enhances partnerships (Fernando & Wulansari, 2020). Brand enthusiasts are more likely to remain loyal to a company that improves or prolongs the life of its goods. Supply chain customer integration helps producers keep ahead of industry trends and make informed strategic decisions by enabling data-driven decision-making (Aslam et al., 2023). To summarize, integrating customers into manufacturing firms' processes brings innovation, increases customer satisfaction, and gives a firm a competitive advantage. It also creates and sustains strong customer relationships, an ongoing, dynamic process requiring effort (Aslam et al., 2023; Khanuja & Jain, 2020).

2.3.3 Collaboration Integration

In the manufacturing sector, collaboration integration refers to aligning and coordinating different internal and external stakeholders, including partners, customers, suppliers, and employees, to improve overall performance (Min et al., 2005). Manufacturing SMEs that wish to be involved in supply chains adopt new business strategies and work closely with a selected set of supply chain partners (L. Li et al., 2023; Min et al., 2005; Panahifar et al., 2018). Joint decision-making is a crucial element in supply chain collaboration, as it involves coordinated strategic and operational decisions, such as joint planning, demand forecasting, and synchronized production planning, made collaboratively by supply chain partners to optimize shared outcomes. Simatupang and Sridharan (2005) highlight this as a foundational element of high-performing collaborative frameworks, where decisions are made jointly rather than in isolation.

Supply chain collaboration also involves resource sharing, which refers to the collective leveraging of assets, capabilities, technology, and data across supply chain partners to enhance efficiency, reduce costs, and create a synergistic advantage. Bowersox et al. (2003), cited in Simatupang and Sridharan (2005), emphasize that sharing resources, including infrastructure and knowledge, across SMEs enables them to achieve greater benefits together than individually. It is crucial to choose the right supply chain partners. Process mapping can help identify what has to be done externally with an outside partner and what can be done internally by the company. Further advantages of creating internal alignments can be realized by optimizing processes in core areas, such as manufacturing cycles, forecasting methods, customer service, sales, logistics, and information systems. These alignments might result in a seamless procedure for delivering value to customers (Nguyen Thi & Nguyen Thi Thu, 2022).

Manufacturing SMEs must develop software tools to interact with, manage, and assess their suppliers' performance in real-time. Closely monitoring relationships between supply chain participants will increase the pressure on coordination and efficiency (Li et al., 2023; Mofokeng & Chinomona, 2019). Collaborative tools and technologies, such as vendor-managed inventory (VMI) systems, can help in seamless communication and coordination between manufacturers and suppliers (Panahifar et al., 2018). By utilizing information-sharing techniques like CPFR and VMI in supply chain collaboration, trading partners have enhanced forecast accuracy, reinforced partner relationships, and provided better customer service (Nguyen et al. Thu, 2022; Shin et al., 2019). Information sharing to enhance collaboration is one way for the business to improve performance, but it is not free from challenges (Panahifar et al., 2018). Some examples of collaborative tools and technology can support smooth coordination and communication between suppliers and manufacturing firms. It includes Vendor-managed inventory (VMI) systems that enhance supply chain visibility, which is necessary for effective cooperation.

Manufacturing SMEs need accurate data on inventory levels, production plans, and demand forecasts that are beneficial for the smooth management of the business (Dubey et al., 2020). Nguyen Thi & Nguyen Thi Thu (2022) argued that transparent communication anticipates problems and takes proactive measures to resolve them, which reduces disruptions. In this context, sharing in a timely and accurate manner is crucial for effective teamwork (Nguyen et al., Thu, 2022). This means information sharing between partners and suppliers about demand forecasts, inventory levels, and production schedules creates trust among supply chain partners. Initiatives for collaborative planning, forecasting, and replenishment (CPFR) enhance supply and demand alignment by facilitating the ability of decision-makers to work together.

Manufacturing SMEs need to build trust with supply chain partners; it builds confidence and long-term relationships between partners (Baah et al., 2022; Panahifar et al., 2018). Collaboration with suppliers yields lower costs, shorter lead times, and improved quality. Vendor-managed inventory (VMI) systems are one technical development and collaborative tool that can help manufacturing SMEs and suppliers coordinate and communicate more easily (Zhong et al., 2023). Technology enhances teamwork by providing a central location for information sharing and decision-making. These technologies include advanced planning and scheduling (APS) software, enterprise resource planning (ERP) systems, and supply chain management (SCM) platforms (Asamoah et al., 2015; Panahifar et al., 2018). Regular performance reviews, platforms for feedback, and collaborative problem-solving techniques support continuous supply chain improvements (Zhong et al., 2023).

Stakeholder trust, as outlined in the theoretical backdrop, is a significant factor in business collaborations, as SMEs are fundamentally partnerships with a range of stakeholders (Jing et al., 2019; Swift et al., 2019). It illustrates how building stakeholders' loyalty and sense of trust depends greatly on giving them accurate and transparent information (Panahifar et al., 2018). However, integration can be extended to sustainability initiatives, such as reducing environmental footprint, gas, and carbon emissions, and encouraging moral behavior along the supply chain. Reaching common sustainability goals will benefit manufacturing companies and their partners (Baah et al., 2022; Panahifar et al., 2018; Shin et al., 2019).

In summary, collaboration in the supply chain encompasses several key activities, including sharing information, integrating new technologies, effective communication, and a commitment to ongoing improvement. Collaboration is crucial for manufacturing organizations to achieve a more resilient, adaptable, and prosperous supply chain ecosystem.

2.3.4 Performance Measurement Integration

It is one of the types of integration that ensures each component within the organization is accountable for achieving its own goals (Vergara et al., 2023). In this context, supply chain partners co-develop Key Performance Indicators (KPIs) metrics jointly to measure and align performance expectations. These KPIs drive transparency and accountability across the firm, empowering collaborative performance management. Partners share scorecards as an essential tool in strategic supplier Relationship management. They may also have standards that create a report card on how each member is performing (Baah et al., 2022; Panahifar et al., 2018).

In Rwanda, a unique mechanism known as "Imihigo" performance contracts plays a central role in driving accountability, goal alignment, and measurable outcomes across organizations, including manufacturing SMEs. These contracts inherently promote the development and tracking of shared performance metrics, effectively functioning as joint KPIs that align the objectives of SMEs with broader performance targets and stakeholder expectations (Uwamahoro et al., 2024). Performance contracts should be written to support desirable supply chain outcomes by increasing supply chain surplus and avoiding actions that harm performance (Vergara et al., 2023). Return on investment (ROI) is a key financial metric that serves as a benchmark for individual and collective performance. Rwanda's manufacturing SMEs reported an average return on investment of approximately 20% (National Institute of Statistics, 2024).

A performance contract should ideally be structured to increase the firm's and supply chain's profitability, avoid information distortion, and provide incentives to the supplier to improve performance across critical dimensions (Mofokeng & Chinomona, 2019; Ruel et al., 2018). Many supply chain performance issues arise because the customer and supplier are separate companies, each attempting to maximize profits (Vergara et al., 2023). Performance contracts should be written to support desirable supply chain performance outcomes by increasing supply chain surplus and avoiding actions that harm the performance of manufacturing SMEs (Vergara et al., 2023). On the other hand, Relevant KPI metrics are frequently already known to a business (Vergara et al., 2023). KPIs in Supply Chain integration include "backorder percentage," "emergency purchases," and "late delivery to important customers (Wijeyaratne, 2018). Because KPIs indicate the company's performance in the most crucial variables, managers may substantially improve performance by taking control of these elements. Organizational measurements can be seen at different levels, which correspond to the hierarchy of a supply chain (Ali et al., 2023).

2.3.5 Performance of Manufacturing SMEs

Manufacturing organizations are evaluated based on attributes or metrics that enable the assessment of whether the strategic goals provide data and input directly related to the performance of the Supply chains (Saleheen & Habib, 2023b). The characteristics provide a framework for locating and evaluating solutions that help satisfy the needs for choices and improve business operations. Performance measuring is the process of determining the effectiveness and efficiency of an action. Metrics include process management, clear roles and duties, continuous learning, and model success (Takayabu, 2024). Evaluating each supply chain's performance independently is essential to consider industry-specific regulations.

There are two types of approaches to measuring the performance of manufacturing SMEs. Financial and non-financial approaches fall under these two categories. Some techniques include information technology integration, safety stock, feedback, and self-evaluation (Zhou & Li, 2020). Among the various methods employed in modern performance measurement are return on assets, return on investment (ROI), and customer satisfaction. Kaplan & Norton's 1992 balanced scorecard proposes four main perspectives for evaluating performance. These consist of different viewpoints on finances, customers, business operations, and organizational learning (National Bank of Rwanda et al., 2020).

Supply chain performance measurement is used to measure ten (10) manufacturing attributes. The ten supply chain performance measurement attributes that the researcher categorized for a manufacturing firm were: Financial Health, Collaboration, Velocity, Resilience, Reliability, Continuous Improvement, Visibility, Work People Health, Sustainability, and Quality Service (Ali et al., 2020; Saleheen & Habib, 2023b). Organizational performance refers to how well a business achieves its objectives regarding money and the market (Agyei-Owusu et al., 2022; Z. Ali et al., 2020). In this context, organizations implement appropriate policies and methods to enhance their financial performance, foster innovation, and deliver greater consumer satisfaction. Flexibility, speed, quality, and cost are used to explain the performance of manufacturing SMEs for this study. An organization's flexibility is its ability to swiftly adapt to changes in the market, including modifications to product mix, schedules, and quantity. Speed performance measures how quickly a good or service is delivered to a consumer; the faster the delivery, the better the speed performance (Takayabu, 2024).

One firm's performance indicator is quality, which is measured in several ways, including parts per million, customer defects per supplier, and field failure rates by purchase item and by supplier (Li et al., 2019; Zhou & Li, 2020). A study on the role of logistics in the performance of manufacturing firms in Nigeria, conducted using a cross-sectional survey with a sample of 144 firms and regression analysis through PLS-SEM, reveals that the performance of manufacturing SMEs may stem from the relationship between inbound and outbound logistics. The same study was conducted in Ghanaian manufacturing breweries, utilizing the services of a third-party logistics provider (DHL), which assessed the importance of outbound Logistics on performance Management in Manufacturing Companies in Ghana and Guinea, using a structured questionnaire. The findings showed that the relationship between outbound logistics and performance was not significant. The implications of these findings suggest that managers of manufacturing SMEs cannot entirely rely on logistics to enhance a firm's performance (Mat Isa & Mohammad Al Dweiri, 2020).

Performance in manufacturing SMEs can be effectively assessed through key indicators such as on-time delivery, cycle time reduction, and responsiveness to schedule, which collectively reflect operational efficiency and customer responsiveness (Zhou & Li, 2020). The primary objective of the study is to illuminate current performance measurement practices. Through advanced analytical techniques—including multiple regression, cluster, and gap analyses—it has been demonstrated that performance can be gauged using dimensions such as responsiveness, time, and delivery (Saleheen & Habib, 2023a). Additionally, performance is frequently operationalized as the duration from concept initiation to the first shipment or final product delivery to market measured in weeks or months, with the goal of continually reducing this time-to-market metric (Kamble et al., 2020).

The present goals and objectives primarily focus on profitability, liquidity, growth, and stock market performance (Müller & Birkel, 2020). Performance indicators are considered essential components of a practical and sustainable performance measurement framework, providing organizations with actionable and meaningful management information to guide decision-making and improve overall performance (Neely, 2005). These practices include metrics, approaches, tools, systems, and processes used in performance measurement. Metrics include management of organizational processes, clear roles and responsibilities, continuous learning, and modeling success. The tools include safety stock, information technology integration, self-evaluation, and feedback. By ensuring performance indicators, people can transform complex processes into simplified, conceptual information for easy communication and action (Zhou & Li, 2020).

Manufacturing SMEs have, over time, transitioned from relying on traditional performance metrics, such as profits, production output, efficiency, on-time delivery, and inventory turnover, to adopting modern approaches to performance measurement (Müller & Birkel, 2020). The modern approaches to performance measurement include the balanced scorecard, quality management, Return on Investment (ROI), Return on Assets, and customer satisfaction, among others. They are: the financial perspective, the customers' perspective, the internal business processes perspective, and the organizational learning perspective. Other performance measures include quality and cost, with common price performance examining the actual purchase cost against the planned purchase price, and cost analysis evaluating cost changes and cost avoidance. A cost change refers to the increase or decrease in cost resulting from a change in purchasing strategy, whereas cost avoidance represents the difference between the price paid and a potentially higher price that might have occurred if the purchase had not been obtained at a lower price (Nkwabi & Fallon, 2020).

2.3.6 Information Sharing

In the supply chain, manufacturing organizations work together to produce and distribute goods to customers. These organizations include retailers, distributors, manufacturers, suppliers, and peripheral ones like logistics service providers (Jen et al., 2022). Previous studies have demonstrated the need for information sharing among production sites, distributors, retailers, and third-party organizations, such as logistics service providers. Supply chain management has become simpler because of technology, which is also necessary for better supply chain management (Panahifar et al., 2018). Shin et al. (2019) asserted that real-time supply chain data offers a trustworthy indicator of information quality in the supply chain. Insufficient data for planning and forecasting produces inaccurate information. Inaccurate information weakens trust between parties and makes it easier for the supply chain system to make erroneous decisions (Kauppi et al., 2023). Information sharing reduces information asymmetry and uncertainty which are major impediments to effective collaboration allowing for synchronized planning and execution across supply chain partners (Panahifar et al., 2018).

Nguyen Thi and Nguyen Thi Thu (2022) have underscored the need to share reliable data. They argued that working together is essential and that safe information-sharing tools are crucial for providing precise and timely information. In addition to information security, collaboration and data sharing must become more crucial. It makes sense that certain partners could be hesitant to contribute sensitive data, such as financial reports, manufacturing schedules and plans, and inventory levels and values, to platforms when the integrated information systems are ineffective (Panahifar et al., 2018). It can only be handled by implementing protective measures for all parties. Information security needs to become more critical, particularly as teamwork and sharing sensitive information become increasingly common, and as these activities are facilitated through information-sharing protocols.

To help manufacturing SMEs reduce lead times and inventory costs, suppliers and customers have developed collaborative systems like VMI and CPFR to help with information-sharing techniques (Nkwabi & Fallon, 2020; Panahifar et al., 2018). The exchange of data regarding inventory levels can help decision-makers in a distribution supply chain make more informed choices regarding transshipment, order replenishment, and where to allocate safety stock. The vendor-managed inventory (VMI) helps to oversee the supplier activities and share accurate information. On the other hand, VMI helps the supplier monitor stock movement and advises the client on important issues, such as inventory replacement. In this instance, managing information sharing and security is necessary to optimize the benefits of business collaboration (Panahifar et al., 2018). Moreover, they assert that partners find it easier to confirm product stock levels when they have accurate information. In this context, accurate information sharing significantly enhances trust and collaboration within supply chains.

2.4 Empirical Review

2.4.1 Communication Integration and Performance of Manufacturing SMEs

Resource-Based View (RBV) theory posits that enhanced organizational performance and a sustained competitive advantage can arise from distinctive and valued organizational resources and competencies (Barney, 1991). Many organizations actively adopt ICT alignment to enhance organizational processes and raise customer service standards. This enables the organization to achieve high operational and financial performance in the face of a changing competitive environment (Saleheen & Habib, 2023b). Integrating internal operations and coordinating internal organization activities through Information Communication alignment can improve business efficiency and customer response (Zhou & Li, 2020). Information communication alignment may assist businesses in creating and introducing new goods and services. It expands the market share and more effectively responds to shifts in consumer demand by utilizing customer demand information (Saleheen & Habib, 2023b).

Supply chain communication ensures efficient collaboration between various departments in a manufacturing firm. The coordination of many tasks, including distribution, production, and procurement, as well as the sharing of information among numerous teams, has become simple through the integration of communication channels (Asamoah et al., 2015). As a result, it reduces the production process, and operations run more smoothly. Manufacturing SMEs can use integrated communication systems to get real-time data from different sources, such as production equipment, inventory management systems, and consumer feedback (Tan & Sidhu, 2022). Managers are better able to make informed decisions, address problems as they develop, and optimize procedures to increase productivity when they have quick access to this data. Having smooth communication integration makes it possible to communicate with vendors, suppliers, and distributors (García-Alcaraz et al., 2020).

Manufacturing companies that successfully apply communication integration may quickly get customer feedback and improve their products and services (Tan & Sidhu, 2022). Maintaining open lines of communication helps businesses better understand the wants and needs of their customers. Communication integration improves coordination, decision-making, supply chain management, quality control, employee commitment, innovation, and customer satisfaction (Nguyen et al., 2021). It helps businesses function more effectively, react swiftly to market changes, and keep a competitive advantage, hence overall SC performance. With open communication, industrial businesses may develop and apply quality control procedures more successfully (Can Saglam et al., 2022). Integration makes communication between frontline staff, quality assurance teams, and production managers easier and ensures that requirements for quality are recognized and maintained throughout the manufacturing process (Fernando & Wulansari, 2020).

Research on supply chain communication integration and SME performance reveals conflicting evidence. Several studies indicate that enhanced communication through timely and accurate information exchange leads to superior operational outcomes, such as increased responsiveness and logistics efficiency (Flynn, Huo, & Zhao, 2010; Van der Vaart & Van Donk, 2008). While some authors argue that integration improves performance, recent evidence suggests that integration sometimes fails to enhance transparency outcomes for SMEs, implying that integration benefits are conditional and may be null under certain unpredictable contexts (Sègbotangni, Laguir & Gupta, 2024).

Conversely, other reports have shown that the impact of communication-based collaboration on firm performance is insignificant or negligible (Sinkovics & Roath, 2004; Fawcett et al., 2015). While Macro-level constraints in East Africa, high trade/connectivity costs, and regulatory barriers can erode expected SCI benefits by blocking market access and scale economies for SMEs, producing mixed or negative empirical results (de Melo et al., 2020).

2.4.2 Customer Integration and Performance of Manufacturing SMEs

Customer integration refers to the process by which an organization incorporates its customers' needs, preferences, and feedback into various aspects of its operations. These include product development, production processes, and service delivery. Customer relationship management aims to improve customer satisfaction by understanding the needs, desires, and expectations (Zhong et al., 2023). Tasks related to customer integration include resolving issues, conducting face-to-face conversations with customers, responding to their complaints, enhancing customer satisfaction, and fostering long-lasting relationships with them. To achieve organizational performance, an organization needs to foster collaboration, transparency, and responsiveness (Dzogbewu et al., 2021).

By involving customers in product development, manufacturing companies may ensure that their products meet specific consumer wants and market demands (Ali et al., 2023). Ultimately, this may result in more innovative, competitive, and customer-focused products, leading to increased sales and market share. Understanding customer feedback offers valuable insights into product quality and performance (Agag et al., 2023). By promptly identifying and resolving issues and incorporating customer feedback into their quality control systems, manufacturing organizations can enhance customer satisfaction and produce higher-quality products (Nguyen Thi & Nguyen Thi Thu, 2022). Customer integration helps manufacturing organizations forecast demand, streamline production schedules, and optimize inventory levels. Tailored solutions that more effectively meet the customer's demand of the client can increase customer retention and loyalty (Nguyen Thi & Nguyen Thi Thu, 2022).

By closely collaborating with their customer, manufacturing organizations can improve their capacity to forecast demand, maximize inventory levels, and accelerate production schedules (Nguyen Thi & Nguyen Thi Thu, 2022). Effective communication leads to lower costs, shorter lead times, and increased supply chain efficiency. By maintaining continuous communication with their customers throughout the lifecycle of their products, manufacturing organizations may increase customer satisfaction and strengthen their relationships with them (Panahifar et al., 2018). This could lead to customer loyalty, responsiveness, supply chain efficiency, and an improved reputation for the company (Nguyen Thi & Nguyen Thi Thu, 2022).

Manufacturers can help customers by providing up-to-date information on inventory levels, production schedules, and transportation status through supply chain visibility programs (Nguyen Thi & Nguyen Thi Thu, 2022). Due to this visibility, customers can prepare and make informed decisions. Maintaining an open line of communication with clients to keep them informed of any developments, challenges, or changes in the supply chain is known as continuous communication (H. Nguyen et al., 2021; Tan & Sidhu, 2022). Take proactive steps to resolve difficulties or concerns, improving collaboration and fostering trust. Businesses can enhance customer satisfaction, boost operational efficiency, and obtain a competitive edge in the market by integrating customers into the supply chain. Mukasekuru (2018) argued that use-related information is often 'sticky,' which means that the information is difficult and costly to acquire, transfer, and use in a new situation, such as in the service development process Mukasekuru (2018) developed a model for integrating a new service within an existing service system. User information and experiences from both customers and employees play a vital role in the success of service development.

Empirical findings on the effect of Customer Integration on the performance of manufacturing SMEs are mixed. In some cases, such as research on SMEs in Pakistan, a significant positive link is observed, particularly when mediated by strong supply chain capabilities. However, the broader literature cautions that results are often inconclusive or equivocal, largely due to variations in firm contexts, contingency factors, and the measurement of performance (Mohammed, 2024). This suggests that Customer Integration may only translate into performance improvements when supported by complementary organizational capabilities and favorable environmental conditions.

2.4.3 Collaboration Integration and Performance of Manufacturing SMEs

In manufacturing firms, SC collaboration integration describes how several cross-functional departments and even outside partners collaborate to accomplish shared objectives (Panahifar et al., 2018). Enhancing overall performance and competitiveness in the market requires this integration (Zhong et al., 2023). These are a few of the most significant ways that collaboration integration influences the operations of manufacturing companies. Numerous tasks, including supply chain management, engineering, marketing, and sales, are involved in manufacturing firms. These capabilities are guaranteed to function together effectively through collaboration integration. For example, good communication between the manufacturing and sales departments helps guarantee that output matches market demand and minimizes stockouts (Panahifar et al., 2018).

The term "supply chain performance" refers to the degree to which a company's supply chain effectively handles all activities required to serve the final customer in the supply chain (Flynn et al., 2010). They include order-taking, purchasing, production, packaging, quality controls, and outbound logistics activities. The metrics to measure the performance of the supply chain include production rate, input, output levels, and environmental sustainability (Shah & Soomro, 2021). Modern technology assists in increasing SC visibility and enhances shareholder trust (Tarigan et al., 2021; Tiwari, 2021). They include radio frequency identification devices (RFID), artificial intelligence (IT), and the Internet of Things (IoT) to improve workflow and communication.

Integrated information systems and data-sharing structures among SC partners improve operational performance. VMI and CPFR help manufacturing SMEs improve SC performance by reducing operational costs, inventory, production, distribution, and logistics costs (Panahifar et al., 2018). Nevertheless, it may be challenging for many suppliers to fully leverage the benefits of teamwork when they do not have access to accurate information (Betti & Basso, 2019). There is still confusion over the number of collaboration partners, the duration of the agreements governing the cooperation, and the total number of investments made. Building and maintaining long-term, mutually beneficial, and profitable relationships between stakeholders is crucial to organizational success and customer satisfaction (Zhong et al., 2023).

Manufacturing organizations are evaluated based on attributes or metrics that enable the assessment of whether the strategic goals provide data and input directly related to the performance of the Supply chains (Saleheen & Habib, 2023b). The characteristics provide a framework for locating and evaluating solutions that help satisfy the needs for choices that improve business operations. Performance measuring is the process of determining the effectiveness and efficiency of an action. Metrics include process management, clear roles and duties, continuous learning, and model success Takayabu (2024). Evaluating each supply chain's performance independently is essential to consider industry-specific regulations.

There are two types of approaches to measuring the performance of manufacturing firms. Financial and non-financial approaches fall under these two categories. Some techniques include information technology integration, safety stock, feedback, and self-evaluation (Zhou & Li, 2020). Among the various methods employed in modern performance measurement are return on assets, return on investment (ROI), and customer satisfaction. Kaplan & Norton's 1992 balanced scorecard proposes four main perspectives for evaluating performance. These encompass various perspectives on finances, customers, business operations, and organizational learning.

On the other hand, the smooth and timely exchange of accurate information among SC networks is essential to the SC's performance (Daghar et al., 2021; Zhong et al., 2023). Prior research has shown that SC networks with larger information volumes outperform those with lower information (Li et al., 2023; Min et al., 2005; Panahifar et al., 2018). Moreover, SC collaboration ensures visibility to stakeholders, fostering trust and improving performance. Coordination across business partners practically makes flexibility easier by reducing costs and adapting to market changes, leveraging CPFR, VMI, joint planning software, and ECR. These advantages typically include improved sales and profits, reduced bullwhip effect, increased reactivity, and more accurate forecasts. On the other hand, SC integration and visibility, enhanced demand and inventory forecasts, and strategic shipment management can all help reduce the bullwhip effect.

In today's rapidly changing business environment, manufacturing SMEs must be agile and flexible to adapt to market fluctuations (Baah et al., 2022). By promoting collaboration and communication across various organizational components, collaborative integration helps businesses quickly adjust their operations. Collaborative integration with suppliers can take various forms, including coordinating manufacturing schedules, sharing information, and working together on quality improvement efforts (Formentini & Romano, 2016; Ghariani & Boujelbene, 2024). It could lead to lower procurement costs, better-quality supply, and faster response times to changes in demand.

Manufacturing companies must understand and meet their customers' needs. Working together to create products, get input, and provide customized solutions are all examples of collaborative integration with clients (Shin et al., 2019). It could lead to higher revenue, happier customers, and greater customer loyalty. Collaborative integration fosters a culture of knowledge sharing within the company. While using this method, teams and departments share innovative concepts, best practices, and insights (Ali et al., 2023).

Ultimately, essential performance measures should be employed to assess the collaborative integration process. Metrics like inventory turnover, customer satisfaction ratings, new product launch timeliness, and on-time delivery may be among them (Vergara et al., 2023; Zhong et al., 2023). Businesses may evaluate the success of their collaborative integration initiatives and pinpoint areas for development by monitoring these KPIs (Nkwabi & Fallon, 2020). Collaborative integration enhances the performance of industrial companies by increasing productivity, responsiveness, innovation, and customer satisfaction. In today's competitive economic market, companies that can effectively integrate collaboration both internally and with external partners will stand a better chance of success (Vergara et al., 2023).

2.4.4 Performance Measurement Integration and Performance of Manufacturing SMEs

Improving the performance of manufacturing Small and Medium-sized Enterprises (SMEs) requires the integration of performance measurement (Saleheen & Habib, 2023b). Performance measurement integration helps ensure that key performance indicators (KPIs) align with the strategic objectives of SMEs (Kamble et al., 2020). SMEs can enhance their overall performance by assigning and prioritizing tasks effectively. SMEs enhance their overall performance by effectively allocating resources and prioritizing tasks, focusing on indicators that align with their business objectives. SMEs can use performance measurement to identify operational and process inefficiencies (Takayabu, 2024). SME productivity and efficiency can be enhanced by identifying bottlenecks and implementing targeted improvements based on key performance indicators (KPIs) in various functional areas, including manufacturing, sales, and inventory control. Small and medium-sized SMEs(SMEs) can identify and reduce the variables driving expenses by incorporating performance monitoring systems (Saleheen & Habib, 2023b).

Performance measurement is integrated into the production process to facilitate the tracking of quality indicators by keeping key performance indicators (KPIs) related to product defects, defect rates, and customer complaints up to date. SMEs can identify areas for quality improvement and implement corrective actions to improve product quality and customer satisfaction (Z. Ali et al., 2020). SMEs can use integrated measurement tools to optimize inventory levels while lowering carrying costs. Key performance indicators (KPIs) such as stockouts, order fulfillment delays, and inventory turnover can be monitored by small and medium-sized businesses (SMEs) to ensure that inventory levels meet customer demand and, as a result, avoid excess inventory and related storage expenses (Saleheen & Habib, 2023b).

By incorporating performance measurement, businesses can monitor the key performance indicators (KPIs) related to customer satisfaction and loyalty (Z. Ali et al., 2020; Saleheen & Habib, 2023b). The organization can monitor key performance indicators (KPIs) such as on-time delivery, product quality, and customer feedback.

SMEs can also identify areas for improvement and implement policies to improve the entire customer experience (Li et al., 2019).

Several tools and techniques, including the Economic Value Added, Balanced Scorecard (BSC) Model, SCOR Model, Key Performance Indicators (KPI), Management by Objectives (MBO), Total Productivity Management, and Activity-Based Costing, have already been used to assess the performance of the supply chain (Saleheen & Habib, 2023b). Accordingly, the two most valuable tools are the Balanced Scorecard (BSC) model and the SCOR model, both of which have acquired universal support (Kamble et al., 2020). Integrating performance evaluation fosters a culture of continuous improvement between SMEs (E. Ali et al., 2023; Takayabu, 2024). Thus, the critical assessment and analysis reveal ten main drawbacks that are necessary while measuring supply chain performance models to diagnose and evaluate manufacturing organizations. The authors Saleheen & Habib (2023a) and Takayabu (2024), mentioned financial health, Partnerships, Information Sharing, Capacity, and Speed. They also added Traceability in Supply Chain Risk Management, Reliability in Internal Operations, Culture to Achieve Performance, Leadership and Corporate Governance, CSR, Technical Innovation, and Service Quality as tools for measurement.

Previous studies (Saleheen & Habib, 2023b; Tanrıverdi et al., 2023; Zhou & Li, 2020) discussed how the organization can measure performance using financial metrics like balance sheets, cash flows, and income statements connected to sales, inventory cost, cost-based, and operational costs. These measures can help the organization measure operational performance. The management can use these metrics to decide how to maintain long-term relationships with suppliers and customers (Saleheen & Habib, 2023b). Kamble et al. (2020). A study conducted in the auto components manufacturing industry found that Industry 4.0 enabled SMEs to offer more competitive benefits compared to traditional manufacturing systems. They argued that ten dimensions can be used to measure performance: cost, quality, flexibility, time, integration, optimized productivity, real-time diagnosis and prognosis, computing, and social and ecological sustainability. Measurement integration can be measured using resilience, reliability, continuous improvement, visibility, and environmental sustainability (Mohamed et al., 2023; Vergara et al., 2023).

In summary, performance measurement integration is essential for manufacturing SMEs to increase output, reduce costs, improve quality, increase customer satisfaction, and support informed decision-making (Saleheen & Habib, 2023b). The use of integrated performance monitoring systems can enhance the marketability and foster sustainable growth of small and medium-sized businesses (SMEs) (Takayabu, 2024). Performance measurement integration is assessed in this study by evaluating the integration of simulation-based metrics, network quality, and service quality in supply chain management. Thus, SMEs can identify opportunities for improvement, gain valuable insights into their operations, and enhance their overall performance.

2.4.5 Information Sharing and Performance of Manufacturing SMEs

The survival of any organization depends on sharing the correct information (Tiwari, 2021). With technological advances, information sharing in the supply chain enables long-term collaboration and coordination, ultimately leading to a competitive advantage. Adequate information sharing within the supply chain enhances the efficiency of organizational performance in the manufacturing sector (Li et al., 2019).

Information sharing plays a crucial role in the success of manufacturing SMEs. Managers who share the correct information with their team members can ensure everyone is on the same page and working towards the same goal (Fernando & Wulansari, 2020). This can lead to improved communication, increased productivity, and better decision-making (Kamble et al., 2020). Additionally, sharing information with suppliers and customers can lead to better relationships, increased trust, and business success (Pattanayak et al., 2024b). Therefore, it is essential for manufacturing SMEs to prioritize information sharing as a critical component of their overall performance measurement strategy.

Information technology (IT) is used as a tool to access, analyze information, and execute it to improve the performance of the supply chain (Huggins et al., 2014). Without information, managers cannot know what customers want, how much inventory is in stock, or when more products are produced or shipped (Vafaei-Zadeh et al., 2020). A study conducted using Smart PLS-3 to analyze data gathered from textile SMEs in Pakistan found that the information shared between SMEs has a positive and significant effect on supply chain performance. The relationship is mediated by extranet technology applications, namely, EDI, VMI, and POS (Hamann-Lohmer et al., 2023). Furthermore, information sharing presents a significant advantage to manufacturing companies (Vafaei-Zadeh et al., 2020).

Information sharing in supply chains can bring numerous benefits for manufacturing SMEs, including improved coordination, reduced lead times, increased efficiency, and enhanced customer satisfaction (Vergara et al., 2023). By sharing information with suppliers, customers, and other stakeholders, SMEs can enhance their capacity to respond to shifting market conditions and evolving customer demands. Information sharing can also help reduce costs and improve quality, enabling SMEs to identify and address issues more quickly and effectively. Furthermore, information sharing can facilitate collaboration and innovation, which are critical for supporting sustainable growth and development in the manufacturing sector (Mohamed et al., 2023). Information sharing is essential for manufacturing SMEs to compete effectively in today's global marketplace and achieve long-term success.

According to Zsidisin et al. (2024) Information Technology tools such as the Internet, VMI, and EDI are popular among manufacturing SMEs for exchanging information with partners. Of these tools, the Internet is most commonly used to exchange information with suppliers (Zsidisin et al., 2024). However, the study highlights that such tools are only helpful if they transmit relevant information across the supply chain. Kamble et al. (2020) asserted that the Internet of Things (IoT) and an extension of ICT improve supply chain performance. They also explained that IoT can optimize how people and systems interact, promote best practices for excellent performance, and enhance operational efficiency, safety, security, and customer experience. Technology can further reinforce supply chain integration and minimize costs by optimizing operations and reducing human intervention (Zsidisin et al., 2024).

Information sharing in the supply chain can significantly impact the performance of SMEs. When SMEs share information with their suppliers, they can better understand the needs and requirements of their customers, which can help them improve their products and services (Li et al., 2019). Additionally, sharing information can help SMEs identify areas for improvement in their operations, allowing them to streamline their processes and reduce costs (Sheikhi et al., 2018). Furthermore, information sharing can help SMEs build stronger relationships with their suppliers and customers, leading to increased loyalty and repeat business (Vafaei-Zadeh et al., 2020). Information sharing is a critical aspect of supply chain management that can help SMEs improve their performance and achieve sustainable growth. Effective information sharing is a critical strategy for companies to survive and thrive, enabling seamless supply chain integration (Vafaei-Zadeh et al., 2020).

With advancements in information and communication technologies, information sharing is more accessible than ever. It is now widely acknowledged that sharing information can be a powerful driver of economic growth. Accurately assessing the impact of procurement on secondary policy objectives is becoming increasingly crucial (Müller & Birkel, 2020). Measuring its impact becomes increasingly difficult as the public procurement activity becomes more complex. The author has noted that while the impacts of information sharing are widespread, no systematic measurement frameworks are available to demonstrate the benefits or drawbacks of procurement policies (Huo et al., 2021). High-level indicators may be used to measure progress against objectives. However, data availability and complexity necessitate centralized activity to support the development of a comprehensive measurement framework that encompasses the entire procurement system (Nkwabi & Fallon, 2020).

2.5 Critique of Existing Literature

The primary goal of integrating supply chains is to enhance customer value and create a collaborative approach to value creation with both customers and suppliers (Freije et al., 2021; Lu et al., 2018). To achieve this, companies must effectively coordinate cross-functional activities and establish solid external links with partners, suppliers, and customers in the supply chain (Freije et al., 2021). However, with the recent advancements in Information and Communication Technology (ICT), it is now possible to fully integrate the complexities of supply chain management into a single system that provides real-time supply and demand information and visibility of materials flow throughout the supply chain network (Chari et al., 2023). In a study conducted by Mostafa et al. (2019), argued that the impact of the Internet of Things (IoT) on supply chains was examined, focusing on developing a framework for warehousing in manufacturing companies in Egypt. The study proposed an approach to warehouse management that leverages IoT technology. This new technology enables managers to provide real-time visibility of everything in the warehouse, improving speed and efficiency and reducing counterfeiting and inventory shortage. Their findings focused on workers' satisfaction with logistics operations, showing a decrease in functional conflicts and an increase in the reliability and credibility of information available to customers and suppliers, which leads to improved performance. In this aspect, using tools to manage and control material handling and storage is essential for fast and efficient logistics (Zsidisin et al., 2024).

Other scholars (Garay-Rondero et al., 2020; Kumar et al., 2023; Zsidisin et al., 2024) have focused on supply chain management practices, including cooperation with Suppliers, digital integration, Green Purchasing, Green Logistics, and Cooperation with Customers. Their studies also focused on organizational performance in general without involving information sharing on the relationship between supply chain integration aspects. Based on the existing literature, several critiques and gaps exist. One critique is that most studies have focused on large companies, neglecting the challenges that small and medium-sized enterprises face in managing their supply chains. Additionally, some studies have overlooked the specific context of the manufacturing industry in different countries, which may have distinct regulatory, cultural, and economic factors that impact supply chain integration.

The literature on supply chain integration (SCI) and performance in Uganda, Kenya, and Tanzania offers valuable insights, but it also presents notable limitations. For instance, Bongei et al. (2020) and Michael (2022) primarily emphasize the positive effects of SCI on large-scale firms, overlooking the distinct dynamics and challenges faced by SMEs. This narrow focus raises concerns about the generalizability of their findings, particularly given that SMEs dominate the manufacturing landscape in the region. Consequently, a critical gap remains in understanding how SCI influences the performance of SMEs, warranting further empirical investigation. Another critique is that while some studies have found a positive relationship between supply chain integration and performance (Freije et al., 2021; Suryanto & Mukhsin, 2020) while Mofokeng & Chinomona, (2019) ; Zhong et al., (2023) found mixed or inconclusive results between supply chain integration and performance. This suggests that factors beyond supply chain integration may also impact the performance of manufacturing SMEs, including organizational culture, human resources, and the adoption of technology.

Most studies employ cross-sectional surveys, which capture relationships at a single point in time and cannot adequately establish causal links between SCI practices and performance (Agyabeng-Mensah et al., 2020). This makes it difficult to determine whether integration drives performance or if high-performing SMEs are simply more likely to integrate. Finally, there is a lack of studies investigating the moderating effect of information sharing on the relationship between supply chain integration and performance, particularly in developing countries such as Rwanda. Therefore, this research should address these gaps by conducting more comprehensive and context-specific studies that consider the unique challenges of manufacturing SMEs in Rwanda and explore the moderating role of information sharing in the relationship between supply chain integration and performance.

2.6 Research Gaps

A research gap is a question or a problem that has not been answered by any existing studies or research within your field (Mukasekuru, 2018). Sometimes, a research gap exists when a concept or new idea has not been studied at all. You may put research gaps into seven different types: empirical gap, knowledge gap, evidence gap, theoretical gap, population gap, application or implementation gap, and methodology gap. However, numerous studies have been conducted on supply chain strategy promotion worldwide. Researchers have addressed one fundamental research question: How can collaborative and coordinative issues in supply chains be addressed (Ali et al., 2023; Ghariani & Boujelbene, 2024). All these studies were conducted in different contexts, assuming that supply chain integration strategies have a universal effect on performance, which is not the case.

Most studies on supply chain integration (SCI) and the performance of manufacturing SMEs have focused on developed countries or emerging countries; therefore, their findings may have limited specific application to manufacturing SMEs in Rwanda. This represents a contextual research gap that the current study aims to address. Prior research relies on cross-sectional data, neglecting longitudinal designs that show changes in integration and performance over time. Again, existing literature predominantly relies on qualitative case studies, with limited quantitative analyses to measure the strength of relationships between collaboration and performance (methodological gap). Few studies have applied the Resource-Based View (RBV) to explain the link between supply chain collaboration and SME competitiveness in the manufacturing sector (theoretical gap).

Additionally, some findings on the supply chain Integration relationship left unresolved issues regarding integration dimensions (internal, supplier, and customer) and lacked a moderating variable. Furthermore, those studies that did include a moderating variable did not share their findings. This drives in resource-constrained manufacturing SMEs. This is a conceptual research gap that the study aimed to fill. This is why the researcher decided to conduct a study that addresses the aforementioned gaps by demonstrating the moderating effect of information sharing on the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda.

2.7 Summary of Literature

The above chapter provides a comprehensive analysis of the impact of information sharing on supply chain integration theories and models. The SCOR model is examined to measure performance in terms of upstream and downstream relationships. The resource-based view (RBV) also emphasizes the significance of supply chain resources and capabilities in determining the performance of manufacturing firms. The study also applies the RBV theory to explain inter-organizational relationships and their impact on performance. Finally, network theory is explored to highlight the role of technology in facilitating information sharing between supply chain partners. The reviewed theories are carefully analyzed for their relevance to specific variables. Furthermore, this chapter explores the conceptualization of independent and dependent variables by examining the relationships between the two sets of variables. The study also conducts an empirical review of previous research, both global and local, based on criteria such as title, scope, and methodology, leading to a critique. From these critiques, the research gap is identified.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methods employed in conducting the research. It begins with an overview of the research design, philosophy, target population, sample frame, sample, and sampling techniques, as well as data collection instruments, instrument validity and reliability, data collection procedures, pilot testing, and data processing and presentation techniques. Finally, the analysis method used to test the hypotheses is presented.

3.2 Research Design

A research design is a strategy or plan for carrying out the investigation (Saunders et al., 2016). It ensures that a study method is systematic and scientific enough for the outcomes to be applied in real life (Rahi, 2017). The study adopted a cross-sectional survey design, incorporating both qualitative and quantitative approaches to provide a comprehensive understanding of the research problem. For this particular study, an explanatory research design was chosen, as its focus is on explaining the aspects of the study. This type of research is quantitative and typically tests prior hypotheses by measuring relationships between variables. Statistical techniques were employed to analyze the collected data. Explanatory research aims to explain phenomena and predict future occurrences (Osoro et al., 2016). Research hypotheses are vital to explanatory studies, as they specify the nature and direction of the relationships between or among variables being studied. Given that the study aimed to test various research hypotheses, this research design was the most suitable choice.

3.2.1 Research Philosophy

The system of assumptions and beliefs that control how the researcher interprets the world is called research philosophy. It is a knowledge foundation, and the nature of that foundation involves crucial assumptions about the researcher's worldview (Rahi, 2017). This study identified two types of research philosophy: phenomenological and

Positivist. Realism or pragmatism could be the research philosophies. These ideologies share a set of assumptions that explain why they were used as examples of more prominent philosophies. This study employed a positivist research philosophy to uncover the causes that influence outcomes. The study was founded on theoretical foundations from which hypotheses were developed, and logic and evidence were tested using quantitative methodologies (Osoro et al., 2016). A study was conducted to investigate the monitoring practices, tools, and techniques adopted in planning and their influence on the linkages between supply chain integration and manufacturing firm performance in Rwandan manufacturing SMEs. The positivist philosophy method is quantitative and focused on rational, truthful, and valid values. Positivism asserts that reality is stable and can be measured objectively by claiming that events can be isolated and observations can be replicated.

3.3 Target Population

The target population was a collection of research components that refers to all members of an actual or imaginary group of people, events, or objects to whom the findings were applied. It can also be described as the set of sampling units or cases the researcher is interested in (Rahi, 2017). The study population for this research comprises all registered manufacturing small and medium-sized enterprises (SMEs) operating in Rwanda. Manufacturing SMEs are defined in accordance with the Rwanda Development Board (RDB) and the Ministry of Trade and Industry (MINICOM) classification, which categorizes SMEs as those with between 4 and 100 employees and an annual turnover not exceeding RWF 1 billion. This population is suitable because manufacturing SMEs play a crucial role in Rwanda's industrialization and economic transformation agenda; however, they face persistent challenges related to supply chain inefficiencies, market access, and performance measurement (MINICOM, 2021; NISR, 2023).

The unit of analysis is the manufacturing SME as an organizational entity. These manufacturing SMEs are six hundred and eighty-two (682) grouped in seven (7) clusters: food and beverage, textile, clothing and leather goods, wood, paper and printing, chemical, rubber and plastics, non-metallic mineral products, metal products, machinery and equipment, furniture and other manufacturing. They are located in Kigali City, Musanze, Rwamagana, and Muhanga Towns (MINICOM, 2024). The unit of observation for this study comprises managers, supply chain officers, and other key personnel responsible for supply chain activities within manufacturing SMEs in Rwanda.

Additionally, these respondents were in the best position to impart knowledge about the relationship between supply chain integration and the performance of manufacturing SMEs. Collecting data from these respondents helps ensure the validity and reliability of firm-level responses (Sukati et al., 2022; Agyemang et al., 2023). Table 3.1 presents the target population.

Table 3.1: Targeted Population

Products types	No of SMEs	%
Food & Beverage	126	18
Textile, clothing, and leather goods	65	10
Wood, paper, and printing	102	15
Chemical, rubber, and plastics	75	11
Non-metallic mineral products	98	14
Metal products, Machinery & Equipment	111	16
Furniture& other manufacturing	105	15
Total	682	100

Source: NIRDA, 2024

3.4 Sampling Frame

In this study, the sampling frame consisted of a list of manufacturing SMEs in Rwanda. The sample frame had six hundred and eighty (682) SMEs from various sectors, namely: food and beverage, textile, clothing and leather goods, wood, paper and printing, chemical, rubber and plastics, non-metallic mineral products, metal products, machinery and equipment, furniture and other manufacturing. The sample frame for this study includes manufacturing SMEs from four (4) provinces:

Rwamagana, Muhanga, Kigali City, and Musanze, which have supply chain networks for upstream and downstream markets (NIRDA, 2023).

An open-ended questionnaire was developed to collect and distribute the data using a mixed approach. Hard copies were for on-site completion in person by participants through scheduled appointments, and the electronic questionnaire was sent via e-mail to those who preferred an online format. Furthermore, semi-structured interviews were conducted with twelve (12) Managers of the businesses. The twelve (12) interviewee respondents were selected purposively as they are in a position to know internal and external integration activities. A total of 252 manufacturing SMEs were chosen using a random sampling technique and a formula by Kothari (2017). The office assistants, procurement/Logistics/sales/supplier and customer sales officers, Managers, and senior managers were selected using purposive sampling to ensure their role/experience in professional duties, including procurement, sales, and supplier and customer management.

3.5 Sample Size and Sampling Techniques

A sample is a representative of a certain known percentage and frequency distributions of elements' characteristics similar to the corresponding distributions within the whole population (Saunders et al., 2016). Rahi (2017) explains that sample size refers to the number of items selected from the universe to constitute a sample, while sampling procedures refer to the technique used to select the items of the sample.

Rahi (2017) contends that sampling is selecting a group of people, events, or behaviors to conduct a study. Sampling is appropriate when involving the entire population in the study is not feasible. The probability sampling technique was used in this study. The probability sampling technique selects samples to ensure that all elements in the population have an equal chance of being included in the sample, and that this probability can be accurately calculated. This study employed stratified random sampling. The hypothesis was that stratified random sampling was appropriate when the population was not homogeneous (Osoro et al., 2016).

Stratified sampling is regarded as the most efficient sampling system, as it minimizes the likelihood of any essential population group being wholly excluded.

The basis of stratification was the number of sectors in manufacturing SMEs in Rwanda. Random sampling was then used to ensure that each element in each stratum had an equal probability of being selected for the study. The advantage of random sampling is that it minimizes sampling error, thereby increasing the precision of the estimation techniques in use (Kothari, 2017). The overall sample size for this study was determined using a formula by Kothari (2017).

The Kothari sample size states that:

$$N= N/(1+Ne^2)$$

Where;

n= The sample size

N The target population size (682) in the case of this study.

e= Margin of error based on the research condition at 0.05 significance.

That is, if you want to be 95% sure about the results, then e=0.05

The sample size for this study will be determined as follows;

$$\text{Required sample size } \mathbf{(s)} = \frac{N}{(1 + Ne^2)}$$

The sample size for this study will be determined as follows;

$$\text{Required sample size } \mathbf{(n)} = \frac{682}{1 + 682\ (0.05^2)}$$

n= 252 manufacturing SMEs

The sample was allocated to each sector using probability proportional sample size using the formula in equation 3.1 as provided by Kothari (2017)

N(sector)=-- Equation

The sample size for this study will be determined as follows;

$$\text{Required sample size } \mathbf{(n)} = \frac{\text{N (Sector*n (all sectors)}}{\text{N (all Sectors)}}$$

Where:

n (Sector) is the sample size at the sector level.

N (Sector) is the population of a sector.

n (all sectors): is the combined sample size of the sectors.

N (all Sectors) is the population of the sectors.

The sample size for each stratum is shown in Table 3.2.

Table 3.2: **Sample Size**

Products types	No of SMEs	Sample size
Food & Beverage	126	47
Textiles and Garments	65	24
Metal and Allied	102	38
Chemical and allied products	75	27
Coffee and Tea processing	98	36
Building and Construction Materials	111	39
Plastics and Rubber	105	41
Total	682	252

Source: Researcher, 2024

3.6 Research Collection Methods (Instruments)

A standardized questionnaire was developed to capture the various variables under study. For the independent variables, a modified questionnaire by Ahmed and Schroeder (2003) was adopted. The use of the questionnaire was preferred as it ensured confidentiality was upheld, saved time, and was easy to administer (Mugenda, 2008).

The questionnaire is advantageous since it covers a population in a short time and at a low cost, and it increases the independence and accuracy of responses from respondents. In addition, respondents are given a structured questionnaire, which was chosen since it provides a more thorough picture than any other research instrument. The questionnaire was developed systematically in accordance with the study objectives.

The questionnaire was used to collect primary data. There are three basic types of questionnaires: closed-ended, open-ended, or a combination of both. Close-ended questionnaires are used to generate statistics in quantitative research, while open-ended questionnaires are used in qualitative research, although some researchers quantify the answers during the analysis stage. This study used both closed-ended questions and open-ended questions to collect the data. Closed-ended questions were used, where respondents were restricted from providing further explanation for their answers, while open-ended questions sought respondents' views on the variables being studied (Osoro et al., 2016). A semi-structured questionnaire was also adopted in their studies.

The questionnaire includes Likert scale psychometric constructs with a scale ranging from 1-5, where each respondent will be required to rate every statement describing a given variable. The scale ranges from 5=Strongly Agree, 4=Agree, 3=No Opinion, 2=Disagree, and 1=Strongly Disagree. At the end of each Likert scale question, open-ended questions are included to allow respondents to provide additional information not captured in the Likert scale questions. This section enabled the study to capture vital information directly from the respondents, based on their understanding of supply chain integration and its impact on performance.

3.6.1 Primary Data

Primary data is defined as first-hand information received from manufacturing SMEs in Rwanda. For example, managers' views were collected through questionnaires and interviews to capture their experiences with SCI and performance. The secondary data. There are two types of data: qualitative and quantitative. Quantitative data is data that can be measured, while Qualitative data, on the other hand, is data that cannot be quantified or measured (Kothari, 2004).

3.6.2 Secondary Data

The secondary data were collected from company reports, government statistical publications, government reports from the National Industrial Research and Development Agency (NIRDA) and the Ministry of Commerce (MINICOM), as well as relevant academic articles. The documents were obtained through institutional databases, SMEs' archives, and official websites. The analysis was conducted using a document analysis guide, which involves reviewing each source for its relevance, reliability, and accuracy. Key information related to supply chain integration practices, performance indicators, and industry trends was extracted, categorized, and triangulated with primary data to strengthen validity.

3.7 Data Collection Procedures

According to Rahi (2017), data collection refers to gathering information to support or verify certain facts. Burns and Grove (2013) define data collection as the precise and systematic gathering of information relevant to the research sub-problems, using methods such as interviews, participant observations, focus group discussions, narratives, and case histories. The questionnaire method has been selected because it is an unobtrusive and cost-effective method for data collection (Osoro et al., 2016). For this study, data collection was conducted by distributing and collecting questionnaires. Based on the nature of the survey interaction, questionnaires were distributed to respondents using several modes: mail or face-to-face. This study adopted the self-administered questionnaire and interview approach. Self-administered questionnaires offer researchers the potential to reach a large number of respondents in various locations, allowing them to incorporate this method into their studies. It took approximately 20–30 minutes to complete the questionnaire, which was returned within one week of distribution.

Before embarking on data collection, relevant approvals were obtained. An introductory letter from the JKUAT Nairobi campus was provided, introducing the researcher to relevant authorities for field data collection. This letter was used to obtain the permit for research from the National Institute of Statistics for Rwanda (NISR). Additionally, the researcher obtained permission from the respective manufacturing companies to collect data within their organizations. Follow-up calls and emails were then made to book an appointment. The study's significance was explained during the appointment. The data was collected from the field with the aid of the research assistants. It was expected that the use of research assistants would bring impetus to the return rate of the questionnaires, as any clarifications on the questionnaire were made contemporaneously. The research assistants were trained in research ethics, the research instrument and administration, interview skills, and data recording. An introductory letter was provided to the research assistants to collect data on the researcher's behalf, and they were given the necessary assistance.

3.8 Pilot Study

The word "pilot study" has two meanings in social science research. It can refer to "feasibility studies," which are small-scale versions. Rahi (2017), an imitation and rehearsal of the primary survey. A pilot study, on the other hand, might be used to test or try out a new research instrument. A pilot study can reveal areas where the major research project might falter, such as when research protocols are not followed or when proposed methodologies or instruments are inadequate or overly complicated. A pilot study was conducted with 10% of the 252 respondents (25) to verify that the items in the questionnaire are stated clearly, have the same meaning for the target respondents, and provide the researcher with an estimate of how long it will take to complete the questionnaire. It is utilized to improve the validity and relevance of the study objectives. The pilot study was conducted in Musanze district, and the consideration was based on the high concentration of manufacturing SMEs outside Kigali, the city of Rwanda. Its diversity and accessibility made it an ideal setting for pre-testing research tools before their nationwide application.

The lessons learned for improving research design and data collection processes should be stated openly in the pilot study report. Because the pilot study was considered an essential component of the study protocol, its lessons will eventually be reflected in the protocol's design and content (Osoro et al., 2016). A pilot study differs from a pre-test in that the results are utilized to refine the theoretical framework and are included in the case study research findings. As a result, it is crucial to note that the results of this pilot study will not be combined with the actual case study research, as the primary objective of the pilot study was to test a hypothesis. These SMEs were not part of the sample while collecting data on a large scale. The researcher considered the pilot study on the established sample because the remaining sample size was not compromised and was still sufficient to meet the study's requirements.

The questions with errors, omissions, ambiguities, and irrelevance were identified, and the questionnaire's content, structure, and sequence were revised to enhance the content's validity and reliability. These improvements in the data collection instruments will be implemented precisely. The pilot test sample was computed using the formula as shown in Equation 3.1 and presented in Table 3.3 below.

Table 3.3: Pilot Test Sample Size

Products types	No of SMEs	Sample	Pilot test Sample size
Food & Beverage	126	47	5
Textile and Garments	65	24	2
Metal and Allied	102	38	4
Chemical and allied products	75	27	3
Coffee and Tea processing	98	36	3
Building and Construction Materials	111	39	4
Plastics and Rubber	105	41	4
Total	682	252	25

Source: Researcher, 2024

3.8.1 Validity of the Research Instruments

According to Mufleh (2016), validity refers to how accurately the data collected for the study represent the variables being studied. Validity is the extent to which an instrument measures what it is supposed to measure. (Aguirre-Urreta & Hu, 2019). The study used open-ended and closed-ended questionnaires with a Likert scale. Another important feature was the population for which the measure was intended, once some of these decisions were made and a measure was developed. With the support of university supervisors and pilot testing, this study verified the validity of the research instrument. To guarantee that the items in the questionnaire yielded reliable data, the following methods were implemented in this study. Expert opinion: Supervisors' comments were incorporated into the instruments to enhance their validity. A pre-test study was conducted among managers/owners and employees. This research assessed content validity (through expert judgment and a pilot study) and construct validity (through factor analysis, convergent validity, and discriminant validity).

Factor analysis: A validity test was performed on the research instrument, and the components were extracted using the Principal Component Analysis (PCA) method. For research with a sample size of less than 200, factor loadings greater than 0.40 are deemed statistically significant. As a result, because the sample size was 252, 0.40

was chosen as the loading cut-off in this investigation. The higher the factor loadings, the more closely related they are to the variable.

3.9 Data Analysis and Presentation

The researcher collected questionnaires, coded them, and entered the data into the Statistical Package for the Social Sciences (SPSS) version 26 for analysis. The sort function was used to perform the initial screening. The data was based on the study objectives and research hypothesis. Descriptive statistical techniques, including frequency, mean, and standard deviation, were used to analyze the quantitative data collected. The results were displayed using frequency distribution tables, which tracked the frequency of each score or response. Content analysis was used to analyze the information gathered from the open-ended questions. Qualitative data collected were analyzed using content analysis.

The study employed inferential statistics, including regression and correlation analysis. Rahi (2017) explains that correlation is a statistical tool to identify relationships between quantifiable variables. The correlation coefficient, which measures the degree of linear relationship between random variables, was used to test the association between the independent and dependent variables. Osoro et al. (2016) note that the correlation coefficient (r) has two characteristics - strength and direction. A value of +1 indicates a perfect positive correlation between variables, while 0 signifies no correlation. A value of -1 indicates a perfect inverse correlation between variables.

A multiple regression model was employed to analyze the impact of independent variables on the dependent variable. Specifically, this study employed multiple regression analysis to investigate the impact of supply chain integration on the performance of manufacturing SMEs in Rwanda. By analyzing the relationship between a group of variables and a specific dependent variable, regression analysis aims to improve the precision of the estimate. A regression model can also reveal whether a positive or negative correlation exists between independent and dependent variables.

Statistical Model

The multiple regression equation model is illustrated below: -

$$Y= \beta_0+ \beta_1X_1+\beta_2X_2+ \beta_3X_3+ \beta_4X_4+\mathcal{E}$$

Where:

$Y =$ performance of manufacturing SMEs (dependent variable),

β_0 =he constant (Coefficient of intercept)

β_1, - β_4 = are the beta correlation coefficients of all independent variables,

X_1 = SC Communication Integration,

X_2 =SC Customer Integration,

X_3 = SC Collaborative Integration,

X_4 = SC Measurement Integration

$\mathcal{E}$ = Error Term

The moderator is crucial in determining the strength and direction of the relationship between the independent variable and the dependent variable. It can either amplify or diminish the direction of this relationship or even reverse it from positive to negative. In this study, information sharing served as the moderating variable, influencing the link between supply chain integration and performance of manufacturing SMEs in Rwanda. The researcher employed hierarchical multiple regression to assess this moderating effect and determine whether the hypotheses were valid. To do this, the interaction between supply chain integration and the performance of manufacturing SMEs was examined to establish its significance. The study employed a multiple regression analysis to investigate the moderating effect of information sharing (Z) on the relationship between supply chain integration parameters and the performance of manufacturing SMEs in Rwanda. Model 1.2 will be used to test the joint moderating effect.

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta zZ + \beta izXiZ + \varepsilon, (i=1, 2, 3, 4) \ldots\ldots\ldots\ldots 1.2$$

β_0 is constant (Y-intercept), which represents the value of Y when X =0

X_iZ_i is the interaction between the moderator (information sharing) and each independent variable (X_1, X_2, X_3, X_4).

BZi is the coefficient of X*Z, the interaction term between the moderator and each of the independent variables for i = 1,2,3,4;

3.9.1 Diagnostic Tests for Regression Assumptions

When the assumptions of the linear regression model are correct, ordinary least squares (OLS) provides efficient and unbiased estimates of the parameters (Long & Ervin, 2000). Independent variables were subjected to the following tests: linearity, multicollinearity, normality, and homoscedasticity before regression analysis was conducted.

3.9.2 Multicollinearity Test

Multicollinearity was addressed using the variance inflation factor (VIF) to measure the variance of the estimators. This is expressed as $VIF = 1/(1-R^2)$. The general rule is that values greater than ten (10) suggest the presence of multicollinearity (Chatterjee & Hadi, 2006). If multicollinearity is detected, the remedy will be to collect more data or drop some correlated variables. The critical limitation of multicollinearity is that it can yield unstable regression coefficients, characterized by significant standard errors and high variances, which leads to inaccurate statistical inferences (Bergmann & Hohenboken, 2015).

3.9.3 Heteroscedasticity Test

In a study, heteroscedasticity is commonly observed when the variance of errors varies across observations. To test whether the error variances are all equal or a function of one or more variables, the Breusch-Pagan and Koenker test is often used. If $p \leq 0.05$, reject the null hypothesis (heteroscedasticity is present). If $p \geq 0.05$, fail to reject the null hypothesis (homoscedasticity).

3.9.4 Normality Test

The study employed an improved Shapiro-Wilk test to assess normality assumptions. The improved Shapiro-Wilk test for normality in regression studies is generally preferred due to its excellent power properties (Mendes & Pala, 2016). The test yields a value W between zero (0) and one (1). One value indicates normality, whereas weak values indicate a departure from normality (Nornadiah & Yap, 2017). This study, in principle, sticks to this convention of interpreting normality.

3.10 Test of Hypotheses

This study aimed to determine the validity of the multiple regression models proposed by Mason et al. (2019) using ANOVA and F distribution. ANOVA is a statistical technique that compares the means of two or more groups or samples at a given probability level (Mugenda & Mugenda, 2018). A T-test was conducted to determine the significance of the regression coefficient (Mason et al., 2019). The study also performed individual tests on all independent variables to identify which regression coefficient could be zero and which could not. The conclusion was based on the p-value, where rejecting the null hypothesis of the beta indicates a significant overall model, and failing to reject it implies an insignificant overall model. If the p-value is less than 0.05, the researcher can conclude that the overall model is significant and has good predictors for the dependent variable, and the results are not based on chance. Conversely, if the p-value is more significant than 0.05, the model is insignificant and cannot explain the variations in the dependent variable. The decision rule is summarized in Table 3.4.

Table 3.4: Summary of Hypothesis Test

Hypotheses statement	Statistical Test Used	Decision rule
H_{01}: SC Communication integration has no significant influence on the performance of manufacturing SMEs in Rwanda	Karl Pearson's coefficient of correlation -F-test (ANOVA) -T-test	Reject H01 if P- value ≤ 0.05 otherwise fail to reject H01 if P is > 0.05
$H_{02:}$ SC customer integration has no significant influence on the performance of manufacturing SMEs in Rwanda.	Karl Pearson's coefficient of correlation -F-test (ANOVA) -T-	Reject H02 if P- value ≤ 0.05 otherwise fail to reject H02 if P is > 0.05
$H_{03:}$ SC collaboration integration has no significant influence on the performance of manufacturing SMEs in Rwanda	Karl Pearson's coefficient of correlation -F-test (ANOVA) -T-test	Reject H02 if P- value ≤ 0.05 otherwise fail to reject H03 if P is > 0.05
$H_{04:}$ SC performance measurement integration has no significant influence on the performance of manufacturing SMEs in Rwanda	Karl Pearson's coefficient of correlation -F-test (ANOVA) -T-test	Reject H04 if P- value ≤ 0.05 otherwise fail to reject H04 if P is > 0.05
$H_{05:}$ Information sharing does not moderate the relationship between supply chain integration and performance of manufacturing SMEs in Rwanda	Karl Pearson's coefficient of correlation -F-test (ANOVA) -T-test	Reject H05 if P- value ≤ 0.05 otherwise fail to reject H05 if P is > 0.05

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1. Introduction

This chapter provides the research findings and discusses the study. This section presents the demographic characteristics and descriptive results of secondary and primary data. It also presents the pilot study results and inferential statistics, including correlation tests, regression analysis, and the corresponding results. The chapter further presents optimal model results and a summary of the tested research hypotheses. The results are presented in the form of tables and charts.

4.2. Results of the Pilot Study

The researcher purposively selected 25 respondents from the same target population of supply chain managers in manufacturing SMEs. Those 25 respondents already exposed to the instrument were excluded from the final data collection to avoid response contamination (bias due to familiarity with the tool).

4.2.1 Reliability of the Data Collection Instrument

It is a common practice to report the reliability coefficient of the instrument used when presenting research findings. This helps establish the instrument's internal consistency and the confidence level that can be placed in the data obtained (Shrestha, 2021). Reliability testing was conducted using the data gathered following the pilot study. Instrument reliability is the consistency of scores or responses throughout several administrations of an instrument as well as over various item sets (Fraenkel & Wallen, 2018). Cronbach's Alpha (α) was used to test for the instrument's reliability, and the results obtained are presented in Tables 4.1 and 4.2 as follows.

Table 4.1: Reliability Test Results

Variable	Number of Items	Cronbach's Alpha	Conclusion
Communication integration	10	0.835	Reliable
Customer integration	10	0.857	Reliable
collaborative integration	10	0.769	Reliable
Measurement integration	10	0.787	Reliable
Performance of firms	10	0.826	Reliable
Information Sharing	10	0.819	Reliable

Table 4.2: Reliability and Validity of Research Instrument

Variables	Items	Item-Total Statistics: Scale means if the Item Deleted	Scale variance if Item Deleted	Corrected Item-Total (R)	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	Reliability Statistics: Cronbach's Alpha	Cronbach's Alpha Based on Stdzd Items	No. of Items
Communication	LT1	46.6087	21.067	.450	.543	.826	.835	.806	10
	LT2	46.6957	24.040	-.037	.491	.857			
	LT3	46.4348	18.530	.756	.820	.799			
Integration	LT4	46.4783	19.261	.810	.796	.799			
	LT5	46.6957	22.130	.219	.370	.845			
	LT6	46.8261	19.696	.476	.656	.826			
	LT7	46.3478	20.328	.658	.785	.812			
	LT8	46.3913	19.340	.763	.795	.802			
	LT9	46.6087	19.522	.590	.820	.814			
	LT10	46.4783	21.443	.397	.699	.830			
Customer	DF1	43.4783	39.715	.255	.589	.859	.857	.842	10
	DF2	43.4783	41.534	.195	.515	.858			
	DF3	43.4783	36.625	.652	.740	.831			
integration	DF4	43.6087	33.704	.788	.906	.818			
	DF5	43.7391	41.020	.154	.626	.866			
	DF6	43.3913	42.431	.081	.722	.865			
	DF7	43.3913	38.704	.605	.887	.837			
	DF8	43.6087	32.704	.842	.870	.812			
	DF9	43.7826	35.178	.717	.917	.825			
	DF10	43.6087	37.885	.542	.644	.838			
Collaborative	LS1	43.6087	20.704	.238	.620	.772	.769	.761	10
integration	LS2	43.3478	21.146	.270	.676	.765			
	LS3	43.2174	22.360	.067	.729	.781			
	LS4	43.2174	20.996	.324	.806	.761			
	LS5	43.6087	18.249	.614	.686	.728			
	LS6	43.6957	19.312	.563	.693	.737			
	LS7	43.8696	19.300	.437	.766	.749			
	LS8	43.7391	20.838	.385	.739	.756			
	LS9	43.3913	19.613	.505	.542	.743			
	LS10	44.2174	18.360	.385	.707	.761			
Performance	BF1	40.7391	13.474	.541	.704	.675	.787	.788	10
Measurement	BF2	41.0000	12.727	.598	.796	.662			
	BF3	41.3043	13.676	.455	.657	.687			
	BF4	40.8261	13.787	.450	.572	.688			
Integration	BF5	41.2174	16.451	.660	.418	.756			
	BF6	40.6087	15.613	.143	.451	.726			
	BF7	40.9565	12.680	.442	.491	.688			
	BF8	40.7391	13.656	.500	.546	.681			
	BF9	40.7826	14.905	.512	.483	.695			
	BF10	41.2174	16.451	.560	.418	.756			
Performance	CL1	46.9565	58.589	.603	.818	.806	.826	.841	10
	CL2	46.7391	58.292	.847	.910	.797			
	CL3	47.0000	55.636	.793	.854	.792			
Of SMEs	CL4	46.9565	52.953	.764	.906	.788			
	CL5	47.4348	51.984	.691	.764	.794			
	CL6	46.5217	56.988	.810	.792	.794			
	CL7	46.8696	55.482	.668	.728	.798			
	CL8	47.3043	52.676	.748	.866	.789			
	CL9	48.0435	69.589	.516	.771	.862			
	CL10	46.7826	63.087	.429	.816	.819			
Information	SCL1	38.7391	47.656	.762	.743	.929	.819	.822	10
	SCL2	39.1739	46.423	.751	.802	.925			
	SCL3	38.9565	41.407	.713	.651	.926			
Sharing	SCL4	39.7391	44.383	.791	.790	.923			
	SCL5	38.7391	48.020	.462	.864	.934			
	SCL5	39.0435	48.407	.690	.877	.927			
	SCL6	39.4783	47.170	.770	.844	.924			
	SCL7	39.7826	40.451	.552	.590	.933			
	SCL8	39.6087	44.522	.568	.646	.931			
	SCL9	39.9130	41.901	.907	.923	.918			
	SCL10	38.7391	47.656	.762	.743	.929			

Cronbach's alpha (α) measures the degree to which each variable in a scale is interconnected. (İnal et al., 2017). As stated by Ongeri and Osoro (2021), the basic assumption of the alpha coefficient is that the correlation between all items being studied should be positive, as they all measure the same thing. Additionally, a dependable coefficient should fall between 0.00 and 1.00. A coefficient of 0.00 indicates an inconsistent measurement, while a coefficient of 1.00 indicates perfect consistency in the instrument. However, Rwagombwa (2019) asserts that a general rule for measuring Cronbach's coefficient should be above 0.7, meaning a high and truthful degree of internal consistency exists in the responses. The first independent variable of the study was SC communication integration. Ten items measured this variable. The items were subjected to Cronbach's alpha analysis.

As shown in Table 4.6 above, the overall Cronbach's alpha for the ten items related to communication integration was 0.806. This indicated that all ten items quantifying the variable were reliable.

In the study, four independent variables were measured and assessed for reliability. Customer integration, collaborative integration, measurement integration, and information sharing were each measured by ten items and subjected to Cronbach's alpha analysis. The results in Tables 4.6 and 4.7 indicate that all forty items were reliable, with Cronbach's alpha values above the recommended threshold of 0.7. The study's dependent variable was the performance of manufacturing SMEs in Rwanda, measured by ten items with a high level of consistency and reliability, as evidenced by an overall Cronbach's alpha of 0.819.

4.2.2 Validity of the Data Collection Instrument

Research validity in surveys relates to the extent to which the survey measures the correct elements that need to be measured. In simple terms, validity is the degree to which an instrument measures what it is intended to measure to obtain the required data. Research validity can be classified into two broad categories: internal and external. Internal validity can be explained as to how the research findings match reality. In contrast, external validity refers to the extent to which the research findings can be replicated in other surroundings (Rwagombwa, 2019). Moreover, there are many types of validity; however, for this study, emphasis was given to construct and content validity.

4.2.2.1 Construct Content Validity

Construct validity involves ensuring that the method of measurement used matches the construct the researcher aims to measure. To achieve construct validity, the researcher, supervisors, and other senior scholars should ensure that the indicators and capacities are carefully developed based on relevant existing knowledge. The questionnaire must include only relevant questions that measure known indicators of variables under investigation. It relates to the assessment of the suitability of the dimension tool to measure the phenomenon under study. The application of construct validity can be effectively facilitated by the involvement of a panel of experts who are closely familiar with the measure and the phenomenon.

Construct validity was assessed using convergent and discriminant validity, which measure the degree to which a test measures what it claims to measure. According to Rwagombwa (2019), convergent validity refers to the degree to which two measures of constructs that theoretically should be related are indeed related, while divergent validity tests whether the capacities that are supposed to be unrelated are indeed unrelated.

4.2.2.2 Content Validity

Content validity refers to the degree to which items in an instrument reflect the content universe to which the instrument is generalized (Ominde et al., 2022). Content validity assesses whether a test accurately represents all aspects of the construct. It measures the extent to which underlying constructs are represented in the research instrument, such as whether the instrument accurately measures knowledge of the content domain for which it was designed (Rwangobwa, 2019). To produce valid results, the content of a test, survey, or measurement method must cover all relevant parts of the subject it aims to measure. The validity is threatened if some aspects are missing from the measurement or if irrelevant aspects are included.

In this research study, a judgmental approach was applied to establish the content validity of the research instrument. The study involved a literature review on the indicators of the study variables, followed by the development of a content validity survey. The content validity survey on supply chain practices was then sent for evaluation by experts in supply chain management. This involved engaging my supervisors and their colleagues in supply chain management. As observed by Ominde et al. (2022) at least two or three experts in the content to be measured can evaluate the validity of the items in the instrument. After evaluation by the study's experts, a content validity ratio (CVR) was calculated for each item using the laws' method. Items found to be insignificant or less significant at the critical level were expunged from the questionnaires. The average CVR obtained was 0.87, indicating that the instrument demonstrated content validity. Rwagombwa (2018) asserts that a CVR greater than 0.7 is acceptable, although a score of 0.5 or higher is very significant.

The CVR, as proposed by Rwagombwa (2019), is a linear transformation of a proportional level of agreement on how many experts within a panel rate an item as essential, valid, or significant, calculated as follows;

$$\text{CVR} = \frac{n_e - (\frac{N}{2})}{\frac{N}{2}}$$ *Where* CVR is the Content Validity Ratio

n_e; is the number of panel members indicating essential

N is the total number of panel members.

The average CVR obtained in the present research was 0.877, indicating that the instrument was valid in terms of content validity.

4.3 Response Rate

The target sample population consisted of 252 respondents, comprising managers of manufacturing firms. Out of this targeted sample population, twenty-five (25) respondents participated in the pilot study; thus, they were excluded from the final analysis. Two hundred twenty-seven (227) respondents were given the questionnaires and completed them on tablets, with 213 respondents fully participating and sharing their views. The overall response rate, therefore, stood at 94% (percent). This response rate was deemed satisfactory, as suggested by Sekaram and Bougie (2018), who recommend at least 75% (percent) as a rule of thumb for minimum responses. The response rate is presented in Table 4.3 below:

Table 4.3: Response Rate

Questionnaires Circulated	No respondents	Percent
Filled and returned	213	94
Not returned	14	6
Total	227	100

Table 4.3 shows that out of 227 questionnaires distributed to the respondents, 213 were completed and returned. After thorough scrutiny and screening, four questionnaires were excluded due to incomplete responses. This implied that only 213 questionnaires were considered for data analysis. Thus, constituting 94% of the study population. As a result, this was deemed sufficient for analysis and inference. According to Garba (2020), a response rate of more than 70% in a social science study is enough for analysis. Neumann (2020) further proposed that a response rate of more than 60% in a study is sufficient to effectively represent the sample size and the population; hence, such data can be used to draw conclusions and make recommendations.

4.3.1 Respondents' View on Communication Integration

The study aimed to determine the implementation of communication integration in manufacturing SMEs. Inadequate communication integration methods are prone to complaints, which is a cost and negatively impacts the performance of manufacturing firms (Chen et al., 2019). Nguyen et al. (2021), Fatima and Attia (2021) stated that communication integration is thoroughly related to the performance of manufacturing SMEs. Thus, the respondents were asked whether their organizations had adopted communication integration. The findings are presented in Table 4.4.

Table 4.4: Respondents' View on the Implementation of Communication Integration

Communication integration	Frequency	Percent
Yes	155	72.86
No	58	27.14
Total	213	100

The findings in Table 4.4 indicate that 72.86 % (N = 155) of the respondents had their SMEs implement communication practice(s), whereas 27.14% (N = 58) of the respondents indicated that their organizations did not use or implement any form of communication for inventory control practice(s) in their operations. The study assumed that the internal communication environment inside the organization and performance are correlated (Zsidisin et al., 2024). These results align with Kumar et al. (2023), who asserted that digital technologies in communication contribute to manufacturing resilience and performance.

4.3.1.1 Factor Loading Analysis for SC Communication Integration

The study's first independent variable, SC communication Integration, was measured using ten items that underwent factor analysis. The results are shown in Table 4.5.

Table 4.5: Factor Loading for SC Communication Integration

Loading for SC Communication Integration	Factor Loadings
Our firm shares relevant supply chain information with partners in a timely manner	0.719
Delays in information sharing within our supply chain are minimal	0.756
Critical updates are communicated promptly to all relevant stakeholders	0.86
The information shared with our supply chain partners is accurate	0.792
Information received from partners is reliable and trustworthy	0.838
Errors in shared information are rare in our supply chain	0.603
Communication with supply chain partners occurs regularly and consistently	0.681
The quality of communication (clarity, completeness) with partners is high	0.854
Our supply chain partners actively respond to queries and feedback in a timely manner.	0.798
Top management needs communication integration for the firm's performance	0.657
Overall Factor Loading	0.754

Among the ten items used to measure SC communication integration, the one that required the respondents to indicate if critical updates are communicated promptly to all relevant stakeholders was the highest, with a factor loading of 0.860. The item that loaded lowest required respondents to indicate the frequency of errors in shared information within the supply chain, with a factor loading of 0.603, indicating that errors in shared information are uncommon. However, none of the items were dropped from the variable since all the items were loaded at more than 0.500. Moreover, the average factor of 0.754 indicates that all items were valid in terms of convergent validity.

4.3.1.2 Factor Loading Analysis for Customer Integration

The second independent variable of the study was Supply Chain Customer Integration, measured by ten items. The items were subjected to factor analysis, the result of which is shown in Table 4.6 below.

Table 4.6: Factor Loading for SC Customer Integration

Loading SC Customer Integration	Factor Loadings
Our company promptly responds to customer inquiries and requests	0.826
Customer feedback is addressed quickly and effectively.	0.786
Our supply chain is able to adapt quickly to changes in customer demands.	0.76
Our firm maintains strong, long-term relationships with our key customers	0.876
Our firm regularly engages with customers to understand their needs.	0.852
Customer information is systematically managed to support supply chain decisions	0.862
Orders are fulfilled accurately according to customer specifications	0.443
Deliveries are made on time, as promised to customers	0.833
Our firm consistently meets customer expectations for product quality and service	0.789
Customer integration can affect the performance of manufacturing SMEs	0.488
Overall Factor Loading	0.749

Out of the ten factors used to measure SC customer integration, the one with the highest factor loading score of 0.876 was related to assessing whether our firm maintains strong, long-term relationships with our key customers. On the other hand, the factor that scored the lowest factor loading score of 0.443 was related to evaluating whether orders are fulfilled accurately according to customer specifications. This indicates that manufacturing SMEs are not being fully integrated into supply chain practices, limiting the effectiveness of integration.

4.3.1.3 Factor Loading Analysis for SC Collaboration Integration

The third independent variable of the study was SC collaboration integration, measured by ten items. The items were subjected to factor analysis, whose result is shown in Table 4.7 below;

Table 4.7: Factor Loading for SC Collaborative Integration

Loading for SC Collaborative Integration	Factor Loadings
Our firm involves supply chain partners in important decision-making processes	0.660
Key supply chain decisions are made collaboratively with partners.	0.71
Partners' input is valued and considered in strategic supply chain planning	0.64
Our firm shares relevant resources (information, technology, or expertise) with partners to improve supply chain performance.	0.493
Partners are willing to share their resources with us to enhance joint outcomes	0.604
Resource sharing between our company and partners is frequent and effective	0.475
There is a high level of trust between our company and supply chain partners.	0.589
Our firm adopted a joint production plan and impacted production yield	0.788
Our firm and partners demonstrate reliability and integrity in all interactions	0.535
Collaborative integration affects the performance through cost control	0.57
Overall Factor Loading	0.576

A study was conducted to measure SC collaborative integration using ten different items. The item that received the highest factor loading of 0.788 asked respondents if adopting a joint production plan impacts production yield in the firm. These findings align with those of Zhong et al. (2023), who asserted that joint planning with suppliers improves performance. However, two (2) items did not meet the required threshold of 0.5. These included the item asking if manufacturing SMEs share relevant resources (information, technology, or expertise) with partners (factor loading of 0.493) and the item asking if resource sharing between manufacturing SMEs and partners is frequent and effective (factor loading of 0.475). The item asks if Sc collaboration integration plays a significant role in the performance of manufacturing SMEs through cost control (factor loading of 0.570). These items were removed from the analysis and re-formulated as they did not meet the threshold. These findings align with Chinomona (2019), who asserted that SC partnership and integration do not necessarily influence performance as they cannot be achieved individually.

4.3.1.4 Factor Loading Analysis for Performance Measurement Integration

The fourth independent variable in the study was SC Performance Measurement Integration. Ten items were used to evaluate performance Measurement Integration. The items were subjected to factor analysis, and the outcomes are shown in Table 4.8 below.

Table 4.8: Factor Loading for Performance Measurement Integration

Loading for Performance Measurement Integration	Factor Loadings
Our company and supply chain partners agree on shared key performance indicators (KPIs).	0.711
The KPIs used are relevant for evaluating the performance of all supply chain partners	0.717
Performance metrics are consistently monitored and aligned across the supply chain	0.813
Our company uses joint dashboards with partners to track supply chain performance	0.624.
Real-time performance data is shared with partners to support decision-making	0.700
Partners actively contribute to maintaining accurate and up-to-date performance dashboards	0.707
Our company regularly provides feedback to partners on their performance.	0.774
Feedback from partners is used to improve supply chain processes and outcomes.	0.622
Constructive discussions with partners about performance gaps occur frequently	0.685
Maintaining responsive customer requests reduces costs	0.612
Overall Factor Loading	0.7

In the study, SC Performance measurement integration was assessed using a set of ten items. The item with the highest factor loading of 0.813 required respondents to indicate whether performance metrics are properly monitored and aligned across the supply chain to improve the quality of goods and services. The results indicate that the proper measurement of quality goods and services integration improves the performance of manufacturing SMEs. These findings align with (Kamble et al., 2020; Saleheen & Habib, 2023b), who asserted that performance measurement attributes improve the performance of manufacturing SME and the community.

The item with the lowest factor loading, 0.612, asked respondents if maintaining responsive customer requests reduces manufacturing costs through supply chain integration. Despite the range in factor loadings, all ten items were kept in the variable since they loaded above 0.500. Additionally, the average factor loading of 0.700 explains the convergent validity of the items. These affirm the findings (Kamble et al., 2020) that smart manufacturing performance measurement integration guides practitioners to evaluate investment performance.

4.3.1.5 Factor Loading Analysis for Information Sharing

The moderating variable of the study was information sharing, which was also measured using a ten-item scale. The items were subjected to factor analysis, which yielded results as shown in Table 4.9 below.

Table 4.9: Factor Loading for Information Sharing

Loadings for Information sharing	Factor Loadings
Our firm has adopted the latest information-sharing technology	0.786
Our firm has adopted the latest information-sharing technology	0.826
I am satisfied with the information-sharing technology adopted in our firm	0.769
Information sharing enhances the performance of manufacturing SME	0.867
Quality of information gives manufacturing SME a competitive advantage	0.627
I am satisfied with the quality of information shared in our firm	0.832
Our firm ensures relevant information is shared with the relevant groups	0.722
I am satisfied with the type of information shared in our firm	0.833
Information sharing influences firm performance	0.84
Information sharing moderates supply chain integration and performance	0.812
Overall Factor Loading	0.719

Ten items served as the moderating variable in measuring information sharing. Out of the ten items, the one that asked respondents if information sharing enhances performance loaded highest (factor loading: 0.867), while the one that asked if the quality of information gives manufacturing SME a competitive advantage loaded lowest (factor loading: 0.627). However, none of the item indicators were excluded from the variable because all items were loaded at a value greater than 0.500, which is considered good. Furthermore, the average factor loadings of 0.719 demonstrate the items' convergent validity.

4.3.1.6 Factor Loading Analysis for Performance of Manufacturing SMEs

The study's dependent variable was the performance of manufacturing SMEs, which was also measured by ten items. The items were subjected to factor analysis, which yielded results as shown in Table 4.10 below.

Table 4.10: Factor Loading for Performance of Manufacturing SMEs

For the last 3-5 years, the Performance of Manufacturing SMEs	Factor Loadings
Our firm has increased its share in the local market over the past year	0.671
Our firm is successfully entering new markets and attracting new customers	0.648
Our products/services are preferred over competitors by a growing number of customers	0.611
Our company quickly responds to changes in customer demand	0.714
Our firm can adjust our production and delivery schedules promptly to meet market needs	0.893
Customer complaints and requests are addressed efficiently and effectively	0.725
Our firm has successfully reduced production and operational costs over the past year	0.781
Our firm utilizes resources efficiently to minimize waste and optimize costs	0.711
Cost-saving measures have improved overall profitability without compromising quality	0.711
In our firm, the quality of goods and services offered has improved	0.648
Overall Factor Loading	0.697

Ten items were used to measure the dependent variable of supply chain integration of the performance of manufacturing SMEs. None of the ten items was dropped from the variable, as all items loaded with a value greater than 0.500, which is often considered the threshold. Moreover, the average factor loadings of 0.695 indicate that the items demonstrated valid convergent validity.

To establish discriminant validity, it was desired to show that the four independent constructs that should not be related were unrelated. Discriminant validity was assessed using Inter-Construct Correlation. According to Musau et al. (2018), correlation values of less than 0.5 show low correlations among variables. Table 4.11 presents the results for the inter-construct correlation of the study's independent variables.

Table 4.11: Inter-Construct Correlation

Variables		**SC Communication integration**	**SC Customer Integration**	**SC Collaboration Integration**	**Performance Measurement Integration**
SC Communication Integration	Pearson Correlation	1			
	Sig. (2-tailed)				
SC Customer Integration	Pearson Correlation	.394**	1		
	Sig.(2-tailed)	0			
SC Collaboration Integration	Pearson Correlation	.421**	.307**	1	
	Sig. (2-tailed)	0	0		
SC Performance Integr.	Pearson Correlation	.417**	.391**	.443**	1

Predictor: SC Communication integration, SC customer integration, SC collaborative integration, and Performance measurement integration

Dependent: Performance of manufacturing SMEs

The results in Table 4.11 above indicate that the correlations between the four independent variables are less than 0.5. This implies that the four independent constructs that should not be related were unrelated and met the discriminant construct validity condition.

4.4 Descriptive Analysis of the Study Variables

The researcher employed descriptive statistics, where the examination of data was explained, illustrated, or summarized in a meaningful manner. This descriptive analysis was employed to describe the basic features of the data in the study, providing a summary of the sample and the measures, thereby helping to simplify massive amounts of data in a clear and concise manner. It expressed the variables in terms of frequencies, percentages, means, and standard deviations. The study analyzed descriptive statistics for all the variables under investigation.

4.4.1 Communication Integration

The study aimed to investigate the impact of SC communication integration on the performance of manufacturing SMEs in Rwanda. This objective was measured using the following indicators: timeliness of information sharing, accuracy and reliability, and frequency and quality, as indicated in the opinion statements. Respondents were asked to indicate how communication integration influenced the performance of manufacturing SMEs in Rwanda. This was based on a Likert scale of not at all, small extent, moderate, large extent, and considerable extent. Therefore, in this study, a scale of not at all and a small extent implied disagreement, while a considerable extent implied agreement. The results were expressed as frequencies, percentages, mean, and standard deviation, as indicated in Table 4.12 below.

Table 4.12: Descriptive Analysis of SC Communication Integration

Statements on SC Communication integration	1 %	2 %	3 %	4 %	5 %	Mean	Std Dev
Our firm shares relevant supply chain information with partners in a timely manner	0	1	23.8	51.7	24.5	3.71	0.696
Delays in information sharing within our supply chain are minimal	1	0	20.7	55.2	24.1	4.13	0.670
Critical updates are communicated promptly to all relevant stakeholders	0	1	20	49.0	31	4.12	0.713
The information shared with our supply chain partners is accurate	0	0	3.4	51.7	44.8	4.42	0.559
Information received from partners is reliable and trustworthy	0	0	13.4	51.7	34.8	4.01	0.664
Errors in shared information are rare in our supply chain	0	0	3.4	41.4	55.2	4.42	0.565
Communication with supply chain partners occurs regularly and consistently	0	0	17.6	44.5	37.9	4.21	0.715
The quality of communication (clarity, completeness) with partners is high	0	0	6.9	65.5	27.6	4.21	.551
Our supply chain partners actively respond to queries and feedback in a timely manner	0	0	10.7	57.9	31.2	4.21	.610

Key: 1 Not at all; 2-Small Extent; 3-Moderate Extent, 4-Large Extent, and 5- Very Large Extent

Most respondents (76.2%) agreed that the firm shares relevant supply chain information with partners in a timely manner, while 23.8% indicated a moderate level of agreement. The results showed a mean (M = 3.71) on a 5-point Likert scale, indicating that the respondents agreed with the statement, and a standard deviation (SD = 0.696), which suggests relatively low variability, meaning that most respondents shared the same view with little disagreement.

A large number of respondents 79.3% agreed that delays in information sharing within the supply chain are minimal, while 20.7% moderately agreed. The results showed a mean (M = 4.13), indicating strong agreement with the statement that delays in information sharing within the supply chain are minimal. The standard deviation (SD = 0.670) indicates low dispersion, meaning the statement was fairly consistent across participants. Elsewhere, 80% of the respondents agreed that Critical updates are communicated promptly to all relevant stakeholders, while 20%

moderately agreed. The mean (M = 4.12) on a 5-Likert scale indicates strong agreement, reflecting a positive perception. While a standard deviation (SD = 0.713) indicates low to moderate variation, meaning most respondents share similar views, with only a slight difference.

The information shared with our supply chain partners is accurate as indicated as indicated by 96.5% of the respondents who agreed and 3.4% of the moderate responses. The results show a mean (M=4.42), coupled with a small standard deviation (SD=0.559), indicating a strong and uniform consensus among respondents on the statement. Most respondents (86.5%) agreed that information received from partners is reliable and trustworthy, while 13.4% agreed to a moderate extent. The results show a mean (M=4.01) and a standard deviation (SD=0.664), demonstrating a strong and consistent agreement between respondents. This is in line with the findings (Zsidisin et al., 2024) who asserted that communication integration in the supply chain improves internal integration, supplier integration, and supplier performance.

On the other hand, the statement that errors in shared information are rare in our supply chain was reported by respondents as follows: 96.6% agreed, and 3.4% agreed or moderately agreed. The results show that the mean (M = 4.21) indicates strong agreement with the statement, while the standard deviation (SD = 0.715) indicates low dispersion, meaning a fairly consistent response among participants. Furthermore, most respondents (82.4%) agreed that Communication with supply chain partners occurs regularly and consistently, with 17.6% indicating moderate levels. The results show a high mean (M = 4.21) and a low standard deviation (SD = 0.551), indicating a strong and consistent consensus among respondents on the statement. The statement that the quality of communication (clarity, completeness) with partners is high, and that supply chain partners actively respond to queries and feedback in a timely manner, was reported at 82.7% and 86.2%, respectively. Both groups scored a high mean of more than 4.0 and small standard deviations, indicating a strong and uniform consensus among participants on the statement.

These findings align with Ghariani and Boujelbene (2023), who viewed that supply chain communication has a substantial and favorable effect on manufacturing SME performance. The management's responsibility is to maintain supply chain integration within the context of a relationship with a market orientation and the firm's overall performance (Suryanto & Mukhsin, 2020; Yang et al., 2023). Supply market scanning and the organization's internal communication climate are positively related to the internal integration of supply management. Not all SMEs implementing supply chain integration can achieve the desired goal; when supply chain communication is imbalanced, it can lead to a decline in supply chain performance. Supply chain communication is positively related to supplier integration, which partially mediates the relationship between supplier integration and supplier performance. Internal communication integration is also positively and directly related to supplier performance (Suryanto & Mukhsin, 2020).

4.4.2 Customer Integration

The respondents were probed on various indicators of customer integration and the performance of manufacturing SMEs in Rwanda. This objective was measured using the following indicators: responsiveness, customer relationship management, and order fulfillment reliability, as indicated in the opinion statements. The responses were rated on a 5-point Likert scale where respondents indicated not at all, small extent, moderate extent, large extent, and considerable extent. In this study, the scales' not at all' and 'small extent' indicated disagreement, whereas 'considerable extent' indicated agreement. The results were expressed as frequencies, percentages, mean, and standard deviation, as shown in Table 4.13 below.

Table 4.13: Descriptive Analysis of SC Customer Integration

Statements on SC Customer integration	1 %	2 %	3 %	4 %	5 %	Mean	Std Dev
Our firm promptly responds to customer inquiries and requests	0	0	17.2	69	13.8	3.98	.557
Customer feedback is addressed quickly and effectively	1	0	14.1	61.7	24.1	4.17	.608
Our supply chain adapts quickly to changes in customer demands	0	0	13.8	58.6	27.6	4.24	.629
Our firm maintains strong, long-term relationships with our key customers	0	0	11.0	51.7	37.2	4.25	.639
Our firm regularly engages with customers to understand their needs	0	1	3.4	55.2	41.4	4.37	.553
Customer information is systematically managed to support supply chain decisions	0	0	6.9	65.9	27.2	4.20	.551
Orders are fulfilled accurately according to customer specifications	0	0	10.3	58.6	31	4.21	.610
Deliveries are made on time, as promised to customers	0	0	17.2	65.5	17.2	4.01	.588
Our firm consistently meets customer expectations for product quality and service	0	0	13.8	65.2	21	4.17	.584

Key: 1 Not at all; 2-Small Extent; 3-Moderate Extent, 4-Large Extent, and 5- Very Large Extent

The respondents were asked to indicate how customer integration enables the supply chains to become resilient to disruptions. Most respondents (82.8%) agreed that integration contributes to a prompt response to customer inquiries and requests, while 17.2% agreed to a moderate extent. The results show a mean (M = 3.9) and a standard deviation (SD = 0.557), indicating that respondents generally agreed with the statement, with little variation in their opinions. The statement by manufacturing SMEs that addresses customer feedback quickly and effectively was agreed upon by 85.8% of the respondents, with 14.1% of the respondents moderately agreeing. The mean (M = 4.17) and the standard deviation (SD = 0.608) indicate strong agreement with low variation in their opinions.

Our supply chain adapts quickly to changes in customer demands, with the respondent agreeing at 86.2%, while 13.8% are moderate. The statement that the supply chain adapts to changes in customer demands has a Mean (M = 4.24) and a standard deviation (SD = 0.629), indicating that the respondents generally agreed with the statement, with little variation in their opinions. On the statement that the firm maintains strong, long-term relationships with our key customers.

The statement that SMEs maintain strong, long-term relationships with key customers has made supply chain alignment possible, as indicated by 88.9% of the respondents, while 11.1% hold a moderate view. The mean (M = 4.24) and the standard deviation (SD = 0.629) indicate that respondents largely agreed with a strong positive perception, with fairly consistent variation in their views. Respondents (96.6%) agreed that manufacturing SMEs regularly engage with customers to understand their needs, and 3.4% moderately agreed. In response to how systematically customer information is managed to support supply chain decisions. The respondents viewed the statement, with 93.1% agreeing and 6.9% moderately agreeing.

A majority of respondents (89.6%) agreed, and 10.3% moderately agreed, that orders are fulfilled accurately according to customer specifications. Furthermore, 82.7% of the respondents indicated that deliveries are made on time, as promised to customers, while 17.2% moderately agreed with this. By consistently meeting customer expectations for product quality and service, manufacturing SMEs can recover from inevitable risk events more effectively than others, as indicated by 86.2%. On the other hand, 13.8% of the responses agreed or moderately agreed with the statement.

In general, resilience is typically focused on restoring supply chain operations to their previous condition following a crisis; however, some manufacturing processes within supply chains have proven to be particularly vulnerable and not resilient. This aligns with the findings of Ongeri and Osoro (2021). All means are greater than 4.00, and the standard deviations are greater than 0.55, indicating that respondents generally hold positive views, albeit with moderate variability in the strength of their opinions.

The findings in Table 4.13 indicate that the integration design of supply chains enables the manufacturing process through supply chains to be resilient by achieving flexibility, alignment, and a reduction in supply chain vulnerability. Manufacturing processes through supply chains are prone to internal or external vulnerabilities and organizational disruptions. Adopting an integration design in supply chains gives manufacturing SMEs the capacity to survive, adapt, and sustain in the event of disruptions. Integration design enables manufacturing processes throughout supply chains to recover effectively from inevitable risky events. The findings of this study corroborate those of Ongeri and Osoro (2021), who investigated self-organization, adaptability, organizational networks, and inter-organizational coordination using empirical evidence from manufacturing SMEs in Uganda. The study also asserted that customer integration enhances resource utilization, helps meet needs, saves lives, and ensures time targets are met. Further, Muazu (2019) established that supply chain re-engineering and risk awareness were significant predictors of organizational customer integration.

4.4.3 Collaboration Integration

The study aimed to investigate the impact of SC collaboration integration on the performance of manufacturing SMEs in Rwanda. This objective was measured using the following indicators: joint decision-making, resource sharing, and mutual trust and commitment, as indicated in the opinion statements provided. Respondents were required to indicate how collaboration integration influenced the performance of manufacturing SMEs in Rwanda. This was on a Likert scale of not at all, small extent, moderate extent, large extent, and considerable extent. Therefore, in this study, the scale of not at all and small extent meant disagree, while considerable extent meant agree. The results were expressed as frequencies, percentages, mean, and standard deviation, as shown in Table 4.14 below.

Table 4.14: Descriptive Analysis of SC Collaboration Integration

Statements on SC Collaboration integration	1 %	2 %	3 %	4 %	5 %	Mean	Std Dev
Our firm involves supply chain partners in important decision-making processes	0	3.8	13.8	55.2	27.2	4.16	.741
Key supply chain decisions are made collaboratively with partners	0	3.4	27.6	31	37.9	4.13	.891
Partners' input is valued and considered in strategic supply chain planning	3.4	3.4	17.2	48.3	27.6	3.98	0.946
Our firm shares relevant resources (information, technology, or expertise) with partners to improve supply chain performance	0	0	34.1	52.1	13.8	3.59	.664
Partners are willing to share their resources with us to enhance joint outcomes	0 (0)	3.4	20.7	37.9	37.9	4.13	.846
Resource sharing between our company and partners is frequent and effective	0	3.4	13.8	31	51.7	4.32	.836
There is a high level of trust between our company and supply chain partners	0	3.4	20.7	34.5	41.4	4.13	.861
Partners are committed to long-term collaboration and shared goals	0	0	13.4	51.7	34.8	4.22	.664
Our firm and partners demonstrate reliability and integrity in all interactions	0	0	13.4	51.4	35.2	4.31	.674

Key: 1 Not at all; 2-Small Extent; 3-Moderate Extent, 4-Large Extent, and 5- Very Large Extent

The majority of respondents (82.4%) agreed that manufacturing SMEs involve supply chain partners in important decision-making processes, 13.8% responded moderately, while 3.8% disagreed with the emphasis. The mean (M = 4.16) indicates that respondents generally agreed, indicating a positive perception of the statement. The standard deviation (SD= 0.741) indicates a moderate spread, indicating the existence of some variations in the strength of the statement.

Many respondents (68.9%) also agreed that key supply chain decisions are made collaboratively with partners, 27.6% agreed to a moderate extent, and 3.4% to a small extent. The mean (M = 3.98) reflects a strong perception, and the standard deviation (M = 0.891) indicates notable variability in the intensity of respondents' views. As indicated in the findings, most manufacturing SMEs (75.9%) of the respondents agreed that partners' input is valued and considered in strategic supply chain planning. While 17.2% of the respondents agreed moderately, 6.8% of the respondents did not agree with the statement. On the other hand, 65.9% of the respondents agreed that SMEs share relevant resources (information, technology, or expertise) with partners to improve supply chain performance, and 34.1% moderately agreed. The mean (M = 3.98, M = 3.59) of both statements indicates that respondents' views are characterized by a positive, moderate perception. The standard deviations (SD = 0.946; SD = 0.664) indicate notable variability in the intensity of respondents' views and greater consistency between respondents, respectively.

Respondents agreed (75.8%) that manufacturing SMEs' partners are willing to share their resources to enhance joint outcomes, 3.4% of the respondents disagreed, and 13.8% moderately agreed with the statement. Likewise, most respondents (82.7%) agreed that resource sharing between manufacturing SMEs and partners is frequent and effective. Furthermore, 82.7% of the respondents agreed that the manufacturing SMEs' partners are committed to long-term collaboration and shared goals. Lastly, 86.6% of the respondents agreed that there is a high level of trust between our company and supply chain partners. Mean that scores above 4.10 (M=4.13; M=4.22; M=31) indicate strong agreement among respondents, while standard deviations above 0.66 (SD=0.861; SD=0.664; SD=674) indicate moderate variations in the intensity of the respondents' views.

Based on the study findings in Table 4.14, integration is an essential design of collaboration in manufacturing processes through supply chains. Supply chain integration design creates checks and balances, enabling systems to improve waste mitigation. Waste elimination is a continuous process in manufacturing SMEs, involving the identification and elimination of non-value-adding activities in the supply chain. Most manufacturing SMEs had managed to eliminate the non-value-adding operations in their supply chains, but some had yet to do so. Minimization of such wastage enhances resource utilization in the organizations. The manufacturing process through supply chains identifies the most effective solutions for creating and storing inventory to deliver products and services to vulnerable populations at minimal operating costs. Amsterdam (2020) noted that most manufacturing processes through supplies fall into the category of relief items and face specific challenges related to in-kind donations, including storage and transportation bottlenecks that lead to inefficiency.

This study's findings agree with Muazu (2019) study on the analysis of lean, agile, and integrated supply chains, which states that efficiency and waste management are essential to integrating the supply chain. Ongeri and Osoro (2021) further confirm that eliminating waste from all supply chain elements calls for continuous improvement processes. Amsterdam (2020) found, in his study on lean and agile model implementation for managing the supply chain, that volatile and unpredictable environments demand supply chains that minimize waste to boost efficiency, as was the case in the findings of this study.

4.4.4 Performance Measurement Integration

The study aimed to investigate the impact of SC performance measurement integration on the performance of manufacturing SMEs in Rwanda. This objective was measured using the following indicators: shared KPIs, joint performance dashboards, and feedback loops with partners, as indicated in the opinion statements given. Respondents were required to indicate the extent to which measurement integration influenced the performance of manufacturing in Rwanda. This was on a Likert scale of not at all, small extent, moderate, large extent, and considerable extent. Therefore, in this study, the scale of not at all and small extent meant disagree, while considerable extent meant agree. The results were expressed as frequencies, percentages, mean, and standard deviation, as shown in Table 4.15 below.

Table 4.15: Descriptive Analysis of SC Performance Measurement Integration

Statement of SC Performance Measurement Integration	1 %	2 %	3 %	4 %	5 %	Mean	Std Dev
Our firm and supply chain partners agree on shared key performance indicators (KPIs)	0	3.4	31	44.8	20.7	3.85	.792
The KPIs used are relevant for evaluating the performance of all supply chain partners	0	3.4	13.8	55.2	27.6	4.17	.742
Performance metrics are consistently monitored and aligned across the supply chain	0	0	20.3	38.3	41.4	4.23	.763
Our company uses joint dashboards with partners to track supply chain performance	0	0	1	55.9	44.1	4.34	.498
Real-time performance data is shared with partners to support decision-making.	0	0	6.9	52.1	41.0	4.34	.604
Partners actively contribute to maintaining accurate and up-to-date performance dashboards	0	0	27.6	51.7	20.	3.93	.693
Our company regularly provides feedback to partners on their performance	0	0	6.9	51.7	41.4	4.04	.604
Feedback from partners is used to improve supply chain processes and outcomes	0	3.4	13.8	31	51.7	4.31	.836
Constructive discussions with partners about performance gaps occur frequently	0	0	33.9	51.7	14.1	3.81	.634

Key: 1 Not at all; 2-Small Extent; 3-Moderate Extent, 4-Large Extent, and 5- Very Large Extent

Most respondents (65.5%) agreed that manufacturing SMEs and their supply chain partners agree on shared key performance indicators (KPIs); 31% indicated moderate, and 3.4% disagreed with the statement. The mean (M = 3.85) indicates that respondents' views leaned towards "Agree”, showing a generally positive perception of the statement. The standard deviation (SD = 0.792) indicates greater variability in the respondents' views on the statement. A majority of respondents (82.8%) agreed that the KPIs used are relevant for evaluating the performance of all supply chain partners. Of the respondents, 13.8% agreed with the statement, while 3.4% disagreed. The mean (M = 4.17) and standard deviation (SD = 0.742) indicate a strong positive perception among respondents, with moderate differences in their views.

The statement on performance metrics is consistently monitored and aligned across the supply chain, with 79.7% of respondents indicating high performance, while 20.3% indicates moderate performance. The mean (M = 4.23) and standard deviation (SD = 0.763) indicate a strong positive perception among the respondents, with moderate variability in the intensity of agreement. Indeed, manufacturing SMEs use joint dashboards with partners to track supply chain performance, as indicated by 100% of the respondents. The mean (M = 4.34) suggests a high level of agreement among respondents, and the low standard deviation (SD = 0.498) indicates that respondents' views are more consistent, with minimal variation.

The real-time performance data is shared with partners to support decision-making, as indicated by 93.1% of the respondents. According to the response, 6.9% indicated moderate, suggesting the significant role of information sharing in the manufacturing process across supply chains. The mean (M = 4.34) suggests a high level of agreement among the respondents, while the standard deviation (SD = 0.604) indicates moderate variation in their views.

Most respondents (72.4%) indicated that manufacturing SME's partners actively contribute to maintaining accurate and up-to-date performance dashboards, and 27.6% moderately agreed with this statement. The mean (M = 3.93) on a 5-point Likert scale indicates that respondents' views generally agreed with the statement, suggesting a very positive perception of it. The standard deviation (SD = 0.693) indicates moderate variation among respondents.

Furthermore, 93.1% of the respondents, representing the majority of manufacturing SMEs, strongly agreed that these SMEs regularly provide feedback to their partners on their performance. Of the respondents, 6.9% indicated a moderate level. Respondents (82.7%) also indicated that feedback from partners is used to improve supply chain processes and outcomes. Both the means (M = 4.04, M = 4.31) on a 5-point Likert scale indicate a positive perception of the respondents' views, and the standard deviations (SD = 0.604, SD = 0.834) suggest moderate and strong variation among the respondents, respectively. Lastly, the findings revealed that constructive discussions with partners about performance gaps occur frequently, as reported by 65.8% of respondents, while 33.9% considered the impact to be moderate. The mean (M = 3.81) indicates that respondents agree with the statement, indicating a positive perception. The standard deviation (SD = 0.634) suggests moderate variation among respondents' views.

The findings corroborate those of Ominde et al. (2022), who argued that performance data among supply chain partners has a leveraged power on organizational performance. This eliminates possible inconsistencies in the exchanged information, ultimately leading to a standardized information-sharing platform. Maria and Ellen (2017) concluded that information is one element that connects all actors in the manufacturing supply chain. In addition, having quality information from supply chain actors enables better planning and judgment, thereby enhancing the response to beneficiaries (Li et al., 2019; Vafaei-Zadeh et al., 2020).

The findings also indicate that manufacturing SMEs embrace framework contracting, where they have standby strategic suppliers for various critical products and services to cater to emergencies (Huo et al., 2021). Embracing integration design enables manufacturing SMEs to consider their partners' input regarding the attributes of products and services needed in emergencies. This aligns with the findings of Victoria, Muazu (2019) that preserving a good liaison with suppliers, practical and competent internal affairs, constant progress, and keeping up with technology to facilitate swiftness in executing the manufacturing SMEs duties, inter-organizational integrations, and effortlessness in internal processes are some of the practices rampant among manufacturing SMEs in Rwanda. Furthermore, Amsterdam (2020) identified poor information integration as one of the key challenges in supply chain management faced by manufacturing SMEs in developing countries.

4.5 Qualitative Analysis

Thematically, recurrent themes were drawn from qualitative responses received from the supply chain managers, and as many potential themes as possible were manually coded to establish patterns.

4.5.1 Communication Integration

Three study questions were employed to investigate the viewpoints of supply chain managers on communication integration. First, various production issues disrupt processes, necessitating the integration of communication in manufacturing SMEs. Secondly, strategies employed by manufacturing SMEs to enhance the agility of their supply chain communication. Lastly, respondents were asked to identify the driving forces that lead manufacturing SMEs to design their supply chains in a way that is responsive to customers' needs. The various production issues that disrupt processes triggering the need for communication integration and the drivers and strategies of communication are thematized in Figure 4.1 below:

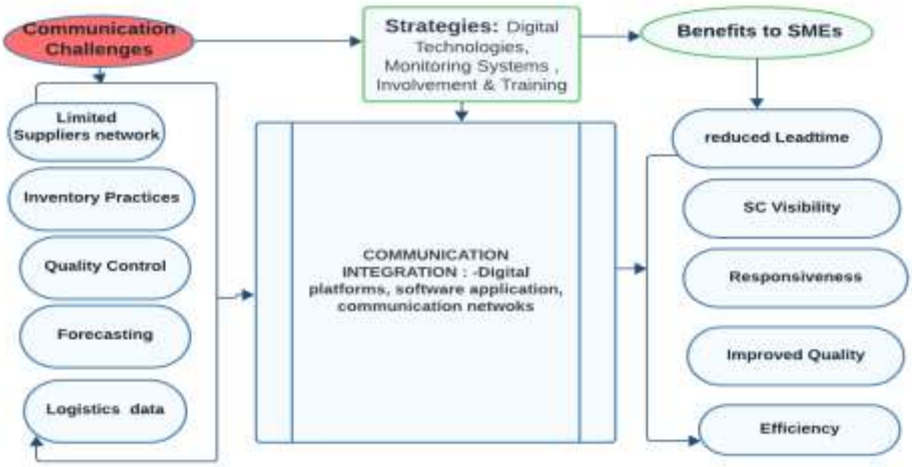

Figure 4.1: Communication Integration

Source: Researcher, 2024

The findings indicated that Rwanda has been subjected to various productions, classified based on origin and cause as either artificial (anthropogenic) or natural. Commonly identified natural disasters include disease outbreaks, plagues/invasions, floods, landslides/mudslides, droughts, and famine. Additionally, although utterly devastating, other natural disasters (geographically) occurred in neighboring countries, including earthquakes and volcanic eruptions. Common artificial production issues, as identified in Figure 4.1 below, include a lack of reliable local suppliers of raw materials, components, and equipment, as well as inconsistency in the supply of raw materials due to transportation issues, import delays, and market volatility.

The study finds a lack of modern technology in Manufacturing SMEs in Rwanda. Most organizations continue to use traditional communication methods in the supply chain to exchange messages, documents, and updates among stakeholders, including suppliers, distributors, and customers. Due to the internet network and technology infrastructure, this may result in delays in decision-making and response times. It also highlights the issue of security gaps in integrated communication platforms, which pose a data security risk. These findings align with those of García-Alcaraz et al. (2020) and Song et al. (2024), who asserted that communication through digital platforms enables SMEs to monitor the availability of raw materials and communicate proactively with suppliers to address challenges. This helps improve supply chain visibility and reduce disruptions while ensuring the sustainability of production operations (Shi et al., 2023). In comparison, Panahifar et al. (2018) emphasized that information security is crucial for enhancing trust between partners.

The study findings also highlighted the challenges of inefficient inventory management practices, which can lead to stockouts, excess inventory, and increased carrying costs for SMEs in Rwanda. By enabling real-time tracking of production plans, demand forecasts, and inventory levels, communication integration helps enhance the understanding of stockouts. Modern software and digital platforms can optimize inventory levels, increase inventory turnover rates, and reduce stockouts, helping SMEs cut costs and improve cash flow. For SMEs, inaccurate demand forecasting is a typical issue that leads to wasted manufacturing and inventory imbalances.

Supply chain communication integration can increase the precision of demand estimates by enhancing communication between the production, marketing, and sales departments. These findings align with (Asamoah et al., 2015; Song et al., 2024; Tan & Sidhu, 2022). By sharing real-time sales data, logistics information, and customer feedback, companies may make more accurate demand forecasting, reducing the risk of excess production or stockouts and enhancing production planning. This argument aligns with Shin et al. (2017), who asserted that effective communication between partners reduces unnecessary arguments and has a positive impact on outcomes, even when actors experience disputes.

The results indicate that SMEs can utilize SC communication integration to automate and streamline various operational processes, including scheduling, inventory control, production planning, and quality assurance (Mo et al., 2023). SMEs can enhance overall productivity, minimize human error rates, and facilitate seamless data sharing and communication across various departments and stakeholders by leveraging IoT technology (Mo et al., 2023). Additionally, it has been demonstrated that SMEs can identify development opportunities, increase reputation, anticipate risks, and make well-informed strategic decisions to propel company success by supporting data-driven decision-making. Employees can exchange ideas, best practices, and feedback internally through collaborative tools and platforms, which fosters innovation and competitive advantage. These findings align with Mo et al. (2023) who contended that interfirm trust and digital trust improve performance.

Three themes commonly emerged from the participating supply chain managers regarding the strategies adopted to increase SC communication integration. The findings indicate that manufacturing SMEs can utilize digital technologies, such as enterprise resource planning (ERP) systems, to integrate their business processes. Cloud-based collaboration platforms facilitate team communication, regardless of team members' locations. The study findings also find the use of supply chain and supply chain management (SCM) software to enhance communication and facilitate real-time data interchange. These findings align with Can Saglam et al. (2022), that communication quality improves relational commitment and reduces supply and circulation risks (Song et al., 2024). For Shi et al. (2023), digitizing communication channels can help SMEs make better decisions, understand their supply chain, and respond to changing demand trends more quickly. SMEs integrate their internal systems (such as ERP, inventory management, and production planning) with those of their suppliers, distributors, and logistics partners to ensure an efficient flow of information throughout the supply chain. Supply Chain Integration allows for automated data sharing, real-time shipment tracking, and inventory level synchronization, which reduces lead times and improves supply chain visibility (Song et al., 2024; Tan & Sidhu, 2022).

Using network theory, manufacturing SMEs can develop contingency plans through networks, leveraging the relationships between multiple actors in the chain. This may help to lower risks and ensure the smooth operation of their supply chain (Chatha & Jalil, 2022). It can also minimize inventory costs, reduce the chance of stockouts or overstocking, and improve supply chain operations in response to customer demand (Fernando & Wulansari, 2020). The network theory also explains that through networks, manufacturing SMEs, apart from reducing risks, enhance suppliers' responsiveness and promote trust (Vafaei-Zadeh et al., 2020). These align with Kauppi et al. (2023) who argued that effective communication identifies and minimizes biases, causing misattribution, and avoids unintentional deterioration of relationships that follow supply chain failure. This can only be achieved by maintaining open lines of communication and sharing accurate, reliable, and timely information. However, Jacobs et al. (2016) find that employee satisfaction can be a barrier to integration, but cannot be an enabler. As a result, making excessive efforts or investments in that direction is not advised.

On the other hand, the strategy commonly identified by supply chain managers as a means to increase responsiveness in manufacturing supply chains is to shorten lead times. Asamoah, Agyei-Owusu, Andoh-Baidoo, and Ayaburi (2021) asserted that analyzing lead times is highly significant, especially in supplying critical items, as time values are more vital in manufacturing SMEs. The time factor is sensitive to the need to deliver goods on time, so they can be made available to customers at the right time and in perfect condition (Porcu et al., 2019). This could be achieved by utilizing local sources of supply or having strategic suppliers ready to deliver when needed.

Transport and capacity planning emerged as a strategy employed by manufacturing SMEs to respond quickly to production needs. Unidentified circumstances and, at times, ruined infrastructure make planning for transportation and volume capability challenging. Muazu (2019) arrived at a similar conclusion, stating that transportation is a significant link between agencies as it facilitates the flow of goods among them. Organizations can use transport to earn a competitive advantage through the supply chain in terms of efficiency (Bae, 2024). Transportation also entails modes of transportation, routing/scheduling, maintenance, shipping, and consolidation. The primary sectors responsible for capacity planning in the distribution logistics of manufacturing SMEs are warehousing, transportation, material handling devices, and human resources.

The postponement strategy dictates that organizations should delay the creation or delivery of the product for as long as possible. Ongeri and Osoro (2021) agreed that the postponement strategy aims to reduce inventory obsolescence and eliminate the risks and uncertainty costs associated with unwanted products. It, however, requires an integrated and agile supply chain to effectively generate and develop the most recent demand forecasts along the supply chain, producing or allocating suitable products for individual clients. The conditions under which postponement becomes the only option are scarce but may occur for specific classes of products or channels within an organization. The driving forces that have led manufacturing SMEs to design responsive supply chains have emerged due to the need to save lives, pressure from partners, and the increased number of production and emergencies in the contemporary period.

4.5.2 Supply Chain Customer Integration

The views of supply chain managers on SC customer integration were examined using two open-ended questions. The first question sought to identify the challenges faced by the manufacturing process through supply chains in implementing customer integration design. The second question sought to investigate how supply chain processes can be resilient and overcome supply chain disruptions. The following Figure 4.2 shows the thematic analysis of the managers' views:

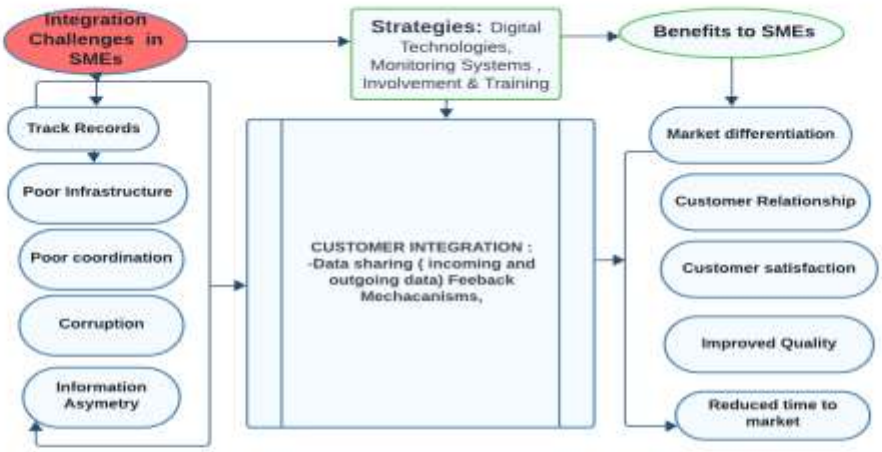

Figure 4.2: Customer Integration

Source: Researcher, 2024

From examining the views of supply chain managers (Figure 3) and track records on performance, insufficient resources (Human and capital), corruption, and information asymmetry emerged as significant challenges for Manufacturing SMEs in implementing SC customer integration. These challenges can be resolved through the implementation of findings, including investment in technology, infrastructure, and continuous monitoring systems such as KPIs, as well as ongoing staff training. Manufacturing SMEs can benefit from market differentiation, strong customer relationships, improved product quality, and a reduced time to market. These results align with Ali et al. (2023); Kamble et al. (2020), who asserted that investments in intelligent manufacturing bring advantages over traditional manufacturing. In contrast, Dzogbewu et al. (2021) argue that performance can only be achieved when manufacturing firms' managers pay critical attention to internal and external SC integration.

The findings reveal that SMEs generally possess lower financial, human, and technological resources than larger firms. The customer integration process, which necessitates investments in technology, training, and organizational restructuring, may exhaust the resources of SMEs. These findings align with those of Mangla et al. (2018), who asserted that infrastructure is a barrier to the manufacturing industry in

Africa, hindering performance. According to Ghariani and Boujelbene (2024), investing in customer relationships, joint knowledge sharing, information sharing, and collaborative planning improves performance. In this context, the findings show that manufacturing SMEs in Rwanda face the challenges of limited access to financing, inadequate infrastructure, and skills gaps in the workforce (Ogutu et al., 2023).

A significant percentage of SMEs in the manufacturing sector likely lack the necessary infrastructure and technology to support SC customer integration. They are also challenged by the high costs of implementing collaborative platforms, linking with customer systems, and sharing real-time data. These challenges hinder Manufacturing SMEs from growing and becoming globally competitive. These findings align with (Nkwabi & Fallon, 2020; Omwoyo et al., 2020b) who asserted that the primary issues facing manufacturing SMEs in developing nations include inadequate production capacities, poor customer relationship management, and poor storage infrastructure facilities. Disparities between platforms, data formats, and business processes may complicate integration and require modifications or workarounds to preserve compatibility (Asamoah et al., 2020). They also claimed external social networks can enhance supply chain resilience and customer-oriented performance.

The findings also reveal that demand uncertainty was a challenge in implementing customer integration design in manufacturing SMEs in Rwanda. The uncertainty and unpredictability of events, which are especially common in sudden-onset productions regarding their timing, location, nature, and magnitude, interfere with the prediction of supply and demand. Therefore, the probability of disturbance increases significantly, making response and preparation equally important. The findings align with those of Abolghasemi et al. (2019), who asserted that the degree to which demand can be projected or forecasted is crucial for informed supply chain decisions. The findings confirm those of Ali et al. (2023), who argued that the manufacturing process, managed through supply chain managers, is under constant pressure from unpredictable possibilities regarding when, where, what, how much, from where, and how frequently.

Singhry and Abd Rahman (2019) noted that production demand forecasting is challenging due to the lack of historical reference. However, the data may still be useless, even if available, as it is not guaranteed to predict future production demand due to the unique nature of production, which involves statistical variations every time a production run occurs. Poor coordination and corruption within the manufacturing process, as well as throughout supply chains, were identified as challenges to integration design. In complex emergencies, the sturdier the coordination, the better the quality of services delivered (Yeh et al., 2020). Without coordination, manufacturing SMEs end up duplicating projects in one place or concentrating attention where it is not needed.

Comes, Van de Ongeri, and Osoro (2021) support this by emphasizing that in several instances, the lack of a solid central coordinating mechanism renders the work of manufacturing SMEs appear haphazard. Host governments often prioritize bilateral and multilateral relations over manufacturing firms, particularly when making decisions, which poses a challenge to the integration of supply chains. This is because reports or concerns from manufacturing SMEs are regarded as non-technical and thus not considered (Bag et al., 2020).

The findings reveal that information asymmetry challenges SC customer integration due to the market intelligence gap. Information asymmetry affects customer relationships, particularly in terms of product features and prices. SMEs may struggle to effectively communicate their pricing strategies and product features to customers, which can result in misunderstandings and dissatisfaction. These findings align with Kauppi et al. (2023), who asserted that although transparency might occasionally erode confidence, it can also increase client loyalty. Information asymmetry impacts the competitiveness, operational effectiveness, risk management, regulatory compliance, and customer relationships of Rwandan manufacturing SMEs. By bridging information gaps and improving transparency and communication within supply chains, SMEs can decrease the effects of information asymmetry and boost their resilience and competitiveness in the market (Ali et al., 2023).

4.5.3 Supply Chain Collaboration Integration

An examination of twelve (12) supply chain managers' views on collaboration integration was sought using two items in the research instrument. The first question sought to identify the challenges or barriers to supply chain collaboration and the hindrances to the performance of manufacturing SMEs in Rwanda. The second question aimed to identify how manufacturing SMEs address environmental sustainability and its impact on operational performance. Figure 4.3 below presents a structured overview of the key themes identified as barriers to collaboration in manufacturing SMEs, as well as how these SMEs cope with environmental sustainability.

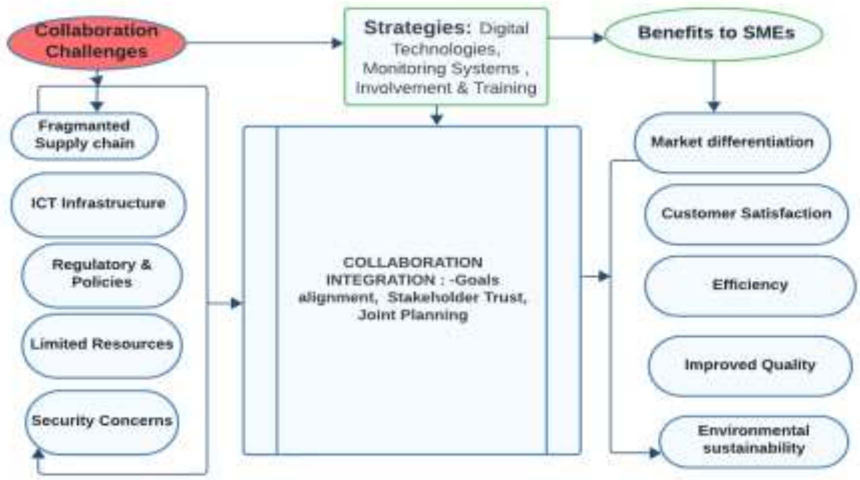

Figure 4.3: Collaboration Integration

Source: Researcher, 2024

The findings reveal that manufacturing SMEs operating in Rwanda face significant challenges in investing in sophisticated collaboration tools due to limited financial, human, and technological resources. Manufacturing SMEs face multiple challenges, including high implementation costs, limited expertise, and pressures that may constrain performance. Their inability to invest in modern digital technology or collaborative platforms makes it more difficult for them to communicate effectively with supply chain partners. These challenges impede the smooth flow of information and communication between SMEs and their partners. This leads to delays, errors, and inefficiencies in collaboration efforts. These findings align with (Ali et al., 2023; Panahifar et al., 2018), who asserted that information sharing is at the center of supply chain collaboration, and management should strive to improve internal capabilities before engaging in external collaboration, teamwork is a precondition for gaining a competitive advantage. Using the SCOR model, identify areas for improvement and align internal capabilities with industry standards.

The findings suggest that manufacturing SME owners and managers frequently lack the necessary skills and awareness for effective supply chain collaboration practices. This hinders the ability to integrate with partners and effectively benefit from collaboration opportunities. These findings align with Ramanathan, (2014), who asserted that supply chain partners' confusion, lack of investment in collaboration, and deadlines are among the barriers to collaborative arrangements. These results align with Zhong et al. (2023), who asserted that the lack of knowledge and experience in manufacturing SMEs can result in lower market competitiveness, operational inefficiencies, and a barrier to adopting best practices, all of which can negatively impact performance in the long run. On the other hand, Mofokeng & Chinomona (2019); Shin et al. (2019) argued that the extent to which collaboration affects performance, the partnership commitment to collaboration, and the firm's performance vary by collaboration structure.

The study reveals that fragmented supply chains and regulatory policies pose significant challenges to collaboration and integration. This creates communication barriers and reduces visibility in the supply chain for suppliers, distributors, and other partners. As a result, there is an inefficient flow of information, materials, and activities necessary for productive collaboration. On the other hand, a lack of clear guidelines or incentives for collaboration may discourage SMEs from investing time and effort in integration efforts. These results align with (Agyei-Owusu et al., 2022; Shin et al., 2019), who asserted that the level of investment exchange moderates effective collaboration.

The study also finds that manufacturing SMEs comply with environmental policies and regulations to gain access to specific markets and fear penalties subject to non-compliance with environmental regulations. These results align with Soomro (2021), who asserted that manufacturing SMEs adhere to environmental policies due to the fear of penalties for non-compliance.

Manufacturing SMEs face significant challenges securing workforce and resource capabilities due to financial constraints, inadequate transportation infrastructure, and unreliable energy supply, which collectively impact green production and distribution. These challenges align with the findings of Sendawula et al. (2021), who emphasized that fostering collaboration helps reduce inefficiencies such as inappropriate processing, excessive inventories, defects, theft, poor tracking and control, and product deterioration. Effective information sharing enables organizations to collaborate closely with partners in delivering products and services that meet customer needs while protecting the environment (Tarigan et al., 2021).

In contrast, Shah and Soomro (2021) argued that establishing clear guidelines for environmental protection mitigates adverse effects on environmental performance. Similarly, the findings support those of Sendawula et al. (2021), who highlighted that mandating compliance with ecological policies can have a positive influence on organizational performance. This perspective is echoed by Ogutu et al. (2023) and Shah and Soomro (2021), who contended that adopting environmental practices minimizes non-compliance penalties and enhances a company's reputation, creating opportunities to improve performance. Furthermore, Romano and Ferreira (2023) and Ogutu et al. (2023) emphasize that reducing air pollution, cutting greenhouse gas emissions, and adopting renewable energy sources are crucial to achieving both environmental sustainability and business objectives.

The respondent contended that management considers the absence of hazardous materials in products when selecting suppliers for manufacturing SMEs. An internal evaluation of suppliers ensures they have a plan in place for environmental protection, recycling, and waste management policies. These findings align with Ogutu et al. (2023); Shah and Soomro, (2021) who asserted that the organization conducts in-house audits before selecting suppliers, in collaboration with environmental protection agencies. They also help suppliers through training and coaching on green procurement and environmental solutions, enabling them to protect their production phase.

Using the SCOR model, manufacturing SMEs can create common performance goals and metrics with suppliers, distributors, and other partners. The model enables priorities and objectives to be more closely aligned, thereby enhancing collaboration, reducing lead times, and increasing overall supply chain efficiency. The SCOR model can be a helpful tool for manufacturing SMEs looking to improve their networks and performance across their supply chain (Girjatovičs et al., 2018; Nguyen et al., 2023). By applying the SCOR model and concepts into practice, SMEs can increase customer satisfaction, reduce costs, and streamline operations in today's competitive market.

4.5.4 Supply Chain Measurement Integration

An examination of supply chain managers' views on the integration of performance measurement was conducted using two items in the research instrument. The first question sought to identify the performance measurement of the actors involved in the flow of goods, services, and information to achieve the goals. The second question sought to identify the challenges and strategies related to the performance of SMEs. Figure 4.4 below shows the performance measurement integration challenges, strategies, and benefits.

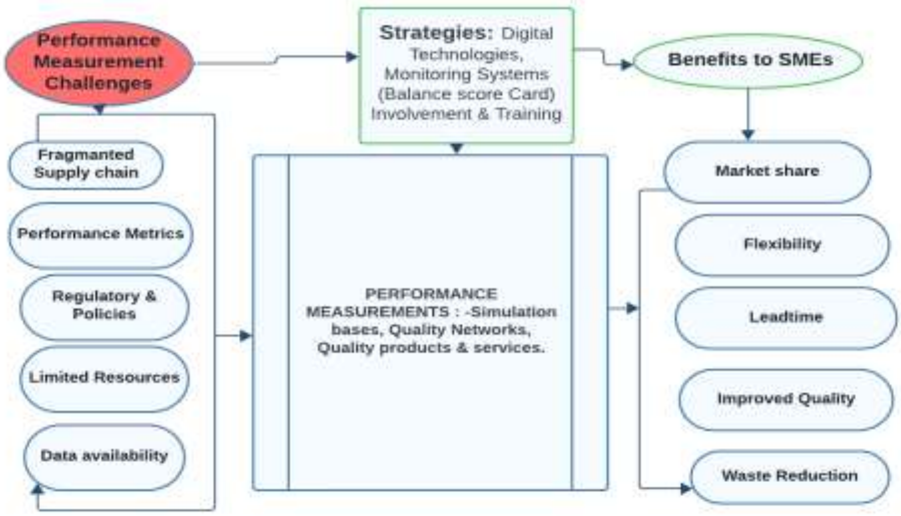

Figure 4.4: Performance Measurement Integration

Source: Researcher, 2024

The findings suggest that manufacturing SMEs encounter challenges due to a lack of reliable and easily accessible data. It is challenging to manage risk and evaluate performance, which complicates the process of making informed decisions and jeopardizes both customer satisfaction and competitive advantage. These findings align with Kamble et al. (2020), who asserted that a lack of reliable data might make it difficult for SMEs to comply with regulations and miss out on opportunities for growth and innovation, which would be detrimental to overall performance. Tan & Sidhu (2022) argued that most SMEs have limited resources to design and implement performance measurement systems.

Manufacturing SMEs require an in-depth analysis of the importance of investing in RFID-IoT to enhance management system efficiency, maximize productivity, and minimize costs. These findings align with (Kamble et al., 2020; Panahifar et al., 2018), who asserted that accurate information sharing within its network of suppliers enhances visibility, which is necessary to guarantee the benefits in the supply network. Members also need quick access to relevant and accurate information.

The findings also reveal that the manufacturing SMEs struggle to get accurate and timely data for measuring performance due to limited access to information, data quality issues, and the challenge of a fragmented supply chain. As a consequence, it reduces efficiency and increases costs. These findings align with those of Nguyen et al. (2023), who used the SCOR model to demonstrate that manufacturing SMEs align standardized performance metrics and objectives with suppliers, distributors, and other stakeholders. Saleheen and Habib (2023a) argued that supply chain performance in SMEs requires assessment for effectiveness, while measuring performance using the Balanced Scorecard (BSC) and the Supply Chain Operations Reference (SCOR) model is inadequate in the context of sustainability and market dynamics.

The findings reveal that donors emerged as significant actors, as raising sufficient financial resources for central crisis containment is essential, making financing a crucial field for SMEs. Furthermore, national and local governments, typically through coordination, often influence the activities of manufacturing SMEs. Ongeri and Osoro (2021) asserted that national and county governments are primarily responsible for keeping their citizens safe from avoidable productions and taking charge of production response activities. However, while some act in a committed and productive manner, others lack the necessary capacity or use their efforts in a partisan manner. Inspired by this, Muazu (2019) asserted that governments hold the primary power regarding their control over political and economic conditions and directly affect supply chain processes through their decisions.

Contrariwise, this study's findings indicated a lack of key performance indicators, and other joint performance measurement dimensions are the main challenges. This is due to poor coordination and inadequate information sharing among manufacturing actors, which negatively influences collective decision-making and actions. The vitality of coordination in crisis response is unquestioned, and a lack of it could lead to many deficiencies. The findings of this study corroborate those of Ongeri and Osoro (2021), who asserted that manufacturing SMEs primarily involve large numbers of domestic and global actors, often working in the same geographical settings and targeting the same objectives. Moreover, Stevenson et al. (2014)

asserted that managers cannot entirely rely on logistics contributions to enhance performance. They also need to investigate the possibility of outsourcing to external partners and consider using drivers, such as information technology, to improve performance.

Nevertheless, the findings reveal that coordination and collaboration among manufacturing SMEs in Rwanda have not yet reached the desired levels. Clarke and Campbell (2018) confirmed that the inability of manufacturing SMEs to compete comes from a lack of clarity regarding strategic goals and objectives. Kamble et al. (2020), using key performance indicators, balanced scorecard, and performance indicators (cost, quality, flexibility, time, integration, optimized productivity, real-time diagnosis and prognosis, computing, and social and ecological sustainability), argued that the lack of strategic direction can hinder decision-making processes and prevent SMEs from allocating resources effectively and enhancing competitiveness. The increase in the number and diversity of manufacturing actors contributes to making coordination appear complicated.

The findings of this study align with Muazu (2019), who noted that manufacturing activities are criticized for their failure to coordinate and collaborate effectively during manufacturing, distribution, and logistics operations. Comes *et al.* (2020) noted that coordination and cohesiveness are challenging to achieve because of variations in structures and systems among manufacturing strategy players. Buba, Das, Ghadai, and Bajpai (2019) advocate for greater coordination among manufacturing SMEs in response to the increasing complexity of production.

The adage that a supply chain is as strong as its weakest link, as espoused by Ongeri and Osoro (2021), is manifested by the findings of this study, strengthening the need for supply chain integration. Thus, in the manufacturing context, the manufacturing process through the supply chain is as integrated as its least responsive and cooperative chain actor. By addressing supply chain challenges and having solid plans, manufacturing SMEs in developing countries may strengthen their efforts to integrate performance measurement and improve their operational efficiency, productivity, and competitiveness in the global market.

4.6 Exploratory Factor Analysis

Exploratory factor analysis (EFA) is a multivariate statistical technique crucial for developing and validating psychological theories and assessments (Watkins, 2018). This study used EFA to make several deliberate, methodologically sound decisions, with multiple possibilities to access a better decision than others. (Maskey et al., 2018). Factor analysis, as a dimension reduction technique, was conducted to retain the smallest number of factors with the strongest influence on the variance explained (Watkins, 2018). Factor analysis was conducted using the Principal Component method approach. The extraction of the factors followed the Kaiser Criterion, where an Eigenvalue of 1 or more indicates a unique factor. Before conducting factor analysis, the Kaiser-Meyer-Olkin (KMO) criterion was used to measure sampling adequacy to determine whether each variable was suitable for factor analysis. KMO values greater than 0.5 indicate that the sample is suitable for factor analysis. The results of the KMO test are shown in Table 4.16 below.

Table 4.16: KMO Test for the Variables

Variables	**Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy**
Communication integration	0.681
Customer integration	0.601
Collaboration integration	0.648
Measurement integration	0.637
Information Sharing	0.639
Performance of Manufacturing SMEs	0.505

From the results in Table 4.16 the KMO values for the variables were as follows: communication integration (0.681>0.5), customer integration (0.601>0.5), collaboration integration (0.648>0.5), measurement integration (0.637>0.5), information sharing (0.639>0.5) and the KMO value for the performance of manufacturing SMEs was 0.505>0.5. Consequently, it was found that factor analysis would be possible with all six variables.

4.6.1 Factor Analysis for Communication Integration

Factor analysis is a valuable tool for reducing a large number of related variables to a manageable number by selecting a few key factors (Shrestha, 2021). Principal Components Analysis (PCA) was used to extract the maximum variance from the dataset, with each component. Based on Kaiser's criterion (Watkins, 2018). The first and second principal components were extracted from the nine principal components. The first two principal components could explain 56.3% of the resulting variance in the data on communication integration. The two extracted principal components have eigenvalues greater than 1.0. The result is shown in Table 4.17 below;

Table 4.17: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.758	39.406	39.406	2.758	39.406	39.406
2	1.183	16.898	56.304	1.183	16.898	56.304
3	.957	9.665	65.969			
4	.790	7.359	73.328			
5	.675	7.065	80.793			
6	.590	5.607	86.400			
7	.502	5.032	91.432			
8	.467	4.674	96.106			
9	.343	3.894	100.000			

Extraction method: Principal Component Analysis

Table 4.17 presents the results of the factor loadings for each construct under communication integration, based on the extracted principal components. The item with absolute factor loadings greater than 0.5 on either of the principal components extracted is retained for further analysis (Muazu, 2019). KMO values below 0.5 (e.g., .467, .343) indicate inadequate sampling adequacy; thus, the corresponding items were excluded from the analysis to improve factor structure reliability. Therefore, the study considered only seven communication integration statements in Table 4.18 below.

Table 4.18: Communication Integration Component Matrix

	Component	
	1	**2**
CI1	.474	.739
CI2	.627	-.043
CI3	.652	.309
CI4	.610	.341
CI5	.727	-.283
CI6	.662	-.343
CI7	.624	-.478
CI8	.645	-.485
CI9	.715	-.218

4.6.2 Factor Analysis for Customer Integration

Table 4.19 presents the total variance explained by the principal components in customer integration data. From the results, the data had nine principal components, of which the first three were extracted based on Kaiser's criterion. The first three principal components could explain 62.8% of the total variance in the data on customer integration.

Table 4.19: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.881	32.000	32.000	2.881	32.000	32.001
2	1.399	15.540	47.541	1.398	15.541	47.540
3	1.371	15.230	62.762	1.371	15.231	62.772
4	.943	10.472	73.244			
5	.805	8.939	82.183			
6	.582	6.451	88.654			
7	.537	4.862	93.495			
8	.325	3.612	97.117			
9	.263	2.893	100.000			

Extraction method: Principal Component Analysis

The factor loadings of each of the constructs under customer integration are presented in Table 4.20. Of the nine statements of customer integration, only seven had a factor loading of greater than 0.5 and were therefore retained for analysis. These items are: CI1, CIL3, CI4, CI5, CI6, CI7 and CI8.

Table 4.20: Customer Integration Component Matrix

	Component		
	1	**2**	**3**
CI1	.723	-.362	-.316
CI2	.492	-.413	.129
CI3	.771	-.097	.078
CI4	.551	.325	.634
CI5	.335	.805	.242
CI6	.499	.175	-.602
CI7	.453	.473	-.532
CI8	.663	-.134	.066
CI9	.463	-.248	.370

4.6.3 Factor Analysis for Collaboration Integration

Table 4.21 shows the total variance explained by the components in the data relating to collaboration integration. The first, second, and third principal components out of nine were extracted based on Kaiser's criterion. The first three principal components could explain 73.55% of the total variance in the data on collaboration integration.

Table 4.21: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.984	37.297	37.297	2.984	37.297	37.297
2	1.593	19.912	57.209	1.593	19.912	57.209
3	1.307	16.338	73.547	1.307	16.338	73.547
4	.656	8.200	81.747			
5	.551	6.893	88.640			
6	.434	5.379	94.019			
7	.263	2.684	96.703			
8	.212	2.247	98.950			
9	.105	1.050	100.000			

Extraction method: Principal Component Analysis

The loadings on the three factors extracted by the principal component method are indicated in Table 4.22 All nine items under collaboration integration had a factor loading greater than 0.5 on either of the three factors; hence, all the statements under this construct were considered for analysis.

Table 4.22: Collaboration Integration Component Matrix

	Component		
	1	**2**	**3**
CI1	.221	-.175	.850
CI2	.667	.099	.337
CI3	.603	.366	.441
CI4	.089	.840	-.165
CI5	.712	.400	-.150
CI6	.703	-.482	-.100
CI7	.665	-.552	-.276
CI8	.820	.127	-.373
CI9	.712	.406	-.155

4.6.4 Factor Analysis for Performance Measurement Integration

Presented in Table 4.23 is the total variance explained by the factors in measurement integration data. The result indicates that only three of the nine factors were extracted based on Kaiser's criterion. The first three factors explained about 73% of the total variance in the measurement integration data.

Table 4.23: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.741	39.156	39.156	2.741	39.156	39.156
2	1.322	18.880	58.035	1.322	18.880	58.035
3	1.047	14.957	72.993	1.047	14.957	72.993
4	.787	11.242	84.234			
5	.464	6.635	90.869			
6	.336	4.799	95.668			
7	.203	2.332	98.000			
8	.116	1.212	99.212			
9	.075	0.788	100.000			

Extraction method: Principal Component Analysis

According to the results in Table 4.24, all items under performance measurement integration were considered to have loadings greater than 0.5 on at least one of the three factors.

Table 4.24: Performance Measurement Integration Component Matrix

	Component		
	1	**2**	**3**
MI1	.858	-.050	-.023
MI 2	.797	-.154	.282
MI3	.701	.078	-.260
MI4	.348	-.851	.195
MI5	.645	.105	.144
MI6	.502	.266	-.710
MI7	.298	.695	.580
MI8	.687	-.245	.445
MI9	.354	.578	-.234

4.6.5 Factor Analysis for Information Sharing

Table 4.25 indicates the total variance explained by the factors in the data on information sharing. Out of the nine possible factors under this construct, only the first two were extracted as they had eigenvalues greater than 1. The results show that these factors explain approximately 61.62% of the total variance in information-sharing data.

Table 4.25: Total Variance Explained

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	2.487	41.456	41.456	2.487	41.456	41.456
2	1.210	20.163	61.619	1.210	20.163	61.619
3	.972	14.205	75.824			
4	.515	6.810	82.634			
5	.318	5.968	88.602			
6	.298	3.985	92.587			
7	.272	2.964	95.551			
8	.212	2.465	98.016			
9	.178	1.984	100.000			

Extraction method: Principal Component Analysis

The component matrix of the extracted factors from the information-sharing data is presented in Table 4.26. Corresponding to each item was its loading on the factors. As revealed by the result, all the items had a factor loading of greater than 0.5 on either of the two factors. Thus, all the statements about information sharing were retained for analysis. The following table (Table 4.25) shows the information sharing component matrix.

Table 4.26: Information Sharing Component Matrix

	Component	
	1	**2**
IS1	.257	.530
IS2	.814	-.263
IS3	.868	-.019
IS4	.655	.166
IS5	.523	-.693
IS6	.565	.593
IS7	.543	.487
IS8	.681	.516
IS9	.546	-.464

4.6.6 Factor Analysis for Performance of Manufacturing SMEs

The results in Table 4.27 show the total variance explained by the components in the data relating to the performance of manufacturing firms. Based on Kaiser's criterion, the Principal Component method extracted one factor out of the possible four factors. The one factor explained approximately 65.49% of the total variance in the data performance of manufacturing SMEs.

Table 4.27: Total Variance Explained

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	1.963	65.481	65.485	1.961	65.481	65.484
2	.978	28.613	93.097			
3	.467	5.122	98.121			
4	.055	1.881	100.000			

Extraction method: Principal Component Analysis

The component matrix results in Table 4.28 show that quality, Market share, responsiveness, and cost reduction had loadings of 0.780, 0.515, 0.673, and 0.981 on the first factor, respectively. Consequently, all the items were considered for analysis as they loaded more than 0.5 on the extracted factor.

Table 4.28: Component Matrix for Performance of Manufacturing SMEs

	Component
	1
Quality	.780
Market share	.515
Responsiveness	.673
Cost reduction	.981

4.7 Test of Assumptions of the Study Variables

4.7.1 Testing of Outliers of the Study Variables

Outliers were tested univariately on independent and dependent variables because variable constructs were on continuous scales. Univariate outliers are extreme values for a single variable. Cases or observations that exhibit characteristics or values markedly different from those of most cases in a specific dataset are typically excluded. This is because they distort the relationship between variables by either creating a correlation that should not exist or suppressing a correlation that should exist. Consequently, multivariate testing of outliers on the dependent variable using Mahalanobis d-squared produced reasonable boxplots, where all the constructs were symmetrical, and no outliers were identified. Multivariate outliers are an unusual combination of scores on several variables (Muazu, 2019).

4.7.2 Normality Tests of the Study Variables

The normality of data distribution was assessed by examining its skewness and kurtosis. A variable with an absolute skew-index value greater than 3.0 is highly skewed, whereas a kurtosis index greater than 8.0 is extreme (Muazu, 2019). Further, Ongeri and Osoro (2021) stated that an index smaller than an absolute value of 2.0, representing skewness, and an absolute value of 7.0 is the least violation of the assumption of normality. The normality test results of the dependent variable indicated skewness and kurtosis in the range of -1 and +1, as shown in Table 4.29. This means that the assumption of normality was satisfied.

Table 4.29: Normality Test of Independent and Dependent Variables

Construct		Statistic	S. E
Communication integration	Mean	4.2128	0.02404
	Median	4.2757	
	Std. Deviation	0.40930	
	Range	1.51	
	Skewness	-0.243	0.145
	Kurtosis	-0.876	0.286
Customer integration	Mean	4.1675	0.02184
	Median	4.2857	
	Std. Deviation	0.35478	
	Range	1.83	
	Skewness	-0.431	0.143
	Kurtosis	1.166	0.281
Collaboration integration	Mean	4.0731	0.02808
	Median	4.121	
	Std. Deviation	0.47823	
	Range	1.88	
	Skewness	-0.715	0.141
	Kurtosis	-0.15	0.285
Supply Chain Integration	Mean	4.1674	0.02438
	Median	4.1429	
	Std. Deviation	0.41521	
	Range	1.86	
	Skewness	-0.53	0.142
	Kurtosis	0.439	0.285
Information Sharing	Mean	4.3503	0.0224
	Median	4.3353	
	Std. Deviation	0.38150	
	Range	1.83	
	Skewness	-0.868	0.143
	Kurtosis	1.255	0.285
Performance of Manufacturing SMEs	Mean	6.7107	0.04028
	Median	6.7308	
	Std. Deviation	0.78815	
	Range	2.79	
	Skewness	0.179	0.143
	Kurtosis	-0.739	0.282

To corroborate the skewness and kurtosis results, the graphical representation showed that the line signifying the actual data distribution closely followed the diagonal in the standard Q-Q plot, as illustrated in Figures 6 and 7 below, indicating a normal distribution (Dametew et al., 2020). In a Q-Q plot, or the standard probability plot, the observed value for each score is plotted against the expected value from the normal distribution, whereby a sensibly straight line implies a normal distribution (Muazu, 2019). By and large, if the points in a Q-Q plot depart from a straight line, the assumed distribution is called into question.

4.7.3 Testing for Linear Regression Assumptions

The pilot results were also used to test for linear regression assumptions. This is a preliminary process where the data is checked to ensure that it does not violate the assumptions of the classical linear regression model and to verify that the data yields the best least squares unbiased estimators. According to Miot (2018), the standard tests that should be conducted are linearity, normality, homoscedasticity, multicollinearity, serial correlation, and autocorrelation. The results of these tests are explained in the sub-sections below;

4.7.3.1 Testing for Normality

Normality tests were used to determine whether the data were collected from the same population. For Rwagombwa (2019), the Q-Q plots can be used to test for linearity. Accordingly, according to Oteki et al. (2018), the plots should lie along a straight line for data to be considered normal. The results for normality are shown in the sections below.

The first independent variable of communication integration yielded the Q-Q plot in Figure 4.5 below.

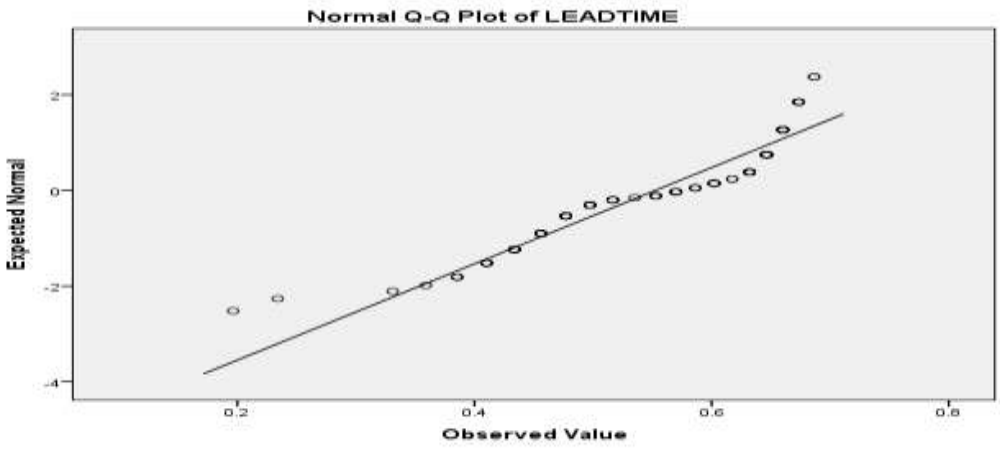

Figure 4.5: Normality Test for Communication Integration

As shown in Figure 4.5 above, the plots are along a straight line, and the data are as expected. The second independent variable of the study was Customer integration. The Q-Q plot for this variable is shown in Figure 4.6 below.

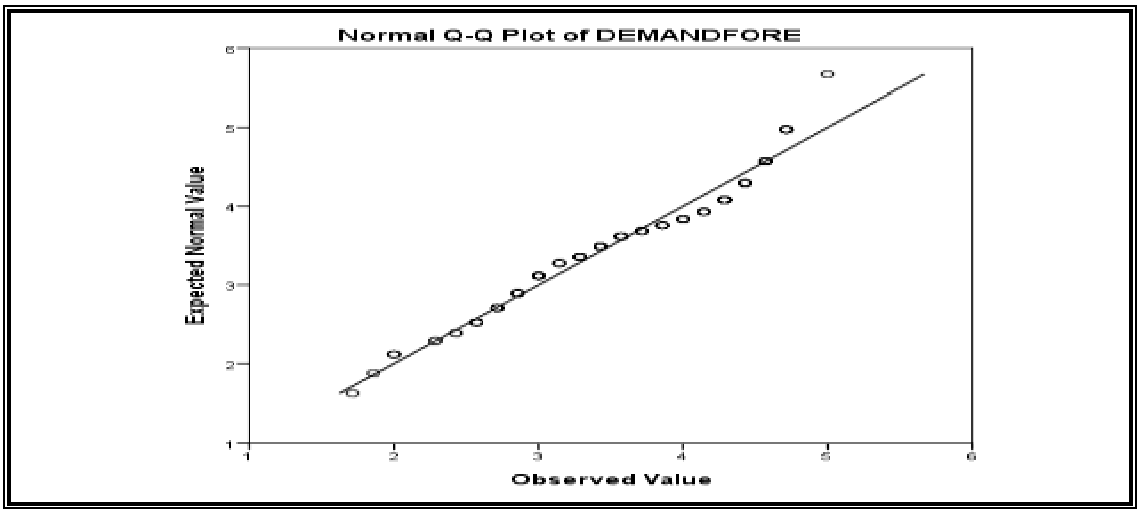

Figure 4.6: Normality Test for Customer Integration

As can be observed from Figure 4.6 above, the plots are along a straight line, indicating that the variable data is standard. The third independent variable of the study was collaborative integration. The Q-Q plot for this variable is shown in Figure 4.7 below.

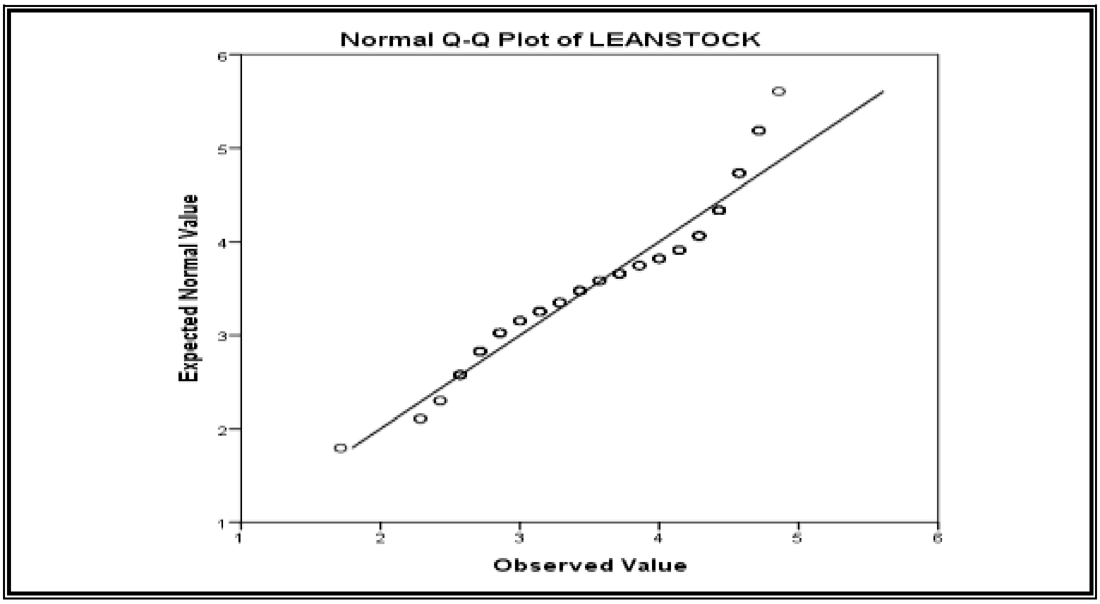

Figure 4.7: Normality Test for collaboration integration

As shown in Figure 8 above, the plots are straight, and the data is expected. The fourth independent variable of the study was measurement integration. The Q-Q plot for this variable is shown in Figure 4.8below.

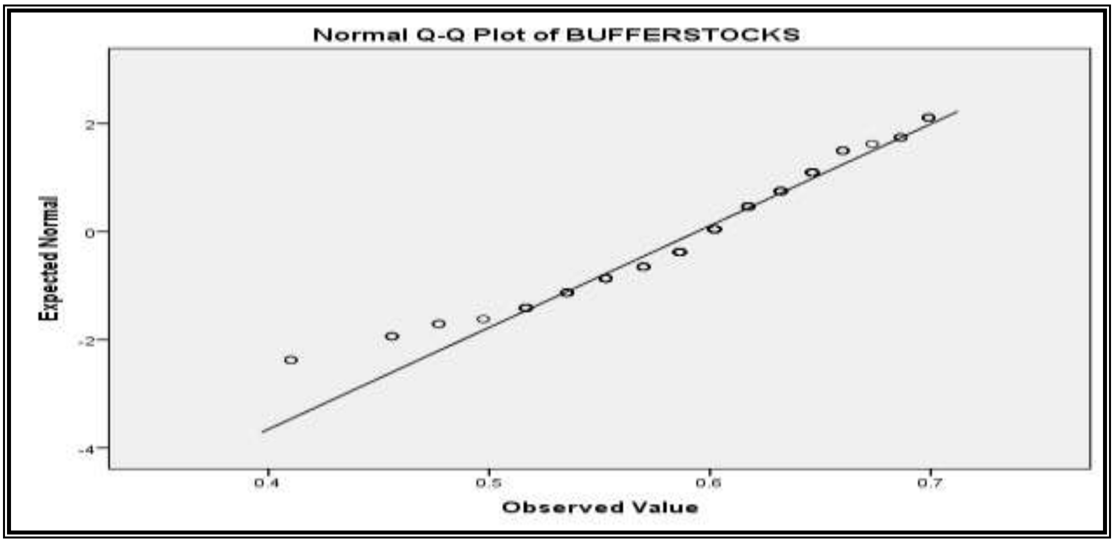

Figure 4.8: Normality Test for Measuring Integration

As shown in Figure 4.8 above, the plots are along a straight line, and the data is expected.

4.7.3.2 Multicollinearity Test

Multicollinearity in multiple regression models was measured using the Variance Inflation Factor (VIF) and Tolerance Levels. A predictor's reciprocal of tolerance, or VIF statistic, in a model shows how much higher the error variance is for the predictor's unique effect. (Shrestha, 2021). According to Shrestha (2021), a VIF of more than 10 indicates the presence of multicollinearity. The results for the multicollinearity test are shown in Table 4.30 below;

Table 4.30: Multicollinearity Test

Coefficients	**Collinearity Statistics**	
	Tolerance	**VIF**
Communication Integration	.136	7.289
Customer Integration	.132	7.623
Collaborative Integration	.171	5.804
Measuring Integration	.122	8.254

The results of tolerance and VIF, as shown in Table 4.30, indicate that there was no problem of multicollinearity among the independent variables because no variable had a VIF value exceeding ten, and no tolerance statistic was below 0.10, as suggested by Shrestha (2021). The data, therefore, satisfied the condition of non-multicollinearity and were fit for linear regression.

4.7.3.3 Heteroscedasticity Test

As Ominde et al. (2022) asserted, the homoscedasticity condition is fulfilled at each level of the predictor variables; the variance of the residual terms is constant. However, when this condition is not fulfilled, heteroscedasticity occurs, meaning the variance of the residual terms is variable. Testing for homoscedasticity was necessary due to the use of hierarchical multiple regression as the primary inferential statistical approach. This study examined homoscedasticity using Levene's test for equality of variances of inventory control practices across the supply chain. Under this test, the assumption was that the variance of adoption levels was equal across groups defined by inventory control analytics. The null hypothesis was that the data were not homoscedastic. The result of the test is shown in Table 4.31 below.

Table 4.31: Testing for Heteroscedasticity

Variable	Levene Statistic	df 1	df 2	Sig
Communication integration	2.251	1	10	0.174
Customer Integration	1.623	1	10	0.484
Collaborative Integration	0.674	1	10	0.42
Performance Measurement Integration	0.484	1	10	0.628

From the results shown in Table 4.31 above, it was concluded that all four independent variables were homoscedastic, as indicated by p-values greater than 0.5, implying that the null hypothesis that the error variance of the dependent variables across groups is equal was rejected, and the alternative hypothesis was accepted.

4.7.3.4 Multicollinearity Test

Multicollinearity is a situation in multiple regression where the predictor variables are highly correlated. Multicollinearity severely affects the least squares estimates of the regression coefficients, with the most significant of these resulting in the acceptance of the null hypothesis more readily (Muazu, 2019). Multicollinearity diagnostics were conducted using the Variance Inflation Factor (VIF) and Tolerance statistics. The VIF is the reciprocal of the tolerance statistics. The variance inflation factor (VIF) for each term in the model measures the combined effect of the dependencies among the repressors on the variance of that term. One or more large VIFs indicate the presence of multicollinearity. Tolerance is the inverse of the coefficient of determination (R^2). Tolerance is estimated by 1 - R^2.

Other factors equal researchers crave soaring tolerance levels, as low tolerance levels could severely affect results that involve multiple regression analysis. A VIF of above five is usually regarded as evidence of Multicollinearity. A tolerance statistic of less than 0.20 is also considered a cause for concern regarding multicollinearity. Table 4.32 shows the test results for multicollinearity using tolerance and VIF. With tolerance values exceeding 0.2 and VIF values below 5, this study concluded that there was no multicollinearity problem. This aligns with the findings of Ongeri and Osoro (2021).

Table 4.32: Test of Multicollinearity Statistics

Variable	Tolerance	VIF
Communication integration	.813	1.239
Customer integration	.748	1.346
Collaboration integration	.619	1.635
Supply Chain Integration	.697	1.501
Information Sharing	.673	1.485

4.7.3. 5 Heteroscedasticity Test

Another assumption of multiple regressions is that the residuals are homoscedastic. Heteroscedasticity in regression analysis occurs when the variance of the residuals (errors) varies across the observations. The study employed the Breusch-Pagan test to test the null hypothesis that the errors have equal variance (i.e., the errors are homoscedastic) versus the alternative hypothesis that the errors are heteroscedastic. The Breusch-pagan test gives a chi-square value and a significance value, whereby a p-value < 0.05 indicates heteroscedasticity, while a p-value greater than 0.05 indicates heteroscedasticity does not exist. Table 4.33 shows the results obtained from running the tests. From the table, the Breusch-Pagan test p-value was 0.481, which was more significant than 0.05, indicating that heteroscedasticity does not exist; thus, the assumption of homoscedasticity of the residuals had not been violated. This aligns with the findings of Ongeri and Osoro (2021).

Table 4.33: Heteroscedasticity Test Results

Test	Chi-square value	Sig.
Breusch-Pagan	3.483	.482

4.7.3.6 Linearity Test

Linearity of the regression model tests the consistency of the gradient that represents the relationship between the response and predictor variables. If the slope of change in the relationship between the variables is unstable, it becomes challenging to perform a regression analysis on the study data (Muazu, 2019). Testing for linearity can be done using several methods; however, the easiest is the deviation from linearity test, which is performed by ANOVA. The test indicates that the variables are not linear if the significant value for deviation from linearity is less than 0.05. Linearity was tested using the ANOVA test for linearity, which computes the linear and nonlinear components of a variable duo. Nonlinearity is significant if the F significance value for the nonlinear component is below 0.05. All computed readings were above 0.05, as shown in Table 4.34, confirming linear relationships (constant slope) between the predictor and dependent variables.

Table 4.34: Linearity Test Results

Variable	Sample Size	Linearity (ANOVA Test)	
Threshold: assumption is met		F	p>0.05
Communication integration	213	1.235	0.131
Customer integration	213	0.831	0.881
Collaboration integration	213	1.072	0.152
Performance Measurement Integration	213	1.045	0.098
Information Sharing	213	1.563	0.420

4.8 Inferential Analysis

4.8.1 Correlation of Study Variables

Table 4.35 illustrates the correlation matrix between the independent variables. Correlation is essentially a tool for determining how a collection of variables relates (Muazu, 2019), thereby facilitating the testing of multicollinearity. The fact that the correlation values are not close to 1 or -1 indicates that the factors are sufficiently different measures of separate variables. It also implies that the variables have no multicollinearity. The study can utilize all the independent variables when there is no multicollinearity.

Table 4.35: Results for Correlation of Study Variables

		Performance of Manufacturing SMEs	**Communication integration**	**Customer Integration**	**Collaboration integration**	**Performance Measurement Integration**	**Information sharing**
Performance of Manufacturing SMEs	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	213					
Communication integration	Pearson Correlation	.765**	1				
	Sig. (2-tailed)	0.000					
	N	213	213				
Customer integration	Pearson Correlation	.718**	.595**	1			
	Sig. (2-tailed)	0.000	0.000				
	N	213	213	213			
Collaboration integration	Pearson Correlation	0.681**	0.310	.350**	1		
	Sig. (2-tailed)	0.000	0.002	0.000			
	N	213	213	213	213		
Performance Measurement Integration	Pearson Correlation	.649**	.535**	.423**	.455**	1	
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		
	N	213	213	213	213	213	
Information Sharing	Pearson Correlation	.485**	.275**	.331**	.516**	.308**	1

		Performance of Manufacturing SMEs	Communication integration	Customer Integration	Collaboration integration	Performance Measurement Integration	Information sharing
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	
	N	213	213	213	213	213	213

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation coefficient ranges from -1.00 to +1.00. A value of -1.00 signifies a perfect negative correlation, whereas a value of +1.00 represents a perfect positive correlation. A value of 0.00 implies the absence of any relationship among the variables being tested. These findings align with those of Muazu (2019). Table 4.35 indicates that communication and customer integration have a significant positive relationship, as indicated by the correlation coefficient 0.595 and p-value< 0.05. At 0.595, there is no problematic multicollinearity, so no need to replace either communication integration or customer integration.

The results indicate a positive and significant relationship between communication integration and collaboration integration, as evidenced by the p-value and the correlation coefficient ($r = 0.310$, $p < 0.05$). Typically, waste within the supply chain hinders the ability to respond to societal needs effectively. Inefficiency in activities, due to failed coordination, results in poor responsiveness and time wastage in acquiring the necessary items for a particular production. This aligns with the findings of Ongeri and Osoro (2021).

A moderate and statistically significant positive relationship exists between communication integration and performance measurement integration ($r = 0.535$, $p < 0.05$). This implies that improvements in communication integration are associated with improvements in performance measurement integration. The correlation is below the threshold for multicollinearity, showing that both variables can be included in the regression without compromising coefficient stability.

The results indicate a significant positive weak correlation between customer and collaboration integration ($r = 0.350$, $p < 0.05$). The results indicate a weak to moderate, yet statistically significant, positive relationship between customer integration and collaboration integration. This indicates that higher levels of customer integration are associated with higher levels of collaboration integration. The correlation is sufficiently low to rule out multicollinearity issues, so both variables can be included in the regression analysis.

A significant, moderate positive correlation exists between customer integration and measurement integration ($r = 0.423$, $p < 0.05$). This indicates that as one variable increases, the other tends to increase as well. The correlation is below the critical level of multicollinearity, showing that both variables can be incorporated in the regression analysis. This is because for supply chains to revert to their normal state or transition to a new, more desirable state, a significant amount of information sharing and cohesiveness is required among partners. Resilience in the manufacturing sector refers to the ability of the supply chain to withstand and recover from crises and turbulence, which requires the combined efforts of all parties involved. This aligns with the findings of Ongeri and Osoro (2021).

There is a moderately significant positive relationship between SC collaboration and Performance measurement integration ($r = 0.455$, $p < 0.05$). There is evidence that the presence of SC collaboration enhances overall operational efficiency, while its absence leads to a waste of resources and delays in crucial response times. Failure of manufacturing actors to collaborate can result in gaps in coverage, duplication, and inefficiencies in emergency responses. From the findings in Table 39, all the independent variables are positively related to information sharing as attested by the respective correlation coefficients: communication integration ($r=0.275$, $p<0.05$), customer integration ($r=0.331$, $p<0.05$), collaboration integration ($r=0.516$, $p<0.05$), and measurement integration ($r=0.308$, $p<0.05$). All the relationships are rendered significant since their p-values are less than 0.05.

4.8.2 Multiple Regression Analysis Results

The research employed multiple regression analysis to establish the linear statistical relationship between the independent and dependent variables in this study. The five hypotheses, as stated in this study, were tested using regression models as below:

a) *Test of Hypothesis 1: Communication integration and Performance of Manufacturing SMEs in Rwanda*

A correlation analysis was conducted to determine the correlation between SC Communication integration and the performance of manufacturing SMEs in Rwanda. Correlation coefficients can range from -1.00 to +1.00. The value of -1.00 represents a perfect negative correlation, whereas that of +1.00 represents a perfect positive correlation. A value of 0.00 indicates the absolute absence of a relationship between the tested variables. This finding aligns with the results of Kang et al. (2021). Table 4.36 shows that the Pearson correlation coefficient was 0.769. These findings indicate a strong positive linear relationship between SC Communication integration and the performance of manufacturing SMEs in Rwanda.

Table 4.36: Correlation Analysis for Construct Communication Integration

Variables		**Performance of Manufacturing SMEs**	**Communication integration**
Performance of Manufacturing SMEs	Pearson Correlation	1	.769**
	Sig. (2-tailed)		.000
	N	213	213
SC Communication integration	Pearson Correlation	.769**	1
	Sig. (2-tailed)	.000	
	N	213	213

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The researcher conducted a regression analysis to examine the relationship between communication integration on the performance of manufacturing SMEs. The hypothesis to test for this specific objective was:

H_0: There is no significant relationship between communication integration and the performance of manufacturing SMEs in Rwanda.

The histogram in Figure 4.9 indicates that the data were normally distributed. The residual describes the error in the model's fit to the i^{th} observation, yi, and provides information about the adequacy of the fitted model. According to Muazu (2019), analyzing the residuals is frequently helpful in checking the assumption that errors are normally distributed with constant variance and in determining whether additional terms in the model would be beneficial.

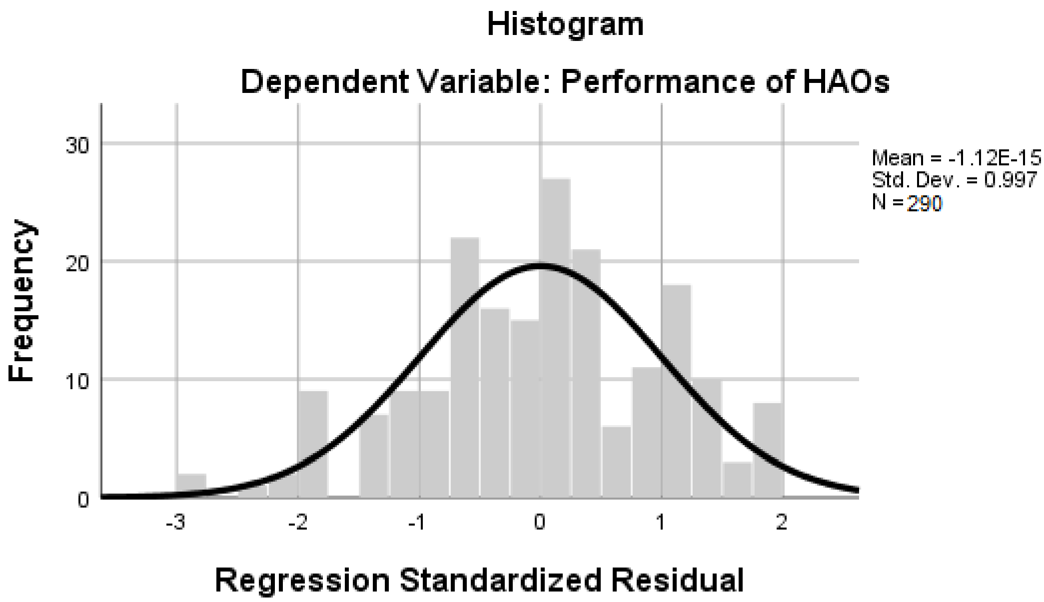

Figure 4.9: Histogram Communication Integration on the Performance of Manufacturing SMEs

The linear regression model yields an R-squared value of 0.585, indicating that approximately 58.5% of the total variance in the performance of manufacturing SMEs in Rwanda can be explained by communication integration. The result is shown in Table 4.37 below.

Table 4.37: Model Summary of Communication Integration

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.765[a]	.585	.579	.74484

a. Predictors: (Constant), Communication integration

b. Dependent Variable: Performance of Manufacturing SMEs

Further testing on the ANOVA shows that the significance of the F-statistic is less than 0.05 (F=12.440, p<0.05), as indicated in Table 4.37. This implies that communication integration has a significant influence on the performance of manufacturing SMEs.

Table 4.38: ANOVA of Communication Integration

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7.439	1	7.439	12.44	.000[a]
	Residual	162.081	212	0.598		
	Total	169.52	213			

a. Dependent Variable: Performance of Manufacturing SMEs
b. Predictors: (Constant), Communication integration

Presented in Table 4.38 are the coefficients and t-statistics of the resulting model. The constant term $\beta_0 = 5.77$. This implies that, if communication integration is held constant, the performance of manufacturing SMEs in Rwanda is expected to increase by 5.77. The regression coefficient for communication integration was positive and significant ($\beta_1 = 0.224$, p<0.05), with a t-value of 3.556. This implies that for every unit increase in communication integration, the performance of manufacturing SMEs is predicted to increase by 0.224 units.

Table 4.39: Coefficients of Communication Integration

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		

1	(Constant)	5.781	0.487		12.101	0.000
	Communication integration	0.224	0.073	0.765	3.556	0.000

a. Dependent Variable: Performance of Manufacturing SMEs

Performance of Manufacturing SMEs= 5.781 + 0.234 Communication integration

From the results in Tables 4.39 and 4.40 above, the null hypothesis that no significant relationship between communication integration and the performance of manufacturing SMEs in Rwanda is rejected. The results revealed that communication integration has a positive contribution to the performance of manufacturing SMEs in Rwanda. The findings are in harmony with those of Omunde et al. (2022), who argued that the operation of manufacturing SMEs in unstable environments necessitates strategies that enhance their responsiveness to customers' needs. This requires supply chain readiness, the swift allocation of necessary resources, and the ability to respond effectively in various settings. Sharing the same view are the existing researchers Kang, Lee, Hwang, Wei, and Huo (2021), who argue that the operational performance of manufacturing processes through supply chains relies on their ability to respond swiftly to customers' needs and undertake dynamic operations. For this to be possible, the manufacturing process through supply chains must be responsive, amenable, and efficient. This is further supported by Ongeri and Osoro (2021), who assert that a proper supply chain response to manufacturing needs in the production process is considered a mitigation strategy and a means of satisfying customers' needs. Thus, it ought to be done in the shortest time using the least resources to reduce the terrible effects of the production.

b) *Test of Hypothesis 2: There is no significant relationship between Customer integration and Performance of Manufacturing SMEs in Rwanda*

A correlation analysis was conducted to examine the relationship between the construct of customer integration and the performance of manufacturing SMEs. Table 44 indicates that the Pearson correlation coefficient was 0.718. These findings indicate a strong positive linear relationship between customer integration and the performance of manufacturing SMEs.

Table 4.40: Correlation Analysis for Construct Customer Integration

Variable		Performance of Manufacturing SMEs	Customer integration
Performance of Manufacturing SMEs	Pearson Correlation	1	.708**
	Sig. (2-tailed)		.000
	N	213	213
Customer integration	Pearson Correlation	.718**	1
	Sig. (2-tailed)	.000	
	N	213	213

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The researcher conducted a regression analysis to establish the relationship between customer integration and the performance of manufacturing SMEs. The hypothesis to test for this specific objective was:

H_0: There is no significant relationship between Customer integration and the performance of manufacturing SMEs in Rwanda.

The histogram in Figure 4.10 indicates that the data were normally distributed. The residual explains the error in the model's fit to the i^{th} observation, yi, and is essential in determining the adequacy of the fitted model. This finding aligns with the results of Li, Cui, Huo, and Zhao (2019). Analysis of the residual is frequently helpful in checking the assumption that errors are normally distributed with constant variance and determining whether additional terms in the model would be helpful.

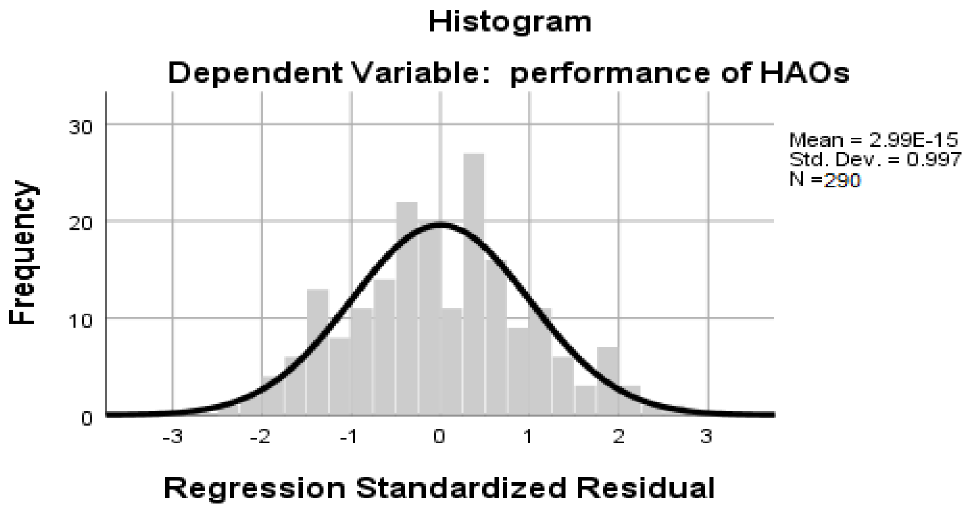

Figure 4.10: Histogram Customer Integration on the Performance of Manufacturing SMEs

The summary of the linear regression model used for this objective indicates a coefficient of determination, $R^2 = 0.501$, which means that approximately 50.1 percent of the variation in the performance of manufacturing SMEs in Rwanda can be explained by customer integration. The result is presented in Table 4.41 below;

Table 4.41: Model Summary of Customer Integration

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.718[a]	.501	.492	.67172

a. Predictors: (Constant), Customer integration

b. Dependent Variable: Performance of Manufacturing SMEs

Table 4.42 presents the ANOVA results of the regression analysis on the performance of manufacturing SMEs in relation to customer integration. The result indicates that the significance of the F-statistic is less than 0.05 ($F = 17.036$, $p < 0.05$), implying that customer integration has a significant relationship with the performance of manufacturing SMEs.

Table 4.42: ANOVA of Customer Integration

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10.026	1	10.026	17.036	.000[b]
	Residual	159.494	212	.589		
	Total	169.520	213			

a. Dependent Variable: Performance of Manufacturing SMEs

b. Predictors: (Constant), Customer integration

As shown in Table 4.43, the coefficients and t-statistics are obtained from the model. The constant term $\beta_0 = 4.527$. This is interpreted to mean that, holding customer integration constant, the performance of manufacturing SMEs in Rwanda improves by 4.53. The regression coefficient for customer integration was positive and significant ($\beta_1 = 0.525$, $p<0.05$), with a t-value of 4.127. This implies that a unit increase in customer integration is predicted to increase the performance of manufacturing SMEs by 0.525 units. The findings align with existing literature on the subject (Li et al., 2019).

Table 4.43: Coefficients of SC Customer Integration

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.527	.532		8.507	.000
	Customer integration	.525	.127	.718	4.127	.000

a. Dependent Variable: Performance of Manufacturing SMEs

Performance of Manufacturing SMEs= 4.527 + 0.525 Customer integration

Based on the results in Tables 4.44 and 4.45 above, the decision is to reject the null hypothesis that there is no significant relationship between customer integration and the performance of manufacturing SMEs in Rwanda, and to conclude that customer integration has a significant relationship with the performance of manufacturing SMEs in Rwanda. In fact, production risks cannot be avoided, but their consequences can be mitigated through the holistic and resilient management of relief supply chain operations. The findings of this study concur with Baah et al. (2022) who argued that collaborative supply chain practices influence supply chain visibility, shareholder trust, and the overall performance of manufacturing SMEs.

Thus, these findings also align with those of Ongeri and Osoro (2021), who argued that a supply chain resilient management strategy improves performance and effectiveness, while a lack of it imposes huge, dramatic consequences for stricken populations. Furthermore, Muazu (2019) identified a platform to encourage the professionalization of supply chain resiliency disciplines in operations and strengthen the corresponding functions during manufacturing strategy processes following production risk events.

c) *Test of Hypothesis 3: Collaboration Integration and Performance of Manufacturing SMEs in Rwanda*

A correlation analysis was conducted to investigate the relationship between collaboration integration and the performance of manufacturing SMEs. Table 48 shows that the Pearson correlation coefficient was 0.671. These findings indicate the presence of a strong positive linear relationship between collaboration integration and performance of manufacturing SMEs.

Table 4.44: Correlation Analysis for Construct Collaboration Integration

Variable		Performance of Manufacturing SMEs	Collaboration integration
Performance of Manufacturing SMEs	Pearson Correlation	1	.661*
	Sig. (2-tailed)		.000
	N	213	213
Collaboration integration	Pearson Correlation	.671**	1
	Sig. (2-tailed)	.000	
	N	213	213

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Regression analysis was conducted to determine the relationship between collaboration integration and the performance of manufacturing SMEs. The hypothesis to test for this specific objective was:

H_{03}: There is no significant relationship between collaboration integration and the performance of manufacturing SMEs in Rwanda.

The histogram in Figure 4.11 indicates that the data were normally distributed. The residual describes the error in the model's fit to the i^{th} observation, yi, and is used to explain the adequacy of the fitted model. This agrees with the study findings of Mat Isa and Mohammad Al Dweiri (2020), which suggest that analyzing residuals is frequently helpful in checking the assumption that errors are normally distributed with constant variance and in determining whether additional terms in the model would be useful.

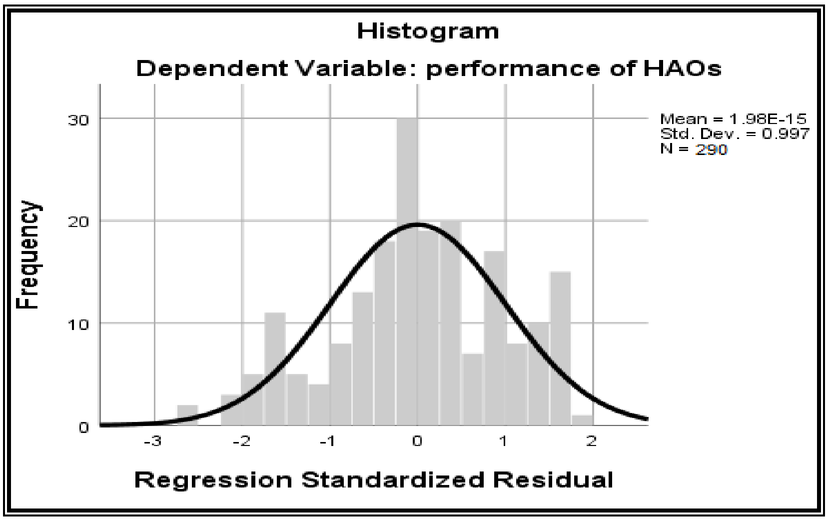

Figure 4.11: Histogram Collaboration Integration and Performance of Manufacturing SMEs

Presented in Table 4.45 is the model summary of the regression of collaboration integration on the performance of manufacturing SMEs. The results show $R^2 = 0.436$, indicating that approximately 43.6% of the total variation in the performance of manufacturing SMEs in Rwanda can be attributed to collaboration integration.

Table 4.45: Model Summary of Collaboration Integration

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.661[a]	.436	.427	.78413

a. Predictors: (Constant), Collaboration integration

b. Dependent Variable: Performance of Manufacturing SMEs

Further testing on the ANOVA reveals that the regression model, with performance of manufacturing SMEs as the dependent variable and collaboration integration as the predictor, is highly significant at a 5% level of significance (F-statistic = 35.587, $p < 0.05$), as shown in Table 4.46. This implies that SC collaboration integration has a significant influence on the performance of manufacturing SMEs in Rwanda.

Table 4.46: ANOVA of Collaboration Integration

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19.743	1	19.743	35.587	.002[c]
	Residual	149.777	212	.555		
	Total	169.520	213			

a. Dependent Variable: Performance of Manufacturing SMEs

b. Predictors: (Constant), Collaboration integration

Further, Table 4.47 presents the coefficients and t-statistic of the resulting model. The constant term$\beta_0 = 4.490$, implies that if collaboration integration is kept constant, then manufacturing SMEs in Rwanda have a positive performance by 4.490. The regression coefficient for collaboration integration was positive and significant at a 5% level of significance ($\beta_1 = 0.547$, p<0.05), with a t-value of 5.965. This is interpreted to mean that for every unit increase in collaboration integration, the performance of manufacturing SMEs is predicted to increase by 0.547 units.

Table 4.47: Coefficients of Collaboration integration

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	4.490	.376		11.949	.000
	Collaboration integration	.547	.092	.671	5.965	.000

a. Dependent Variable: Performance of Manufacturing SMEs

Performance of Manufacturing SMEs= 4.490 + 0.547 Collaboration integration

From the results in Table 4.46 to Table 4.47 above, the null hypothesis that there is no significant relationship between collaboration integration and the performance of manufacturing SMEs in Rwanda is rejected. This result revealed that collaboration integration contributes positively to the performance of manufacturing SMEs in Rwanda. This aligns with the study findings of Muazu (2019), who asserted that for organizational effectiveness and for gaining a competitive advantage in cost, the organization must eliminate waste.

In general, waste is the failure to add value for the customer or is a barrier to adding value. The sourcing officers deal with unknown or ever-changing actors and uncertain supply and demand. The findings also confirm the argument by Muazu (2019), which asserts that manufacturing production operations generally face high uncertainty, changing priorities, and unstable supply chains. This results in a challenging environment for process management, which creates difficulties in waste elimination.

d) *Test of Hypothesis 4: Performance Measurement Integration and Performance of Manufacturing SMEs in Rwanda*

A correlation analysis was conducted to determine the correlation between the construct of performance measurement integration and the performance of manufacturing SMEs. Table 4.48 shows that the Pearson correlation coefficient was 0.649. These findings suggest a positive linear relationship between the integration of performance measurement and the performance of manufacturing SMEs in Rwanda.

Table 4.48: Correlation Analysis for Construct Performance Measurement Integration

Variable		**Performance of Manufacturing SMEs**	**Performance Measurement Integration**
Performance of Manufacturing SMEs	Pearson Correlation	1	.649*
	Sig. (2-tailed)		0
	N	213	213
Measurement integration	Pearson Correlation	.649**	1
	Sig. (2-tailed)	0	
	N	213	213

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The researcher conducted a regression analysis to investigate the relationship between the integration of performance measurement and the performance of manufacturing SMEs. The hypothesis to test for this specific objective was:

H_{04}: There is no significant relationship between Performance Measurement Integration and the performance of manufacturing SMEs in Rwanda.

The histogram in Figure 4.12 indicates that the data were normally distributed. The residual describes the error in the model fit to the i^{th} observation, yi, and provides information about the adequacy of the fitted model. This corroborates the study findings of Muazu (2019), who argued that analyzing the residual is frequently helpful in checking the assumption that errors are normally distributed with constant variance and in determining whether additional terms in the model would be useful.

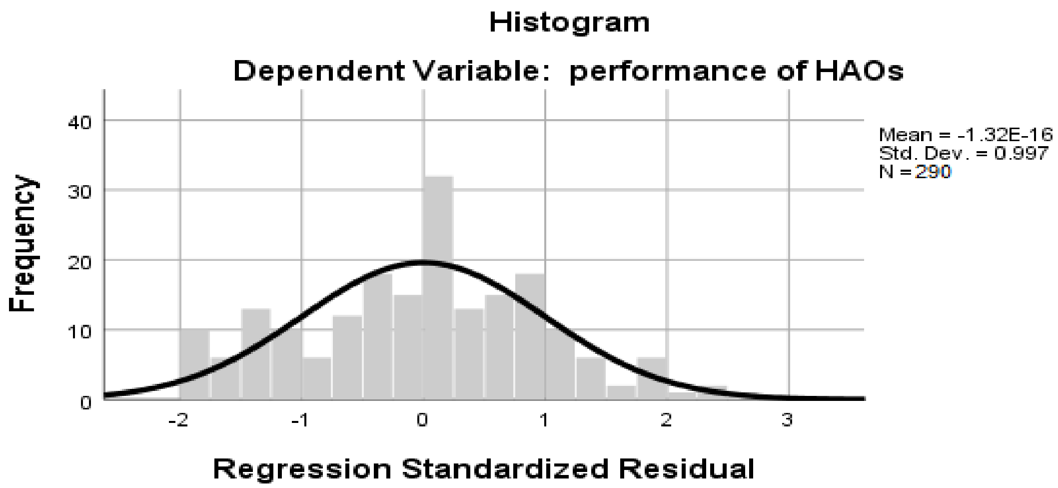

Figure 4.12: Histogram Measurement Integration on the Performance of Manufacturing SMEs

The linear regression model yields an R-squared value of 0.499, indicating that approximately 49.9 percent of the variation in the performance of manufacturing SMEs in Rwanda can be attributed to the integration of performance measurement. The result is shown in Table 4.49 below.

Table 4.49: Model Summary of Performance Measurement Integration

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.639[a]	.499	.398	.73092

a. Predictors: (Constant), Supply Chain Integration

b. Dependent Variable: Performance of Manufacturing SMEs

The ANOVA result in Table 4.50 indicates that the significance of the F-statistic is less than 0.05 (F = 13.406, p < 0.05). This implies that measurement integration has a significant influence on the performance of manufacturing SMEs in Rwanda.

Table 4.50: ANOVA of Performance Measurement Integration

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7.990	1	7.990	13.406	.000[d]
	Residual	161.530	212	.596		
	Total	**1769.520**	**213**			

a. Dependent Variable: Performance of Manufacturing SMEs

b. Predictors: (Constant), Measurement Integration

The results in Table 4.51 provide the coefficients and t-statistics obtained from the model. The constant term $\beta_0 = 5.597$. This indicates that, if measurement integration is held constant, the performance of manufacturing SMEs in Rwanda improves by 5.597. The regression coefficient for performance measurement integration was positive and significant ($\beta_1 = 0.268$, p<0.05), with a t-value of 2.424. This implies that a unit increase in measurement integration is predicted to lead to a 0.268 increase in the performance of manufacturing SMEs in Rwanda.

Table 4.51: Coefficients of Performance Measurement Integration

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.597	.464		12.069	.000
	Measurement Integration	.268	.071	.639	2.424	.000

a. Dependent Variable: Performance of Manufacturing SMEs

Performance of Manufacturing SMEs= 5.597 + 0.268 Performance Measurement integration

From the results in Table 4.50 to Table 4.51 above, the null hypothesis that there is no significant relationship between the integration of performance measurement and the performance of manufacturing SMEs in Rwanda is rejected. This result revealed that the integration of performance measurement is significantly related to the performance of manufacturing SMEs in Rwanda. The study aligns with the findings of Kamble et al. (2020), who asserted that performance measurement is one of the biggest challenges from a management standpoint. To achieve these goals, different supply chain partners must collaborate, provide human resources, coordinate, and possess the necessary organizational and technological capabilities. While Jagan Mohan Reddy et al. (2019) asserted that simulation techniques are the most suitable measurement techniques compared to other techniques and approaches for supply chain performance measurement in a changing environment. On the other hand, Saleheen and Habib (2023a), contented that in a changing environment, it is insufficient to rely solely on the Balanced Scorecard (BSC) and Supply Chain Reference Model (SCOR) model when measuring the performance of manufacturing SMEs. They proposed to use an integrated supply chain performance model that incorporates supplier relationship management (SRM), internal supply chain management, and Customer Relationship Management (CRM) attributes.

Ongeri and Osoro (2021) further noted that the success of production response depends heavily on the information available and the coordination of activities by diverse role players. Their views are corroborated by the study findings of Muazu (2019), who affirmed that performance measurement helps manufacturing SMEs create smooth processes throughout the extended supply chain. Smooth information and material flows blur the boundaries between supply chain partners, enabling manufacturing SMEs to reduce uncertainty in the supply chain and thereby enhance their performance. The study's findings also align with Caldecott (2017), who asserted that the supply chain is often affected negatively due to a lack of coordination approaches during production. It can also be affected by a lack of joints and holistic supply chain strategies between operations management and human actors. On the other hand, Müller and Birkel (2020) asserted that collaboration between manufacturing SMEs is not an easy task due to numerous barriers, as each manufacturing process has its own unique structure, IT system, management style, and distinct rules of procedure.

4.8.3 Overall Regression Model

A multiple linear regression analysis was conducted to examine the relationship between independent and dependent variables before including the moderating variable (information sharing). An ordinary least squares regression model was then established without the moderating variable. The model was of the form:

$$Y= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where: Y=Performance of Manufacturing SMEs

β_0 = Y-intercept

X_1 = Communication integration

X_2 =Customer integration

X_3 = Collaboration integration

X_4 = Performance Measurement Integration.

ε =Error term

β1, β2, β3, and β4 represent the coefficients of each independent variable.

The adjusted R^2 is the coefficient of determination. This value explained how the performance of manufacturing SMEs varied with the integration of communication, customer, collaboration, and performance measurement. The study findings in Table 56 indicate that communication integration, customer integration, collaboration integration, and performance measurement integration are jointly positively associated with the performance of manufacturing SMEs, as indicated by the Pearson correlation coefficient of 0.848. This aligns with the findings of Nkwabi and Fallon (2020).

The histogram in Figure 4.13 indicates that the data were normally distributed. The residual describes the error in the model's fit to the i^{th} observation, yi, and provides information about the adequacy of the fitted model. According to Wogi, Wakweya, and Tesfay (2018), residual analysis is often helpful in verifying the assumption that errors are normally distributed with constant variance and determining whether additional terms in the model are necessary.

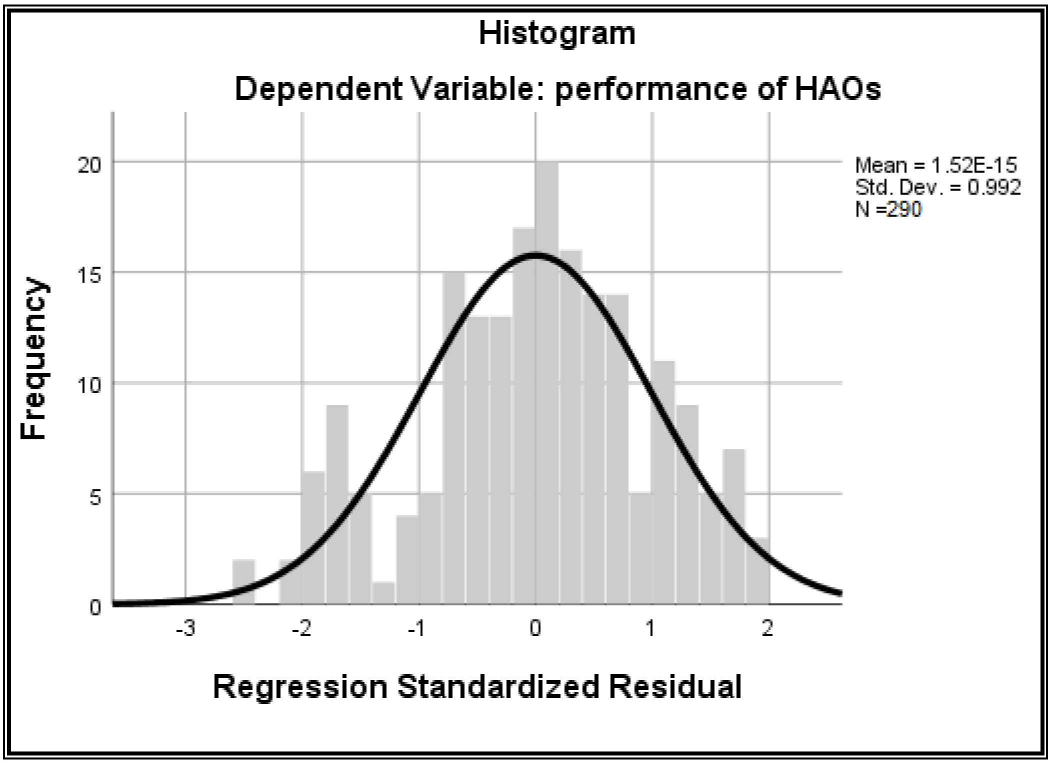

Figure 4.13: Histogram Performance of Manufacturing SMEs

Furthermore, the overall model summary table indicates that 73.9% of the change in the performance of manufacturing SMEs can be attributed to four predictors: communication integration, customer integration, collaboration integration, and performance measurement integration. This implies that the remaining 26.1% of the variation in the performance of manufacturing SMEs can be attributed to other factors not included in this study.

Table 4.52: Overall Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.848[a]	.739	.692	.49346

a. Predictors: (Constant), Communication integration, Customer integration, Collaboration integration, and Performance Measurement integration

Analysis of variance (ANOVA) was done to establish the model's fitness. The ANOVA table indicates that the F-ratio ($F = 10.962$, $p < 0.05$) was statistically significant. This means that the model used was appropriate, and the relationship of the variables shown could not have occurred by chance.

Table 4.53: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	23.935	1	5.984	10.962	.001[b]
	Residual	145.585	212	.546		
	Total	169.520	213			

a. Dependent Variable: Performance of Manufacturing SMEs

b. Predictors: (Constant), SC Communication integration, SC Collaboration integration, and Performance Measurement Integration

The estimated coefficients (βs) show the contribution of each independent variable to the change in the dependent variable. The coefficient table results show that communication integration ($\beta = .532$, $p < 0.05$), customer integration ($\beta = .316$, $p < 0.05$), collaboration integration ($\beta = .415$, $p < 0.05$), and performance measurement integration ($\beta = .458$, $p < 0.05$) all positively and significantly affected the performance of manufacturing SMEs. This implies that an increase in any of the factors improves the performance of manufacturing SMEs in Rwanda.

Table 4.54: Coefficients of Determination

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.419	0.641		5.318	0.000
	Communication Integration	0.532	0.115	0.668	4.626	0.000
	Customer Integration	0.306	0.081	0.442	3.901	0.000
	Collaboration integration	0.425	0.074	0.512	5.608	0.000
	Performance measurement integration	0.468	0.098	0.583	4.673	0.000

a. Dependent Variable: Performance of Manufacturing SMEs

The model before moderation was:

Performance of Manufacturing SMEs = 3.419 + 0.532 Communication integration + 0.306 Customer integration + 0.425 Collaboration integration + 0.458 Performance measurement Integration.

4.8.4 Moderating Effect of Information Sharing

The study hypothesis was;

H_{05}: Information sharing does not significantly moderate the relationship between communication integration, customer integration, collaboration integration, performance measurement integration, and performance of manufacturing SMEs in Rwanda.

The Moderating Effect of Information sharing on the Relationship between Communication integration and Performance of Manufacturing SMEs in Rwanda

To test the moderating effect of information sharing on the relationship between communication integration and the performance of manufacturing SMEs in Rwanda, the study built the following three models;

Models:

Model 1: $Y = \beta_0 + \beta_1 X_1 + \varepsilon$

Model 2: $Y = \beta_0 + \beta_1 X_1 + \beta_Z Z + \varepsilon$

Model 3: $Y = \beta_0 + \beta_1 X_1 + \beta_Z Z + \beta_{1Z} X_1 * Z + \varepsilon$

Upon regressing the variables, as shown in Table 4.55, the Coefficient of Determination (R^2) for the first model was 0.585, indicating that communication integration, on its own, contributes 58.5% to the performance of manufacturing SMEs in Rwanda. Nevertheless, when information sharing was introduced, the relationship between communication integration and the performance of manufacturing SMEs in Rwanda underwent significant changes. Table 4.55 indicates that the R^2 before introducing information sharing was 0.585 (58.5%), which changed significantly to 0.663 (66.3%) upon introducing information sharing, implying a 7.8% increase. This meant that communication integration and information sharing could explain up to 66.3% of the performance of manufacturing SMEs in Rwanda. Upon adding the interaction term X_1*Z, the model improved to an R-squared value of 0.733, representing a 7% increase.

Briefly, the R^2 increased by 7.8 percent when information sharing was considered in addition to communication integration, and by 7.0 percent when the interaction between the moderator and communication integration was considered. This concurs with the findings of Ali et al., (2020) who asserted that, through resource-based theory, digital information sharing enhances the performance of manufacturing SMEs. These findings conform to Li et al., (2019), who argued that the performance of manufacturing SMEs is affected by customer strategic coordination. Structured and unstructured customer information sharing improves operational coordination. In this context, information sharing is a helpful mediator between customer and operational performance (Fatih & Junejo, 2024). The results suggested that information sharing as a predictor enhances the model's value and moderates the relationship between communication integration (X_1) and the performance of manufacturing SMEs in Rwanda (Y).

Table 4.55: Moderating Effect of Information Sharing on the Relationship between Communication Integration and Performance of Manufacturing SMEs in Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change
1	.765[a]	0.584	0.579	0.74484	0.585
2	.814[b]	0.665	0.661	0.33453	0.078
3	.856[c]	0.732	0.731	0.29801	0.07

a. Predictors: (Constant), SC Communication integration
b. Predictors: (Constant), SC Communication integration, Information sharing
c. Predictors: (Constant), SC communication integration, information sharing, interaction between communication integration and information sharing

d. Dependent Variable: Performance of Manufacturing SMEs

Table 4.56 shows the ANOVA results for the models considered in testing for the moderating effect of information sharing on the relationship between communication integration and the performance of manufacturing SMEs in Rwanda. The results, as shown in Model 1 (F-statistic = 12.440, $p < 0.05$), Model 2 (F-statistic = 9.119, $p < 0.05$), and Model 3 (F-statistic = 9.611, $p < 0.05$), indicate that all three models remained significant despite the use of different predictors.

Table 4.56: ANOVA for the Models Used to Test for the Moderating Effect

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7.439	1	7.439	12.440	.000[b]
	Residual	172.081	212	.598		
	Total	179.520	212			
2	Regression	10.723	1	5.362	9.119	.000[c]
	Residual	168.797	212	.588		
	Total	179.520	212			
3	Regression	16.434	1	5.478	9.611	.000[d]
	Residual	163.086	212	.570		
	Total	179.520	212			

a. Dependent Variable: Performance of Manufacturing SMEs

Table 4.57 presents the regression coefficients, t-statistics, and significance levels of the coefficients obtained from the three models used to investigate whether information sharing moderates the relationship between SC communication integration and the performance of manufacturing SMEs in Rwanda. The result indicates that the constant term was used when communication integration was considered in this study in multiple linear regression, implying that if SC communication integration is held constant, there is a positive performance of manufacturing SMEs in Rwanda, with a coefficient of 5.770.

The regression coefficient for communication integration was positive and significant ($\beta_1 = 0.224$, $p<0.05$), with a t-value of 3.556. This implies that for every unit increase in communication integration, the performance of manufacturing SMEs in Rwanda is predicted to increase by 0.224 units. This concurs with the findings of Panahifar et al. (2018) who asserted that effective collaboration has a positive and significant impact on the performance of manufacturing SMEs. Based on network theory, the present study highlights that secure information sharing is the most critical factor in fostering information-sharing-centered collaboration among supply chain partners. This underscores the importance of supply chain integration in enhancing the competitiveness of SMEs in Rwanda's manufacturing sector.

When the moderator is included, the results of Model 2 show that SC communication integration ($\beta = 0.450$, $p < 0.05$) and moderator information sharing ($\beta = 0.244$, $p < 0.05$) have a significant positive influence on the performance of manufacturing SMEs in Rwanda. Model 3 investigated the interaction effect between communication integration and the moderator (information sharing). The results indicated a significant positive relationship between the performance of manufacturing SMEs in Rwanda and the interaction between information sharing and SC communication integration ($\beta = 2.209$, $t = 5.055$, $p < 0.05$).

Table 4.57: Coefficients for the Models Used to Test for Moderating Effect

Model		Coefficients[a] Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.770	.477		12.096	.000
	Communication integration	0.224	.063	.365	3.556	.000
2	(Constant)	2.493	.661		3.772	.000
	Communication integration	0.450	.125	.479	3.600	.000
	Information sharing	0.244	.138	.411	1.768	.000
3	(Constant)	2.131	.622		3.424	.000
	Communication integration	.518	.505	.726	1.026	.000
	Information Sharing	.305	.416	.440	0.733	.000
	Communication integration * Information sharing	2.209	.437	.896	5.055	.000

a. Dependent Variable: Performance of manufacturing SMEs

Thus, the regression models after moderation become:

Model 1: $Y = 5.770 + 0.224X_1$

Model 2: $Y = 2.493 + 0.450X_1 + 0.244Z$

Model 3: $Y = 2.130 + 0.518X_1 + 0.305Z + 2.209X_1Z$

The study hypothesized that information sharing does not moderate the relationship between communication integration and the performance of manufacturing SMEs in Rwanda. The interaction effect between communication integration and information sharing measures the moderation effect. The rule of thumb is that moderation is supported if there is a significant interaction effect on the dependent variable between the moderator and the independent variable. Otherwise, the moderation is not supported. The null hypothesis is rejected based on the results in Table 60 and Table 4.57. The study concludes that information sharing moderates the relationship between SC communication integration and the performance of manufacturing SMEs in Rwanda.

The Moderating Effect of Information sharing on the Relationship between SC Customer integration and Performance of Manufacturing SMEs in Rwanda.

To test the moderating effect of information sharing on the relationship between customer integration and the performance of manufacturing SMEs in Rwanda, the study built the following three models;

Models:

Model 1: $Y = \beta_0 + \beta_2X_2 + \varepsilon$

Model 2: $Y = \beta_0 + \beta_2X_2 + \beta_zZ + \varepsilon$

Model 3: $Y = \beta_0 + \beta_2X_2 + \beta_ZZ + \beta_{2Z}X_2 * Z + \varepsilon$

The model summary result in Table 4.58 indicates that the unadjusted coefficient of determination for model 1 is 0.501. This implies that the customer integration considered in this study accounts for only 50.1 percent of the total variation in the performance of manufacturing SMEs. The remaining 49.9 percent change in the performance of manufacturing SMEs can be attributed to other factors not considered in this study.

For model 2, the R^2 =0.610, an implication that customer integration and information sharing account for about 61.0 percent of the total change in the performance of manufacturing SMEs, and thus, the remaining 39.0 percent of the variation in the performance of manufacturing SMEs can be accounted for by other factors, not of interest in this study. This echoes the findings of Kauppi et al. (2023), who argued that information asymmetry leads to opportunistic behavior by suppliers, who charge higher prices or provide lower-quality products. To reduce information asymmetry in the supply chain. Companies can use transparency, trust, and collaboration to improve communication and information sharing between buyers and suppliers. Hence, build long-term relationships that benefit both parties and improve supply chain performance (Kauppi et al., 2023; Zsidisin et al., 2024).

For model 3, the R^2 =0.669, and this implies that SC customer integration, information sharing, as well as the interaction between customer integration and information sharing, accounts for 66.9 percent of the total variation in the performance of manufacturing SMEs; the remaining 33.1 percent change in the performance of Manufacturing SMEs can be attributed to other factors. The R^2 increased by 10.9 percent when information sharing was considered in addition to customer integration, and by 5.9 percent when the interaction between the moderator and customer integration was considered.

Table 4.58: Moderating Effect of Information Sharing on the Relationship between Customer Integration and Performance of Manufacturing SMEs in Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change
1	.718[a]	.501	.492	.67172	.501
2	.781[b]	.610	.618	.35947	.119
3	.817[c]	.669	.646	.33189	.059

a. Predictors: (Constant), Customer integration
b. Predictors: (Constant), Customer integration, Information sharing
c. Predictors: (Constant), Customer integration, Information sharing, interaction between customer integration and information sharing

c. Dependent Variable: Performance of Manufacturing SMEs

Table 4.59 presents the ANOVA results for the models examined in testing the moderating effect of information sharing on the relationship between customer integration and the performance of manufacturing SMEs. The results, as shown in Model 1 (F-statistic = 17.036, $p < 0.05$), Model 2 (F-statistic = 15.713, $p < 0.05$), and Model 3 (F-statistic = 15.729, $p < 0.05$), indicate that all three models remained significant despite the use of different predictors.

Table 4.59: ANOVA for the Models Used to Test for the Moderating Effect of Information Sharing on the Relationship between SC Customer Integration and Performance of Manufacturing SMEs

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	10.026	1	10.026	17.036	.000[b]
	Residual	169.492	212	.589		
	Total	179.520	212			
2	Regression	17.743	1	8.862	15.713	.000[c]
	Residual	161.797	212	.564		
	Total	179.521	212			
3	Regression	25.434	1	8.478	15.729	.000[d]
	Residual	154.086	212	.539		
	Total	179.521	212			

a. Dependent Variable: Performance of Manufacturing SMEs

Table 4.60 presents the regression coefficients, t-statistics, and significance levels of the coefficients obtained from the three models used to investigate whether information sharing has a moderating effect on the relationship between customer integration and the performance of manufacturing SMEs in Rwanda. The result indicates that when customer integration was considered in this study was used in a multiple linear regression, the constant term $\beta_0 = 4.527$. This implies that, if customer integration is held constant, there is a positive performance of manufacturing SMEs in Rwanda, with a 4.527 increase.

The regression coefficient for customer integration was positive and significant ($\beta_1 = 0.525$, $p<0.05$), with a t-value of 4.127. This implies that for every unit increase in customer integration, the performance of manufacturing SMEs is predicted to increase by 0.525 units. This echoes the findings of Vafaei-Zadeh et al., (2020). Unstructured and structured customer information sharing improves the operational performance of manufacturing SMEs. These findings differ from Kauppi et al., (2023) that two-sided information asymmetry affects the long-term relationship between suppliers and customers.

When the moderator is included, the results of Model 2 show that customer integration ($\beta = 0.539$, $p < 0.05$) and the moderator, information sharing ($\beta = 0.274$, $p < 0.05$), have a significant positive influence on the performance of manufacturing SMEs. In model 3, the interaction effect between the customer integration and the moderator (information sharing) was investigated. The results indicated a significant positive influence on the performance of manufacturing SMEs resulting from the interaction between information sharing and customer integration ($\beta = 0.492$, $t = 1.836$, $p < 0.05$).

Table 4.60: Coefficients for the Models Used to Test for Moderating Effect

Model		Coefficients Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	4.527	.532		8.507	.000
	Customer integration	.525	.127	.708	4.127	.000
2	(Constant)	2.668	.342		7.801	.000
	Customer integration	.539	.218	.539	2.427	.000
	Information Sharing	.274	.008	.281	1.880	.001
3	(Constant)	3.873	.283		13.686	.002
	Customer integration	.654	.070	.663	9.343	.000
	Information Sharing	.356	.075	.357	4.347	.000
	Customer integration * Information sharing	.492	.219	.572	1.836	.000

a. Dependent Variable: Performance of manufacturing SMEs

Thus, the regression models after moderation become:

Model 1: $Y = 4.527 + 0.525X_2$

Model 2: $Y = 2.668 + 0.529X_2 + 0.274Z$

Model 3: $Y = 3.873 + 0.654X_2 + 0.326Z + 0.402X_2Z$

The study hypothesized that information sharing does not moderate the relationship between customer integration and the performance of manufacturing SMEs in Rwanda. The rule of thumb is that moderation is supported if there is a significant interaction effect on the dependent variable between the moderator and the independent variable. Otherwise, the moderation is not supported. The null hypothesis is rejected based on the results in Table 4.61 and Table 4.62. The study concludes that information sharing moderates the relationship between customer integration and the performance of manufacturing SMEs in Rwanda.

The Moderating Effect of Information sharing on the Relationship between Collaboration integration and Performance of Manufacturing SMEs in Rwanda. To test the moderating effect of information sharing on the relationship between collaboration integration and the performance of manufacturing SMEs in Rwanda, the study built the following three models;

Models:

Model 1: $Y = \beta_0 + \beta_3 X_3 + \varepsilon$

Model 2: $Y = \beta_0 + \beta_3 X_3 + \beta_z Z + \varepsilon$

Model 3: $Y = \beta_0 + \beta_3 X_3 + \beta_Z Z + \beta_{3Z} X_3 * Z + \varepsilon$

Upon regressing the variables, as shown in Table 4.61, the Coefficient of Determination (R^2) for the first model was 0.436, meaning that SC collaboration integration, on its own, contributes 43.6% to the performance of manufacturing SMEs in Rwanda. Nevertheless, when information sharing was introduced, the relationship between SC collaboration integration and the performance of manufacturing SME in Rwanda changed significantly. Table 4.62 indicates that the R^2 before the introduction of information sharing was 0.436 (43.6%), which changed significantly to 0.665 (66.5%) upon the introduction of information sharing, implying a 0.229 (22.9%) increase. This meant that SC collaboration, integration, and information sharing could explain up to 66.5% of the performance of manufacturing SMEs in Rwanda.

Upon adding the interaction term X_3*Z, the model improved to an R-squared value of 0.673, representing an increase of 0.011. In a nutshell, the R^2 increased by 22.9 percent when information sharing was considered in addition to collaboration integration, and increased by 1.1 % when the interaction between the moderator and the SC collaboration integration was considered. This differs from Muazu (2023), who argued that the quantity of information negatively affects the relationship between supply chain partners, while information quality positively affects the relationship between suppliers and customers. The results implied that information sharing as a predictor adds value to the model and moderates the relationship between collaboration integration (X_3) and the performance of manufacturing SMEs in Rwanda (Y).

Table 4.61: The Moderating Effect of Information Sharing on the Relationship between SC Collaboration Integration and the Performance of Manufacturing SMEs in Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change
1	.671[a]	.436	.427	.78413	.436
2	.845[b]	.665	.661	.33421	.229
3	.802[c]	.676	.673	.32834	.011

a. Predictors: (Constant), SC Collaboration integration

b. Predictors: (Constant), SC Collaboration integration, Information sharing

c. Predictors: (Constant), SC Collaboration integration, Information sharing, interaction between SC collaboration integration and information sharing

c. Dependent Variable: Performance of Manufacturing SMEs

Table 4.62 presents the ANOVA results for the models examined in testing the moderating effect of information sharing on the relationship between SC collaboration integration and the performance of manufacturing SMEs in Rwanda. The results, as shown in Model 1 (F-statistic = 35.587, $p < 0.05$), Model 2 (F-statistic = 21.884, $p < 0.05$), and Model 3 (F-statistic = 17.951, $p < 0.05$), indicate that all three models remained significant despite the use of different predictors.

Table 4.62: ANOVA for the Models Used to Test for the Moderating Effect

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19.747	1	19.743	35.587	.000[b]
	Residual	159.777	212	.555		
	Total	179.521	212			
2	Regression	23.765	2	11.883	21.884	.000[c]
	Residual	155.755	210	.543		
	Total	179.521	212			
3	Regression	28.432	3	9.478	17.951	.000[d]
	Residual	151.086	209	.528		
	Total	179.521	213			

a. Dependent Variable: Performance of Manufacturing SMEs

Table 4.63 presents the regression coefficients, the t-test statistic, and the significance of the coefficients obtained from the three models used to investigate whether information sharing moderates the relationship between collaboration integration and the performance of manufacturing SMEs in Rwanda. The results indicate that when SC collaboration integration was considered in this study and used in multiple linear regression, the constant term implies that if SC collaboration integration is held constant, manufacturing SMEs in Rwanda exhibit a positive performance of 4.490. The regression coefficient for SC collaboration integration was positive and significant ($p<0.05$), with a t-value of 5.965. This implies that for every unit increase in collaboration integration, the performance of manufacturing SMEs is predicted to increase by 0.547 units.

This echoes the findings of Nguyen et al. (2023), who asserted that competitive advantage can be increased by synchronizing decisions, aligning incentives, and sharing information. This can only be achieved through collaboration among supply chain members, increasing company competitiveness, customer satisfaction, and loyalty (Koolwijk et al., (2022).

When the moderator is included, the results of Model 2 show that SC collaboration integration ($\beta = 0.623$, $p < 0.05$) and moderator information sharing ($\beta = 0.312$, $p < 0.05$) have a significant, favorable influence on the performance of manufacturing SMEs. Model 3 investigated the interaction effect between the SC collaboration integration and the moderator (information sharing). The results indicated a significant, favorable influence on the performance of manufacturing SMEs resulting from the interaction between information sharing and SC collaboration integration ($\beta = 0.345$, $t = 3.165$, $p < 0.05$).

Table 4.63: Coefficients for the Models Used to Test for Moderating Effect

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	4.491	.376		11.949	.000
	Collaboration integration	.547	.092	.661	5.965	.000
2	(Constant)	1.635	.235		7.000	.000
	Collaboration integration	.623	.105	.645	2.543	.000
	Information Sharing	.312	.108	.395	2.888	.000
3	(Constant)	1.093	.153		7.144	.001
	Collaboration integration	.645	.234	.651	2.752	.000
	Information Sharing	.214	.041	.236	5.220	.000
	Collaboration integration * Information sharing	.348	.109	.405	3.165	.000

a. Dependent Variable: Performance of Manufacturing SMEs

Thus, the regression models after moderation become:

Model 1: $Y = 4.490 + 0.547X_3$

Model 2: $Y = 1.645 + 0.623X_3 + 0.312Z$

Model 3: $Y = 1.093 + 0.644X_3 + 0.214Z + 0.345X_3Z$

The study hypothesized that information sharing does not moderate the relationship between collaboration integration and the performance of manufacturing SMEs in Rwanda. The rule of thumb is that moderation is supported if there is a significant interaction effect on the dependent variable between the moderator and the independent variable. Otherwise, the moderation is not supported. From the results in Table 4.64 and Table 4.65, the null hypothesis is rejected, and the study concludes that information sharing moderates the relationship between collaboration integration and the performance of manufacturing SMEs in Rwanda.

The Moderating Effect of Information sharing on the Relationship between Measurement integration and Performance of Manufacturing SMEs in Rwanda

To test the moderating effect of information sharing on the relationship between SC measurement integration and the performance of manufacturing SMEs in Rwanda, the study built the following three models;

Models:

Model 1: $Y = \beta_0 + \beta_4 X_4 + \varepsilon$

Model 2: $Y = \beta_0 + \beta_4 X_4 + \beta_z Z + \varepsilon$

Model 3: $Y = \beta_0 + \beta_4 X_4 + \beta_Z Z + \beta_{4Z} X_4 * Z + \varepsilon$

The model summary result in Table 68 indicates that the unadjusted coefficient of determination for model 1 is 0.409. This implies that the performance measurement integration considered in this study accounts for only 40.9 percent of the total variation in the performance of manufacturing SMEs; the remaining 59.1 percent change in the performance of manufacturing SMEs can be attributed to other factors not considered in this study.

For model 2, the R^2 =0.610, an implication that SC measurement integration and information sharing accounts for about 61.0 percent of the total change in the performance of manufacturing SMEs, and thus, the remaining 39.0 percent of the variation in the performance of manufacturing SMEs can be accounted for by other factors, not of interest in this study.

For Model 3, the R^2 value of 0.750 implies that supply chain integration, information sharing, and the interaction between SC measurement integration and information sharing collectively account for 75.0% of the total variation in the performance of manufacturing SMEs. The remaining 25.0 percent change in the performance of manufacturing SMEs can be attributed to other factors. The R^2 increased by 20.1 percent when information sharing was considered in addition to SC performance measurement integration, and by 14.0 percent when the interaction between the moderator and SC performance measurement integration was taken into account. This echoes the findings of Saleheen and Habib (2023a) who asserted that SC performance measurement through a holistic approach in the manufacturing sector is not comprehensive. They proposed an integrated supply chain model to measure performance and achieve the goal.

Table 4.64: The Moderating Effect of Information Sharing on the Relationship between Measurement Integration and Performance of Manufacturing SMEs in Rwanda

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change
1	.638[a]	.409	.398	.73092	.409
2	.781[b]	.610	.608	.35947	.201
3	.856[c]	.750	.745	.32834	.140

a. Predictors: (Constant), Measurement integration
b. Predictors: (Constant), Supply Chain Integration, Information sharing
c. Predictors: (Constant), Supply Chain Integration, Information sharing, interaction between performance measurement integration and information sharing

d. Dependent Variable: Performance of Manufacturing SMEs

Table 4.63 presents the ANOVA results for the models examined in testing the moderating effect of information sharing on the relationship between measurement integration and the performance of manufacturing SMEs in Rwanda. The results, as shown in Model 1 (F-statistic = 13.406, $p < 0.05$), Model 2 (F-statistic = 9.961, $p < 0.05$), and Model 3 (F-statistic = 9.429, $p < 0.05$), indicate that all three models remained significant despite the use of different predictors.

Table 4.65: ANOVA for the Models Used to Test for the Moderating Effect

ANOVA[a]						
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	7.980	1	7.990	13.406	.000[b]
	Residual	171.531	212	.596		
	Total	179.521	212			
2	Regression	11.654	2	5.827	9.961	.000[c]
	Residual	167.856	210	.585		
	Total	179.520	212			
3	Regression	16.152	3	5.384	9.429	.000[d]
	Residual	163.359	209	.571		
	Total	179.521	213			

a. Dependent Variable: Performance of Manufacturing SMEs

b. Predictors: (Constant), Supply Chain Integration

c. Predictors: (Constant), Supply Chain Integration, Information sharing

d. Predictors: (Constant), Supply Chain Integration, Information sharing, Interaction between Performance Measurement Integration and Information Sharing

Table 4.66 presents the regression coefficients, the t-test statistic, and the significance of the coefficients obtained from the three models used to investigate whether information sharing moderates the relationship between performance measurement integration and the performance of manufacturing SMEs in Rwanda. The result indicates that the constant term was used when performance measurement integration was considered in this study for multiple linear regression. $\beta_0 = 5.597$, implies that if performance measurement integration is held constant, then there is a positive performance of manufacturing SMEs in Rwanda by 5.597. The regression coefficient for measurement integration was positive and significant ($\beta_1 = 0.268$, $p<0.05$), with a t-value of 2.424. This implies that for every unit increase in supply chain integration, the performance of manufacturing SMEs is predicted to increase by 0.268 units. This echoes the findings of Nyile et al. (2022).

When the moderator is included, the results of Model 2 show that measurement integration ($\beta = 0.325$, $p < 0.05$) and moderator information sharing ($\beta = 0.206$, $p < 0.05$) have a significant positive effect on the performance of manufacturing SMEs.

Model 3 investigated the interaction effect between the measurement integration and the moderator (information sharing). The results indicated a significant relationship between the performance of Manufacturing SMEs and the interaction between information sharing and measurement integration ($\beta = 0.976$, $t = 1.914$, $p < 0.05$).

Table 4.66: Coefficients for the Models Used to Test for Moderating Effect

Model		Coefficients Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.597	.464		12.069	.000
	Measurement Integration	.268	.071	.639	2.424	.000
2	(Constant)	2.475	.235		10.532	.000
	Measurement Integration	.325	.206	.359	1.577	.000
	Information Sharing	.206	.087	.247	2.368	.000
3	(Constant)	2.119	.264		8.027	.000
	Measurement Integration	.413	.140	.457	2.950	.000
	Information Sharing	.250	.143	.765	1.748	.001
	Measurement integration* Information sharing	.976	.510	.996	1.914	.000

a. Dependent Variable: Performance of Manufacturing SMEs

Thus, the regression model after moderation becomes:

Model 1: $Y = 5.597 + 0.268X_4$

Model 2: $Y = 2.475 + 0.325X_4 + 0.206Z$

Model 3: $Y = 2.119 + 0.413X_4 + 0.250Z + 0.976X_4Z$

The study hypothesized that information sharing does not moderate the relationship between the integration of performance measurement and the performance of manufacturing SMEs in Rwanda. The rule of thumb is that moderation is supported if there is a significant relationship between the dependent variable and the interaction between the moderator and the independent variable. Otherwise, the moderation is not supported. From the results in Table 4.63 to Table 4.64, the null hypothesis is rejected, and the study concludes that information sharing moderates the relationship between performance measurement integration and the performance of manufacturing SMEs in Rwanda.

The Moderating Effect of Information sharing on the Relationship between Supply chain integration and Performance of Manufacturing SMEs in Rwanda

Moderated Multiple Regression (MMR) analysis was followed to determine the moderating effect of information sharing on the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda. The moderating model tests whether the prediction of a dependent variable Y from an independent variable X differs across levels of a third variable Z. The MMR technique consists of two steps. In the first step, the main effects of the predictor (supply chain integration) and the hypothesized moderator (information sharing) were estimated using regression. The following model was used to assess the moderating effect of information sharing.

$$Y = \beta_0 + \beta_1 X + \beta_2 Z + \varepsilon \qquad (2)$$

The second step consisted of adding the interaction term to the equation (3) as:

$$Y = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 X * Z + \varepsilon \qquad (3)$$

Where

The hypothesis to test for this specific objective was:

H_0: *Information sharing does not moderate the relationship between communication integration, customer integration, collaboration integration, measurement integration, and performance of manufacturing SMEs in Rwanda.*

The moderated multiple linear regression involved three models.

Model 1: estimating the primary influence of the supply chain integration on the performance of Manufacturing SMEs;

Model 2: estimating the primary influence of the supply chain integration and the moderator, and Model 3: estimating the effect of the interaction between the moderator and the supply chain integration.

The model summary result in Table 4.65 indicates that the unadjusted coefficient of determination for model 1 is 0.719. This implies that the supply chain integration considered in this study accounts for only 71.9 percent of the total variation in the performance of Manufacturing SMEs; the remaining 28.1 percent change in the performance of Manufacturing SMEs can be attributed to other factors not considered in this study.

According to the results of model 2, the R2 value is 0.783, indicating that the integration of supply chain and information sharing is responsible for approximately 78.3% of the overall performance change in Manufacturing firms. The remaining 21.7% of the performance variation can be attributed to other factors not investigated in this study. These findings are consistent with the research conducted by Ongeri and Osoro (2021).

For model 3, the R^2 =0.827, and this implies that supply chain integration, information sharing as well, and the interaction between supply chain integration and information sharing account for 82.7 percent of the total variation in the performance of Manufacturing SMEs; the remaining 17.3 percent change in the performance of Manufacturing SMEs can be attributed to other factors. The R^2 increased by 6.4 percent when information sharing was considered in addition to supply chain integration and by 10.8 percent when the interaction between the moderator and supply chain integration was considered.

Table 4.67: Summary Models Used to Test for the Moderating Effect

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R-squared change
1	.848[a]	.719	.692	.49346	.719
2	.885[b]	.783	.763	.71839	.064
3	.909[c]	.827	.818	.65124	.108

a. Predictors: (Constant), supply chain integration

b. Predictors: (Constant), supply chain integration, information sharing

c. Predictors: (Constant), supply chain integration, information sharing, interaction between supply chain integration and information sharing

d. Dependent Variable: Performance of Manufacturing SMEs

Table 4.68 presents the ANOVA results for the models examined in testing the moderating effect of information sharing. The results, as shown in Model 1 (F-statistic = 10.961, $p < 0.05$), Model 2 (F-statistic = 12.770, $p < 0.05$), and Model 3 (F-statistic = 15.92, $p < 0.05$), indicate that all three models remained significant despite the use of different predictors.

Table 4.68: ANOVA for the Models Used to Test for the Moderating Effect

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	23.935	1	5.984	10.961	.001[b]
	Residual	155.585	212	.546		
	Total	179.520	212			
2	Regression	32.953	1	6.591	12.770	.000[c]
	Residual	146.567	212	.516		
	Total	179.520	212			
3	Regression	60.767	1	6.752	15.920	.002[d]
	Residual	118.753	212	.424		
	Total	179.520	213			

a. Dependent Variable: Performance of Manufacturing SMEs

Table 4.69 presents the regression coefficients, the t-test statistic, and the significance of the coefficients obtained from the three models used to investigate whether information sharing moderates the relationship between supply chain integration and the performance of Manufacturing SMEs. The result indicates that when supply chain integration components considered in this study are used together in multiple linear regression, then SC communication integration (β=.532, *p<0.05*), SC customer integration (β=0.316, p<0.05), SC collaboration integration (β=0.415, p<0.05) and performance measurement integration (β=.458, *p<0.05*) have a significant favorable influence on the performance of Manufacturing SMEs. This finding aligns with the results of Li et al. (2023), who discovered that information security and information technology impact supply chain performance. In contrast, Li et al. (2019) suggested that information disclosure does not moderate this relationship.

When the moderator is included, the results of model 2 show that SC communication integration (β=0.529, p<0.05), SC customer integration (β=0.244, p<0.05), SC collaboration integration (β=0.308, p<0.05), performance measurement integration (β=0.450, p<0.05) and the moderator information sharing (β=0.564, p<0.05) have a significant favorable influence on the performance of Manufacturing SMEs.

Model 3 investigated the interaction effect between the supply chain integration and the moderator (information sharing). The result indicated that:

(i) There was a significant positive relationship between the influence on the performance of Manufacturing SMEs from the interaction between information sharing and communication integration (β= 1.101, t = 3.149, p<0.05),

(ii) There was a significant positive influence on the performance of Manufacturing SMEs from the interaction between information sharing and customer integration (β= 1.144, t = 2.816, p<0.05).

(iii) There was a significant favorable influence on the performance of Manufacturing SMEs from the interaction between information sharing and collaboration integration (β= 2.209, t = 5.059, p<0.05) and

(iv) There was a significant positive influence on the performance of Manufacturing SMEs from the interaction between information sharing and performance measurement integration (β= 1.777, t = 3.117, $p<0.05$).

Table 4.69: Coefficients for the Models Used to Test for Moderating Effect

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	3.409	0.641		5.318	0.000
	Communication integration	0.532	0.115	0.668	4.626	0.000
	Customer integration	0.316	0.081	0.442	3.901	0.000
	Collaboration integration	0.415	0.074	0.512	5.608	0.000
	Measurement Integration	0.458	0.098	0.583	4.673	0.000
2	(Constant)	2.493	0.661		3.772	0.000
	Communication integration	0.529	0.114	0.515	4.640	0.000
	Customer integration	0.244	0.038	4.11	6.421	0.000
	Collaboration integration	0.308	0.113	0.487	2.726	0.007
	Measurement Integration	0.450	0.125	0.479	3.600	0.000
	Information Sharing	0.564	0.135	0.273	4.178	0.000
3	(Constant)	31.131	7.278		4.277	0.000
	Communication integration	4.674	1.498	2.427	3.120	0.002
	Customer integration	5.306	1.798	2.388	2.951	0.003
	Collaboration integration	9.168	1.864	5.563	4.918	0.000
	Measurement Integration	7.598	2.536	4.003	2.996	0.003
		8.202	1.723	3.97	4.760	0.000
	Communication integration * Information sharing	1.101	0.35	3.779	3.146	0.002
	Customer integration * Information sharing	1.144	0.406	3.668	2.818	0.005
	Collaboration integration * Information sharing	2.209	0.437	8.896	5.055	0.000
	Measurement Integration * Information sharing	1.777	0.57	6.272	3.118	0.002

a. Dependent Variable: Performance of Manufacturing firm strategy

Thus, the overall regression model after moderation becomes:

Model 1: $Y = 3.409 + 0.532X_1 + 0.316X_2 + 0.415X_3 + 0.458X_4$

Model 2: $Y = 2.493 + 0.529X_1 + 0.244X_2 + 0.308X_3 + 0.450X_4 + 0.564Z$

Model 3:

$$Y = 31.131 + 4.674X_1 + 5.306X_2 + 9.168X_3 + 7.598X_4 + 8.202Z + 1.101X_1Z + 1.144X_2Z + 2.209X_3Z + 1.777X_4Z$$

The study hypothesized that information sharing does not moderate the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda. The interaction effect between the supply chain integration and information sharing measures the moderation effect. The rule of thumb is that moderation is supported if there is a significant interaction effect on the dependent variable between the moderator and the independent variable. Otherwise, the moderation is not supported. From the results in Table 4.65 to Table 4.66, the null hypothesis is rejected, and the study concludes that information sharing has a moderating effect on the relationship between communication integration, customer integration, collaboration integration, measurement integration, and the performance of manufacturing SMEs in Rwanda.

Discussion on the Moderating Effect of Information sharing on the Relationship between Supply chain integration and Performance of Manufacturing SMEs in Rwanda. Three indicators were used to measure information sharing: quality of information, organizational size, and organizational age. Respondents were asked to indicate the number of years their manufacturing SMEs had existed in the manufacturing industry. The study's findings indicated that manufacturing SMEs had varied experiences in the industry. The respondents were also asked to indicate the number of employees in the organizations. The number of employees was used to measure organizational size. The organizational size is associated with the resources in possession and the cost of running the firm. The organizational size decides the systems used to keep its operations running. Manufacturing SMEs differ significantly in financial, technical, and operational capacities, which depend on their sizes, structure, and experience in the industry.

The age of an organization affects the implementation of supply chain integration in manufacturing firms. The efficient and adequate information supply in older SMEs can be attributed to their firm age. The younger a firm is, the fewer relationships it has established. Older SMEs are more experienced in selecting and applying information. According to a study by Rwagombwa (2019), experience gained from being in the manufacturing strategy field for a longer period places older SMEs at an operational advantage. Older SMEs are also safer placed to establish reliable networks and business associates and have the faith of financial institutions. They have also established a good reputation in their line of business, which is a crucial factor in driving operational success.

Conversely, big and old manufacturing SMEs have the fewest barriers and strengths to entry into a production zone among the actors in complex emergencies. Large and experienced organizations have an advantage over their smaller and younger counterparts in implementing supply chain integration. This confirms the findings by Ongeri and Osoro, (2021) that extensive and experienced organizations can respond quickly. This is because most large relief manufacturing SMEs have established procedures in place for emergency responses. They also have access to sufficient labor, material, and monetary resources for emergency response. Additionally, they can easily acquire extra resources when needed. These factors enable large and experienced manufacturing SMEs to respond rapidly to complex emergencies.

Again, experienced manufacturing SMEs have the advantage of maneuverability. This enables manufacturing SMEs to access many complicated or remote locations. Some well-endowed manufacturing SMEs have established air or sea transport capabilities, which enable them to access any location. Rogerson and Ritchie (2020) asserted that small local manufacturing SMEs should be credited for their significant contribution to relief activities. Although they may fall behind their international counterparts in terms of human and financial resources, they compensate for this with their superior domestic knowledge and experience working with distressed populations. Rwagombwa (2019) supported the findings of this study and affirmed that age and size have a positive relationship with an organization's performance; therefore, they should be accorded due attention.

Quality of information entails grouping people and responsibilities into different divisions to enhance the synchronization of communication, decisions, and actions within an organization. The chain of command, reporting structures, span of control, power, authority, and responsibility are specified and assigned to persons according to their organizational status. Subsequently, the organization's structure governs the rate of decision-making and the flow of information in and outside an organization. Making decisions gets slower when many people are expected to contribute, leading to slackened manufacturing services. The quality of information adopted by manufacturing SMEs influences the implementation of supply chain integration in the context of emergency and relief assistance. Centralization, formalization, bureaucracy, and complex structures influence how manufacturing SMEs respond to production. Centralization focuses on the location of decision-making authority in production.

Rwagombwa (2019) notes that if a bureaucrat has limited discretion in decision-making, they would need approval from a higher-ranking official. However, if otherwise, the decision can be made without consent. Formalization refers to an organization's documented rules and regulations, typically recorded on paper. Formalization ensures orderliness and a record of employee conduct. Red tape is burdensome administrative rules and procedures that negatively impact organizational performance. Complexity refers to the number of sub-units, levels, and specializations within an organization. Amsterdam (2020) concluded that the absence or weakness of quality of information has adverse effects on the organization's performance, despite the supply chain design adopted. The organizational structure in production management should be simpler and more centralized. Production response should be prompt to save life and property.

Valero (2015) asserted that an organization's structure is crucial to a swift and on-time production response. This implies that weaknesses in organizational structure inhibit the practical, well-organized, and timely emergency response. Bag, Gupta, and Luo (2020) assert that a rigid administrative authority and bureaucratic control method in production containment usually result in ineffective emergency response. In brief, organizational age, organizational size, and the quality of information all influence supply chain integration and the performance of manufacturing SMEs in Rwanda.

4.9 Summary of Hypothesis Testing

Based on the results of hypothesis testing, a summary of hypothesis testing was conducted. The summary is presented in Table 4.68 below.

Table 4.70: Summary of Hypothesis Testing

S/n	**Objective**	**Null Hypothesis**	**Rule**	**P-Value**	**Comment**
1	To examine the relationship between communication integration on the performance of manufacturing SMEs in Rwanda.	There is no significant relationship between Communication integration and the performance of manufacturing SMEs in Rwanda.	Reject the null hypothesis if P value is less than 0.05	0.00	Reject Null Hypothesis
2	To establish the relationship between customer integration and the performance of manufacturing SMEs in Rwanda.	There is no significant relationship between Customer integration and the performance of manufacturing SMEs in Rwanda.	Reject the null hypothesis if P value is less than 0.05	0.00	Reject Null Hypothesis
3	To determine the relationship between	There is no significant	Reject	0.000	Reject Null

S/n	Objective	Null Hypothesis	Rule	P-Value	Comment
	collaboration integration on the performance of manufacturing SMEs in Rwanda.	relationship between Collaboration integration and the performance of manufacturing SMEs in Rwanda.	the null hypothesis if P value is less than 0.05		Hypothesis
4	To establish the relationship between performance measurement integration and the performance of manufacturing SMEs in Rwanda.	There is no significant relationship between Performance Measurement integration and the performance of manufacturing SMEs in Rwanda.	Reject the null hypothesis if P value is less than 0.05	0.000	Reject Null Hypothesis
5	To determine the moderating effect of information sharing on the relationship between communication integration, customer integration, collaboration integration, and measurement integration, and the performance of manufacturing SMEs in Rwanda.	Information sharing does not moderate the relationship between communication, customer, collaboration, and measurement integration, as well as the performance of manufacturing SMEs in Rwanda.	Reject the null hypothesis if P value is less than 0.05	0.000	Reject Null Hypothesis

A summary of hypothesis testing aimed to guide the derivation of the final model (revised conceptual framework), where only the significant variables were included in the model. After conducting hypothesis testing, the study developed a revised conceptual framework. The new conceptual framework included all the significant variables: SC communication integration, SC customer integration, SC collaboration integration, performance measurement integration, and information sharing. While the performance indicators improved in terms of quality, market share, customer responsiveness, and cost reduction, his improvement is hypothesized to be significantly influenced by effective supply chain practices.

The difference between the conceptual framework on page 21 (Figure 1) and the optimal conceptual framework on page 186 lies in their purpose and refinement. Figure 1 presents the initial framework derived from literature, illustrating the hypothesized relationships between supply chain integration dimensions and SME performance. In contrast, the optimal model on page 164 reflects the empirically validated framework, refined through data analysis and statistical testing, showing only the significant relationships that emerged from the study. The framework is presented in Figure 15, Revised conceptual framework.

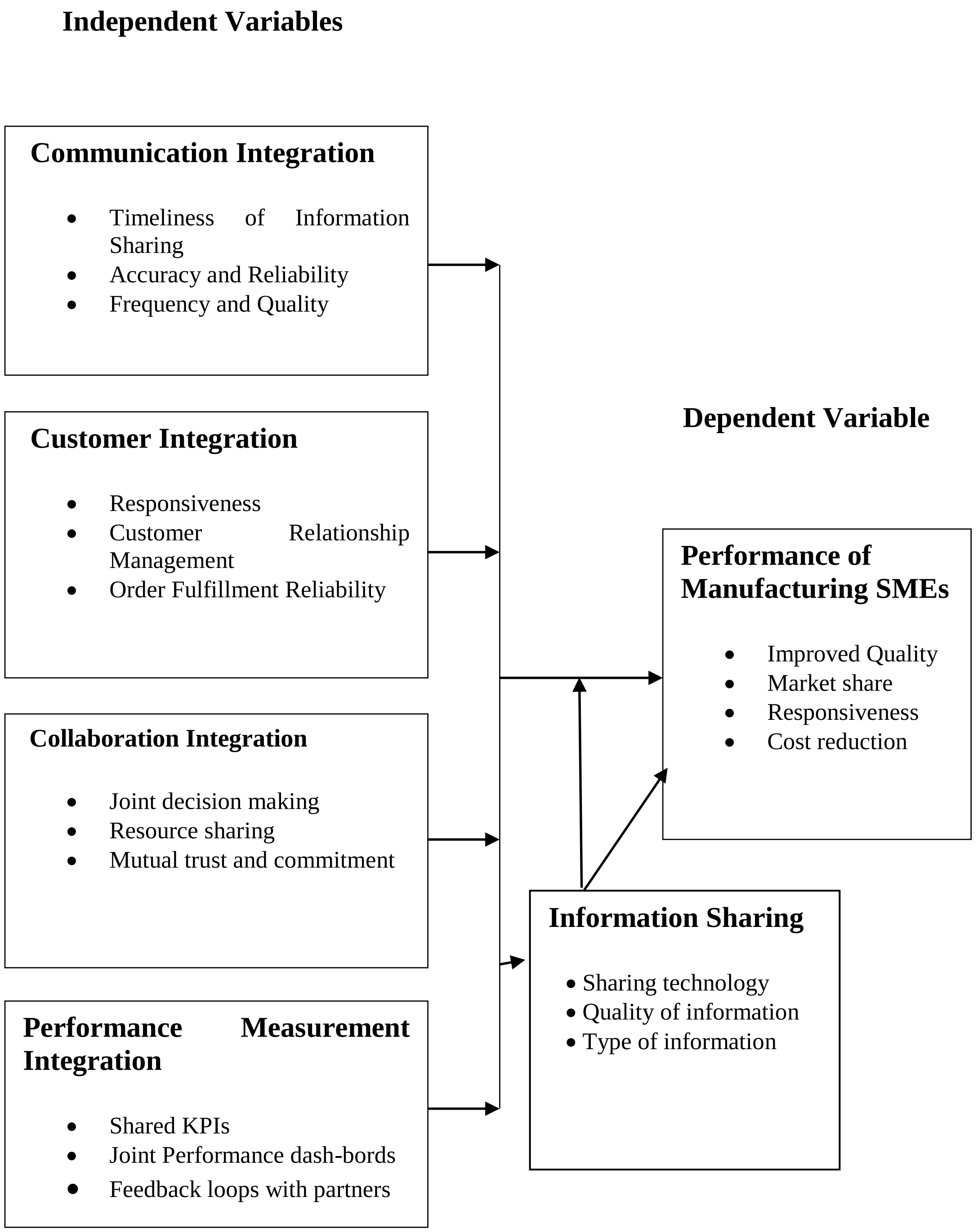

Figure 4.14. Revised Conceptual Framework

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the study's significant findings. It also draws conclusions and recommendations for practice, providing suggestions for areas of further research based on the results of this study.

5.2 Summary

The general objective of this study was to determine the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda. In particular, the study sought to examine the relationship between of SC communication integration and the performance of manufacturing SMEs in Rwanda, establish the relationship between SC customer integration and the performance of manufacturing SMEs in Rwanda, determine the relationship between SC collaboration integration and the performance of manufacturing SMEs in Rwanda; to establish the relationship between performance measurement integration and performance of manufacturing SMEs in Rwanda and to determine the moderating effect of information sharing on the relationship between SC communication integration, SC customer integration, SC collaboration integration, performance measurement integration and performance of manufacturing SMEs in Rwanda.

The study findings indicated that SC communication integration, SC customer integration, SC collaboration integration, and performance measurement integration are jointly positively associated with the performance of manufacturing SMEs. Furthermore, the four predictors account for 71.9% of the variation in the performance of manufacturing SMEs. This implies that the remaining 28.1% of the variation in the performance of manufacturing SMEs can be attributed to other factors not examined in this study.

Secondly, information sharing was found to moderate the relationship between SC communication integration, SC customer integration, SC collaboration integration, performance measurement integration, and the performance of manufacturing SMEs in Rwanda. Supply chain integration and information sharing accounted for about 78.3% of the total change in the performance of manufacturing SMES. The summary of findings focuses on the specific objectives that guided the study.

5.2.1 Relationship between Communication Integration and the Performance of Manufacturing SMEs

The first objective of this study was to investigate the relationship between SC communication integration and the performance of manufacturing SMEs in Rwanda. This objective was measured using timeliness of information sharing, accuracy and reliability, and frequency and quality as indicators of communication integration. The study's findings revealed that manufacturing SMEs in Rwanda have supply chains designed to be responsive to the customers' needs. The manufacturing process through supply chains is designed to evaluate, consider, and address customers' needs quickly while providing a view of the movement of materials along the supply chain. Furthermore, to enhance the elements of communication and reactivity, manufacturing SMEs have established close relationships and partnerships with suppliers to improve their responsiveness. The manufacturing process, facilitated by supply chain communication, is also designed to be flexible, enabling it to meet customers' needs in transportation, assembly, and dispatch.

However, the ability of manufacturing supply chains to respond quickly to emergencies and production is a challenging task, influenced by various challenges, such as a lack of information, insufficient resources, and financial constraints. This means that, despite the supply chains being designed to be responsive, there is still an element of sluggishness in most manufacturing processes throughout Rwanda's supply chains, resulting from the challenges faced. This indicates a lack of preparedness among manufacturing SMEs to respond to emergencies and production disruptions. Preparedness encompasses all the activities undertaken by manufacturing SMEs before a production strike to enhance their readiness to respond effectively to emergencies. Preparedness actions are crucial as they shorten the time required for the subsequent response phase and potentially speed recovery. Supply chain communication integration reduces the time it takes to respond to emergencies, saving lives and improving resource utilization within organizations.

Findings from the interviews on SC communication integration revealed the various productions and situations that triggered the need for supply chains to be responsive, disrupting communities in Rwanda. The findings indicated that Rwanda had suffered a range of productions broadly assorted based on origin, as either artificial (anthropogenic) or natural. Rwanda's commonly identified natural disasters include disease outbreaks, plagues/invasions, floods, landslides/mudslides, droughts, and famine. Other natural productions (geophysical) that can be severely destructive, though not very common in Rwanda, include earthquakes and volcanic eruptions. Joint artificial productions identified included structural/building collapse, chemical leaks, oil spill overs, terrorist activities, human conflicts, traffic accidents, and politically instigated violence between tribes/groups. The study found that the diversity, prevalence, and extent of production have increased significantly recently, resulting in a rise in customer complaints.

Multiple regression analysis revealed a positive, significant linear relationship between SC communication integration and the performance of manufacturing SMEs. The null hypothesis that SC communication integration does not significantly influence the performance of manufacturing SMEs in Rwanda was thus rejected, revealing that SC communication integration positively contributes to the performance of manufacturing SMEs in Rwanda.

5.2.2 Relationship between Customer Integration and the Performance of Manufacturing SMEs

The second objective was to examine the relationship between customer integration and the performance of manufacturing SMEs in Rwanda. This objective was measured using responsiveness, customer relationship management, and order fulfillment reliability in the opinion statements. The study's findings revealed that SC customer integration enables manufacturing SMEs to become resilient by achieving the elements of flexibility, alignment, and cost reduction. Adopting supply chain customer integration enables manufacturing SMEs to survive, adapt, and sustain themselves in the face of turbulence. It enables smooth manufacturing processes and recovers effectively from inevitable risky events.

Narratives from supply chain managers revealed the various challenges faced by the manufacturing process, such as insufficient resources, poor coordination, and demand uncertainty. From examining the views of supply chain managers, insufficient resources emerged as a significant constraint of the manufacturing process through supply chains in Rwanda. Manufacturing SMEs train to access sufficient, necessary, and reliable financing for their operations. Manufacturing SMEs often have limited resource mobilization skills and tend to focus less on raising funds locally, instead opting to wait for global donors to approach them. Donors are highly regarded, creating a need to constantly adapt to match donor expectations. This makes manufacturing SMEs susceptible to donor demands, making it hard to measure their effectiveness.

Demand uncertainty was also identified as a challenge in implementing integration design in manufacturing SMEs in Rwanda. The uncertainty and unpredictability of happenings, especially in sudden-onset productions regarding timing, location, nature, and magnitude, make it hard to predict supply and demand. The disruption risk becomes inevitable, making it appropriate to prepare for production containment. Predetermination of the demand graph is fundamental in making supply chain decisions.

A correlation analysis was conducted for the construct of customer integration to determine its correlation with the performance of manufacturing SMEs, revealing a positive linear relationship between SC customer integration and the performance of these SMEs. The decision to reject the null hypothesis that SC customer integration does not significantly influence the performance of manufacturing SMEs in Rwanda was thus made, concluding that SC customer integration does significantly influence the performance of manufacturing SMEs.

5.2.3 Relationship between Collaboration Integration and the Performance of Manufacturing SMEs

The third objective sought to determine the influence of SC collaboration integration on the performance of manufacturing SMEs in Rwanda. The study findings are based on indicators such as joint decision-making, resource sharing, mutual trust, and commitment. The study found that stakeholder trust is a significant factor influencing supply chain (SC) performance. Specifically, the lack of trust among shareholders hinders the ability of small and medium-sized manufacturing enterprises (SMEs) to adapt to market changes and ensure environmental sustainability. This, in turn, leads to costly conflicts and, in some cases, the termination of partnerships between SC partners.

The study revealed that supply chain collaboration enhances stakeholder responsiveness and satisfaction, leading to improved trust levels. The lack of trust, as evidenced by the findings, is often rooted in the provision of inaccurate and untimely information between SC partners. Additionally, the lack of integrated systems, as well as the absence of teamwork and trust among stakeholders, emerged as significant challenges. The study findings showed that the negative impact of trust deficits on information asymmetry, delays, and misattributed supply failures. Ultimately, the study revealed that performance contract practices ("Imihigo”) promote mutual trust that emerges from such collaborative efforts and benefits all individuals involved in supply chain operations.

The findings showed that despite the significance of traditional values in promoting collaboration and partnership within society, empirical studies examining their role in this regard remain scarce. In Rwanda, cultural norms intersect with contemporary governance structures and development strategies, providing avenues for effective collaboration and trust-building. The values of "Ubumuntu" (humanity) and "Umuganda" (community work) promote empathy, solidarity, and collective responsibility, thereby contributing to the accumulation of social capital and facilitating the sharing of information and the building of trust. These findings highlight the potential of traditional values in shaping collaboration and partnership in contemporary contexts.

Multiple regression analyses revealed a positive, significant linear relationship between SC collaboration integration and the performance of manufacturing SMEs. The null hypothesis that SC collaboration integration does not significantly influence the performance of manufacturing SMEs in Rwanda was thus rejected, revealing that SC collaboration integration contributes positively to the performance of manufacturing SMEs in Rwanda.

5.2.4 Influence of Performance Measurement Integration on the Performance of Manufacturing SMEs

The fourth objective aimed to investigate the impact of performance measurement integration on the performance of manufacturing SMEs in Rwanda. This objective was measured using shared Key Performance Indicators (KPIs), joint performance dashboards, and feedback loops with partners as indicators. The findings revealed that manufacturing SMEs in Rwanda, which utilized shared Key Performance Indicators (KPIs), joint performance dashboards, and feedback loops with partners, had a positive and significant impact on their performance. This indicates that aligning and harmonizing performance metrics supported by interactive dashboards and continuous partner feedback, enhances efficiency, responsiveness, and overall firm outcomes.

From the perspectives of supply chain managers of manufacturing SMEs in Rwanda, the commonly identified actors included logistics providers, the military and police, government agencies, media, and public opinion. Respondents emphasized the critical role and interconnectedness of these actors in facilitating the flow of goods, services, and information across the supply chain. Notably, logistics providers were unanimously identified as imperative, with responsibilities spanning goods assembly, transportation, warehousing, and distribution. In addition to these operational roles, logistics providers actively engage in performance measurement integration through shared KPIs, the use of joint performance dashboards, and the establishment of feedback loops with partners. These practices enhance transparency, accountability, and collaboration, thereby strengthening the efficiency, responsiveness, and overall performance of manufacturing SMEs in Rwanda.

The descriptive analysis revealed that manufacturing SMEs embraced various forms of performance measurement integration, including Key Performance Indicators (KPIs), performance Dashboards, and feedback loops. Establishing a set of KPIs aligned with organizational goals and objectives enables the consistent measurement and monitoring of performance across various departments and functions within the manufacturing firm. Additionally, the qualitative analysis highlighted the complexity of relief activities involving multiple actors throughout the manufacturing process and supply chain, emphasizing the need for coordination and integration. Multiple regression analysis revealed a significantly positive linear relationship between measurement integration and the performance of manufacturing firms.

The null hypothesis that performance measurement integration does not significantly influence the performance of manufacturing SMEs in Rwanda was thus rejected, revealing that measurement integration contributes positively towards the performance of manufacturing SMEs in Rwanda. Overall, the study highlights the importance of integrating performance measurement in enhancing performance and emphasizes the need for improved coordination among manufacturing actors to optimize production response and efficiency.

5.2.5 Moderating Effect of Information Sharing on the Relationship between Supply Chain Integration and Performance of Manufacturing SMEs

The fifth objective sought to determine the moderating effect of information sharing on the relationship between communication integration, customer integration, collaboration integration, measurement integration, and the performance of manufacturing SMEs in Rwanda. The findings revealed that information sharing has a moderating effect on the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda. Supply chain integration and information sharing accounted for about 78.3% of the total change in the performance of manufacturing SMEs. Supply chain integration, information sharing, as well as the interaction between supply chain integration and information sharing accounted for 82.7% of the total variation in the performance of manufacturing SMEs.

The R^2 increased by 6.4 percent when information sharing was considered in addition to supply chain integration and by 10.8 percent when the interaction between the moderator and supply chain integration was considered. The interaction effect between the supply chain integration and information sharing measures the moderation effect. The rule of thumb is that moderation is supported if there is a significant interaction effect on the dependent variable between the moderator and the independent variable. Otherwise, moderation is not supported. Thus, the null hypothesis was rejected, and the study concluded that information sharing moderates the relationship between communication integration, customer integration, collaboration integration, and measurement integration and the performance of manufacturing SMEs in Rwanda.

The quality of information adopted by manufacturing SMEs influences the implementation of supply chain integration in the context of emergence and disruption. Centralization, formalization, red tape, and complex structures significantly impact how manufacturing SMEs respond to production quickly. The organizational structure in production management should be simpler and more centralized. Production response should be swift to avoid loss of funds and resources. The structure of the organization plays a crucial role in quick production response. This implies that a weak organizational structure hinders a proficient, well-organized, and convenient response to emergencies.

It is thus essential to establish a flexible organizational structure for manufacturing SMEs to achieve coordination among bureaucrats during manufacturing production crises. A rigid, bureaucratic command-and-control approach to emergency management generally leads to an ineffective emergency response. Concisely, organizational age, organizational size, and quality of information influence the supply chain integration and the performance of manufacturing SMEs in Rwanda.

5.3 Conclusion

The study concludes that the integration of SC communication, SC customer integration, SC collaboration integration, and performance measurement integration is jointly positively associated with the performance of manufacturing SMEs. Furthermore, the four predictors explain 71.9% of the variation in the performance of manufacturing SMEs, implying that the remaining 28.1% of the variation in their performance could be attributed to other factors not considered in this study.

5.3.1 Communication Integration

Based on the study findings, it can be concluded that the integration of SC communication positively influences the performance of manufacturing SMEs in Rwanda. The study revealed a strong relationship between SC communication integration and the performance of manufacturing SMEs. The study's findings revealed that manufacturing SMEs in Rwanda have supply chains designed to be responsive to the customers' needs. The manufacturing process through supply chains is designed to evaluate, consider, and address customers' needs quickly while providing a view of the flow of materials along the supply chain.

However, the ability of the manufacturing process through supply chains to respond quickly to emergencies and production is a challenging task, influenced by various challenges facing the manufacturing process through supply chains. This means that, despite the supply chains being designed to be responsive to emergencies, there is still an element of sluggishness in most manufacturing processes throughout Rwanda's supply chains, resulting from the challenges faced. This indicates a lack of preparedness among manufacturing SMEs to respond to emergencies and production disruptions. SC Communication integration reduces the time needed to respond to disruptions, address customers' needs, and enhance operational performance.

From the findings, there is a need for supply chains to be responsive, as triggered by the various production and situational disruptions affecting communities at large in Rwanda. The findings indicated that Rwanda has experienced various forms of production, categorized based on their cause/origin as either artificial (anthropogenic) or natural. Frequently experienced natural disasters in Rwanda included disease outbreaks, plagues/invasions, floods, landslides/mudslides, droughts, and famine. Other natural productions (geophysical) that can be utterly devastating but occur less frequently in Rwanda include earthquakes and volcanic eruptions. Joint artificial productions identified included structural/building collapse, chemical leaks, oil spills, artificial fires, terrorist activities, human conflicts, traffic accidents, and politically instigated violence between tribes/groups.

The diversity, frequency of occurrence, and magnitude of the productions have been increasing recently, thereby expanding the number of people affected. Manufacturing SMEs have adopted various strategies to enhance communication integration, including modularization, postponement, shortened lead times, and prior transport and capacity planning. The driving forces that motivate manufacturing SMEs to design responsive supply chains have emerged due to the need to mitigate stakeholder pressure and reduce production and disruption risks.

5.3.2 Customer Integration

It can be concluded that SC customer integration has a positive, significant, and linear influence on the performance of manufacturing SMEs in Rwanda. The findings revealed the various challenges faced by manufacturing SMEs in implementing supply chain integration, including insufficient resources, demand uncertainty, and poor coordination among manufacturing actors. For manufacturing processes within supply chains to overcome these challenges, local resource mobilization enables the raising of funds from local businesses, individuals, the government, and locally generated income. For this to be realized, manufacturing SMEs need strong Leadership, systems that shun fraud, apparent plans, and internal credibility arising from the proper design of their supply chains.

Proper coordination of manufacturing activities and the ability to forecast demand play essential roles in the employment of supply chain integration by manufacturing SMEs. In addition, the increase in the number and complexity of productions intensifies the need for the manufacturing department to include local emergency capacity in its pre-production plan and reinforce this capacity as part of resilient development plans.

The findings of this study indicate that local capacity is one of the main fields in need of improvement and on which to build in the country. To build on the resilience of supply chains, manufacturing SMEs should strive to make local capacity building an essential component in emergency response, where partnerships bring together knowledge and manufacturing experience in a collaborative, risk-sharing relationship that involves the affected populations to avert, alleviate, and prepare for production.

Manufacturing SMEs utilize business continuity frameworks to predict threats and develop organized containment strategies to safeguard key competencies from the destructive effects of prolonged shortages. Business continuity is an administrative method that identifies hazards and shortcomings that may impact the consistency of organizational systems and procedures. The business continuity framework enables the organization to develop flexibility and the capacity to respond effectively to crises. Organizations can react swiftly and efficiently to safeguard processes by creating time for business impact analysis, thereby decreasing damage and expenditure. Sourcing officers should evaluate their weaknesses, establish the implications, and come up with strategies for operating under pressure

5.3.3 Collaboration Integration

Equally, it can be concluded that SC collaboration integration has a positive influence on the performance of manufacturing SMEs. Waste management is a continuous process in the manufacturing supply chain, involving the identification and elimination of non-value-adding activities. Minimization of waste enhances resource utilization in organizations. Most organizations have managed to eliminate the non-value-adding operations in their supply chains, but some manufacturing SMEs still have not. One of the primary objectives of the manufacturing process through supply chains is to reduce the use of rare resources, as this aligns with the aim of maximizing the interests of as many stakeholders as possible.

Forms of waste identified in the manufacturing process through this study's supply chains included corruption and the diversion of funds. High rates of diversion of funds decrease the range of support for those who need it while creating interest for unknown groups of people who were never meant to be the beneficiaries. This affects the value, nature, and necessity of the assistance. Concisely, productions and pandemics provide a smokescreen for dubious transactions that benefit individuals with little or no scrutiny. Mechanisms of addressing supply chain wastes in production containment included eliminating import and tax charges.

In addition, punishments were imposed on individuals who abused services, and annulments were made immediately, accompanied by a binding clarification. Checks and balances also emerged to control theft and the exploitation of goods intended for vulnerable people for private gain. Other internal control mechanisms include audits, which help boost effective resource utilization. To control firms' fraud, performance measurement, monitoring, and evaluation significantly reduced fraud and mismanagement.

5.3.4 Performance Measurement Integration

Another key finding of the study is that the integration of performance measurement has a significant impact on the performance of manufacturing SMEs in Rwanda. The findings of this study indicate that manufacturing SMEs have effective communication among all the supply chain partners. Sharing information enables manufacturing SMEs to make more informed choices and decisions during disruptions or production difficulties. Additionally, when stakeholders have access to quality information, it leads to better coordination and informed decisions, ultimately resulting in improved services for beneficiaries. Furthermore, recent developments in information technology and communication infrastructure have enhanced organization and cooperation among supply chain partners.

Concisely, the findings of this study indicate that a manufacturing SME is not a one-person operation, and all parties involved are potential influencers of its operations. The participation of many diverse actors contributed to the complexity of relief operations, thereby calling for the integration of measurement and proper coordination of manufacturing activities. On the contrary, this study's findings indicated poor coordination and inadequate information sharing among manufacturing actors during inter-agency production responses, thereby negatively influencing collective decision-making and actions. The need for coordination in crisis containment is unchallenged, as a lack of coordination has led to inevitable failures, resulting in crisis intensification and potentially a higher number of victims. Failure of manufacturing SMEs to cooperate can lead to asymmetric information and business failure.

5.3.5 Moderating Effect of Information Sharing

The findings revealed that information sharing moderates the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda. The study concluded that supply chain integration is positively associated with the performance of manufacturing SMEs in Rwanda. Organizational structure is an essential aspect in achieving a swift production response. A frail structure hinders effective, efficient, and timely production responses. It is, therefore, essential to ensure that the organizational structure in manufacturing SMEs is flexible to facilitate easy coordination among bureaucrats in the event of an emergency.

The age and size of manufacturing SMEs were also crucial in establishing networks, mobilizing resources, and maneuverability, giving organizations an operational advantage in responding quickly to disruptions. This enables manufacturing SMEs to reach areas and populations that are previously difficult to access. Concisely, most manufacturing SMEs have partially implemented integration design in their supply chains, knowingly or unknowingly. Despite the implementation of supply chain integration, manufacturing SMEs continue to experience elements of poor information sharing and coordination, sluggish responses, supply chain wastage, and disruptions, all of which hinder the efficient and effective handling of customer needs.

5.4 Recommendations

The study sought to examine the influence of supply chain integration on the performance of manufacturing SMEs in Rwanda and make recommendations to scholars, researchers, the manufacturing industry, donors, and policymakers. The study recommendations align with the study's objectives, findings, and conclusion. To strengthen integration and enhance collaboration across the supply chain, including suppliers, distributors, and customers, manufacturing SMEs need to adopt shared Key Performance Indicators (KPIs). Manufacturing SMEs that cannot afford sophisticated technology should consider adopting mobile applications for tracking, online payments, and communication with customers and suppliers. SMEs should also adopt affordable digital platforms, such as WhatsApp Business and Google Workspace. These platforms are cost-effective tools for sharing information, enhancing visibility, and improving responsiveness.

For policy makers and industry associations to provide staff training on SCM, integration practices, and performance measurement practices aligned to SMEs. The government, through its regulatory bodies, is to develop policies that encourage partnerships, cluster development, and information sharing security measures to empower competitiveness. The government and financial institutions should support financing schemes and infrastructure that help manufacturing SMEs' integration strategies to be effective.

5.5 Contribution of the Study

From a research perspective, the study provides insights into the benefits of collaboration among small and medium-sized enterprises (SMEs) in the manufacturing sector. It highlights the importance of firms' sharing of resources, knowledge, and expertise to improve their overall performance. This research can serve as a basis for further studies on supply chain integration among SMEs in other industries and regions. Specifically, for manufacturing SMEs to connect effectively and efficiently, visibility is required, which upgrades collaborative efforts between supply chain partners and other stakeholders.

The study findings extend the theoretical implications even further, revealing that some firms, as highlighted by the RBV and RV theories, are highly focused on their supply chain processes to achieve a competitive advantage. Thus, based on these theories, organizations can set targets and monitor progress, using “Imihigo" (performance contracts). This can help align the efforts of different partners towards a common goal. Which in turn improves integration and stakeholder trust. This approach can serve as a valuable lesson for other developing countries seeking to improve their supply chain performance and strengthen stakeholder trust.

In terms of practice, the study's findings can help SMEs in the manufacturing sector in Rwanda adopt collaboration strategies that enhance their performance. The study emphasizes the significance of trust, effective communication, and mutual benefits in fostering successful collaborations. SMEs can utilize these insights to form partnerships and collaborations with other firms in their industry, thereby enhancing their competitiveness and increasing their chances of success. Ultimately, from a societal perspective, the study demonstrates how supply chain integration contributes to a country's economic development. By working together, SMEs can create more job opportunities, increase productivity, and contribute to the overall growth of the manufacturing sector in Rwanda. This can lead to increased income and a better standard of living for people in the country

5.6 Areas for Further Research

The study focused on four key components of supply chain integration: communication integration, customer integration, collaboration integration, and performance measurement integration. The findings that these components could not account for up to 28.1% of the variations in the performance of manufacturing SMEs call for future research to investigate other possible supply chain integration components. Furthermore, future studies may consider other moderating variables apart from information sharing.

Similarly, the data was collected from single informant representatives of each participating manufacturing SME, which may be biased. This study recommends that similar research be conducted with multiple informant groups, such as manufacturing production, distribution logistics, and operations managers, as well as finance managers, among others, to enhance the data. This approach can help generate a variety of outcomes by fostering discussions among respondents with diverse skills, experiences, and motivations. Future studies could also conduct a comparative study using a different research methodology and models to determine whether the results would be somewhat different.

This study focused on the downstream part of the entire manufacturing process, relatively neglecting the upstream chain. Future studies may focus on fundraising and donation management, as the manufacturing process through the supply chain is a complex system involving different components from upstream to downstream. The entire chain is an "organic" system that requires seamless integration. Studies on other parts of the holistic manufacturing process, including the supply chain, could be a direction for future research.

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APPENDICES

Appendix I: Letter of Introduction

Alexis Uwamahoro

Jomo Kenyatta University of Agriculture and Technology,

Department of Procurement and logistics

P.O BOX 62000, NAIROBI.

Dear Sir/Madam,

RE: Research Data on supply chain integration and performance of manufacturing SMEs in Rwanda

Dear Respondent,

You have been selected to participate in the ongoing study, which is about 'Supply Chain Integration and Performance of Manufacturing SMEs in Rwanda. This study is based on the themes of SC communication, SC customer, SC collaboration, and performance measurement integration, which likely affect the Performance of Manufacturing SMEs in Rwanda. Please feel free to respond to all questions. I assure you that all data collected will be treated with utmost confidentiality and used solely for the research. You, therefore, do not need to indicate your name. Please take a few minutes to respond to the items by circling and ticking the number that best represents your thoughts and feelings about your organization.

Thanks.

Yours Sincerely.

Alexis Uwamahoro

PhD Student

Appendix II: Questionnaire

SECTION A: SUPPLY CHAIN COMMUNICATION INTEGRATION

Please indicate your level of agreement with the following statements on SC communication integration and performance of manufacturing SMEs. Please kindly tick (√) in the appropriate space that represents your opinion. Use the scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Our company shares relevant supply chain information with partners in a timely manner					
Delays in information sharing within our supply chain are minimal					
Critical updates are communicated promptly to all relevant stakeholders					
The information shared with our supply chain partners is accurate					
Information received from partners is reliable and trustworthy					
In our organization, errors in shared information are rare in the supply chain					
Communication with supply chain partners occurs regularly and consistently					
The quality of communication (clarity, completeness) with partners is high					
Our supply chain partners actively respond to queries and feedback in a timely manner					

How else do you think SC communication integration affects the performance of manufacturing SMEs in Rwanda?

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SECTION B: SUPPLY CHAIN CUSTOMER INTEGRATION

Please indicate your level of agreement with the following statements on SC Customer integration and performance of manufacturing SMEs. Please kindly tick (√) in the appropriate space that represents your opinion. Use the scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

Statements	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Our organisation promptly responds to customer inquiries and requests					
Customer feedback is addressed quickly and effectively					
Our supply chain adapts quickly to changes in customer demands					
Our organization maintains strong, long-term relationships with our key customers.					

Our organisation regularly engages with customers to understand their needs					
Customer information is systematically managed to support supply chain decisions					
Orders are fulfilled accurately according to customer specifications					
Deliveries are made on time, as promised to customers					
Our organisation consistently meets customer expectations for product quality and service					

How else do you think SC customer integration affects the performance of manufacturing SMEs in Rwanda?

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SECTION C: SUPPLY CHAIN COLLABORATION INTEGRATION

Please indicate your level of agreement with the following SC Collaboration integration. Please kindly tick (√) in the appropriate space that represents your opinion. Use the scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5).

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Our company involves supply chain partners in important decision-making processes.					
Key supply chain decisions are made collaboratively with partners					
Partners' input is valued and considered in strategic supply chain planning					
Our company shares relevant resources (information, technology, or expertise) with partners to improve supply chain performance					
Our organization has established collaborative relationships with its partners					
Partners are willing to share their resources with us to enhance joint outcomes					
Resource sharing between our company and partners is frequent and effective					
There is a high level of trust between our company and supply chain partners					

Partners are committed to long-term collaboration and shared goals					
Our company and partners demonstrate reliability and integrity in all interactions					

How else do you think SC Collaboration integration affect performance of manufacturing SMEs in Rwanda?

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SECTION D: PERFORMANCE MEASUREMENT INTEGRATION

Please indicate your level of agreement with the following statements on performance measurement integration and performance of manufacturing SMEs. Please kindly tick (√) in the appropriate space that represents your opinion. Use the scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5)

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Our company and supply chain partners agree on shared key performance indicators (KPIs)					
The KPIs used are relevant for evaluating the performance of all supply chain partners					
Performance metrics are consistently monitored and					

aligned across the supply chain					
Our company uses joint dashboards with partners to track supply chain performance					
Real-time performance data is shared with partners to support decision-making					
Partners actively contribute to maintaining accurate and up-to-date performance dashboards					
Our company regularly provides feedback to partners on their performance					
Feedback from partners is used to improve supply chain processes and outcomes					
Constructive discussions with partners about performance gaps occur frequently					

How else do you think performance measurement integration affects the performance of manufacturing SMEs in Rwanda?

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SECTION E: INFORMATION SHARING

Please indicate your level of agreement with the following statements on information sharing and performance of manufacturing SMEs. Please kindly tick (√) in the appropriate space that represents your opinion. Use the scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5).

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Information Sharing Technology					
Our organisation has adopted the latest information-sharing technology					
Information sharing in our organisation is done through the use of emails and telephone calls					
I am satisfied with the information-sharing technology adopted in our organisation					
Quality of information shared					
Our organisation ensures that the information shared is of high quality					
There are minimal complaints concerning the quality of information shared					

I am satisfied with the quality of information shared in our organisation					
Type of information shared					
Our organisation ensures relevant information is shared with the relevant groups					
I am satisfied with the type of information shared in our organisation					
Information sharing influences organisational performance					

How else do you think information sharing affects the performance of manufacturing SMEs?

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SECTION F: PERFORMANCE OF MANUFACTURING SMEs

Please indicate your level of agreement with the following statements on the performance of manufacturing SMEs. Please kindly tick (√) in the appropriate space that represents your opinion. Use the scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5). For the last 3-5 years (three-five years)

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Our company has increased its share in the local market over the past year					
We are successfully entering new markets and attracting new customers					
In our organization the quality of goods and services offered has improved					
There are minimal complaints concerning the quality of goods and services offered					
Our company quickly responds to changes in customer demand					
We can adjust our production and delivery schedules promptly to meet market needs					
Customer complaints and requests are addressed efficiently and effectively					
Our company has successfully reduced production and operational costs over the past year					
We utilize resources					

efficiently to minimize waste and optimize costs					
Cost-saving measures have improved overall profitability without compromising quality.					

THANK YOU FOR PARTICIPATING

Appendix III: Interview Guide

Supply chain communication integration

1. Indicate various production issues that disrupt your organisation's processes, triggering the need for communication integration in manufacturing SMEs.
2. State the strategies employed by your organisation to enhance the agility of its supply chain communication with SMEs.
3. Identify the driving forces that make manufacturing SMEs design their supply chains to be responsive to customers' needs.

Supply chain Customer integration

1. Identify the challenges faced by your organisation in the process of implementing customer integration design through supply chains.
2. How can your organisational supply chain processes be resilient and overcome supply chain disruptions

Supply chain Collaboration integration

1. Identify the challenges or barriers to supply chain collaboration and the hindrances to the performance of your organisation.
2. Briefly, explain how your organisation copes with environmental sustainability and its impact on operational performance

Performance measurement integration

1. Identify any 5 performance measurements of the actors involved in the flow of goods, services, and information to achieve the goals.
2. Identify the challenges and strategies to improve your performance

Appendix IV: List of Manufacturing SMEs

S/N	Products types	Sector
1	Africa Improved Foods Rwanda Ltd	Food & Beverage
2	Africana Buffalo Ltd	Food & Beverage
3	Alpha Choice Rwanda Ltd	Food & Beverage
4	Asili Natural Oils Ltd	Food & Beverage
5	Benya Company Ltd	Food & Beverage
6	Brioche Ltd	Food & Beverage
7	Crave Liquor Ltd	Food & Beverage
8	Fenly Ltd	Food & Beverage
9	Gasabo Grain Milling Ltd	Food & Beverage
10	Motherland Farmers Ltd	Food & Beverage
11	Rwanda Honey Ltd	Food & Beverage
12	Adma International	Food & Beverage
13	Kabuye Sugar Ltd	Food & Beverage
14	Speranza Group (Liquor)	Food & Beverage
15	Bakhresa (Azam)	Food & Beverage
16	Kasese Distilleries Limited (Beverages (Liguors)	Food & Beverage
17	Brioche (Bread)	Food & Beverage
18	Imena Dairy	Food & Beverage
19	Jabana Maize Flour Ltd	Food & Beverage
20	K&F Maize Manufacturing Ltd	Food & Beverage
21	Inganji Maize Miller Company Ltd	Food & Beverage
22	Hope Millers Ltd	Food & Beverage
23	Destiny Distillers Ltd	Food & Beverage
24	Vibrant Foods Ltd	Food & Beverage
25	Sorwatom Ltd	Food & Beverage
26	Ahava Nzuri Company Ltd	Food & Beverage
27	Dada Foods Industries Ltd	Food & Beverage
28	Rottwyler Beverages Ltd	Food & Beverage
29	East African Foods and Beverages Ltd	Food & Beverage
30	Gold Liquor Ltd	Food & Beverage
31	Gorilla Feed Co. Ltd	Food & Beverage
32	Kigali Farms Ltd	Food & Beverage
33	Yami Foods Ltd	Food & Beverage
34	Green Harvest Products	Food & Beverage
35	Inyange Industries	Food & Beverage
36	Minimex Ltd	Food & Beverage
37	SOSOMA Indutries Ltd	Food & Beverage

38	Kasese Distillers Ltd	Food & Beverage
39	Max Distillers Ltd	Food & Beverage
40	Universal Manufacturer	Food & Beverage
41	Ingufu Gin Ltd	Food & Beverage
42	Kibayi Beer Ltd	Food & Beverage
43	Mount Meru Soyco Ltd	Food & Beverage
44	Ese Urwibutso (Sina Gerard)	Food & Beverage
45	Kigali Food Production Ltd	Food & Beverage
46	Sawa Grain Mills Ltd	Food & Beverage
47	Sotiru Ltd	Food & Beverage
48	UTEXRWA (L'Usine Textile du Rwanda)	Textiles and Garments
49	Pink Mango / C&D Products Rwanda	Textiles and Garments
50	Ufaco Garments	Textiles and Garments
51	Vision Garment	Textiles and Garments
52	Great Generation Garments Ltd (GGG Textile)	Textiles and Garments
53	Rwanda Clothing	Textiles and Garments
54	Mille Collines	Textiles and Garments
55	Uzuri K & Y ltd	Textiles and Garments
56	Moshions	Textiles and Garments
57	C&H Garments	Textiles and Garments
58	Heworks Rwanda	Textiles and Garments
59	Africa Sewing Club	Textiles and Garments
60	New Kigali Designers	Textiles and Garments
61	Promota Creations	Textiles and Garments
62	Ikwize Ltd	Textiles and Garments
63	Lunar Invest	Textiles and Garments
64	Az Media Plus	Textiles and Garments
65	Star Leather Products Co Ltd	Textiles and Garments
66	Tai Rwanda	Textiles and Garments
67	Rwandan Adventures Ltd	Textiles and Garments
68	BCT Ltd	Textiles and Garments
69	Hamzam& Sons Company Ltd	Textiles and Garments
70	M B A Group Ltd	Textiles and Garments
71	Burera Garment	Textiles and Garments
72	Prime Cement Ltd (Musanze Cement)	Cement manufacturing
73	Anjia Prefabricated Construction	Cement & Precast
74	Tolirwa Ltd	Metal and Allied
75	PositivoGmbh	Metal and Allied
76	Bhavesh Overseas Ltd	Metal and Allied
77	Seven Hills Ltd	Metal and Allied
78	S & H Industries Ltd	Metal and Allied

79	Afri Precast Ltd	Metal and Allied
80	Laminar Technologies / Laminar Africa	Metal and Allied
81	Chillington Rwanda	Metal and Allied
82	Imana Steel	Metal and Allied
83	Iron & Steel Rwanda	Metal and Allied
84	Nansteel Manufacturing Co., Ltd	Metal and Allied
85	KICOM Ltd	Metal and Allied
86	Nevil Fabrication Rwanda	Metal and Allied
87	SteelRwa Industries Ltd	Metal and Allied
88	All City Rwanda Ltd	Metal and Allied
89	Tolirwa (additional plants / distribution	Metal and Allied
90	Sonatubes	Metal and Allied
91	Ecomeki Ltd	Metal and Allied
92	C&D Products Rwanda Ltd	Metal and Allied
93	Allied metal traders & Fabricators Ltd	Metal and Allied
94	S&H / SH Steel Manufacturing	Metal and Allied
95	Bems Duhange Ltd	Metal and Allied
96	Atlas Windows Ltd	Metal and Allied
97	Aquasan Ltd	Metal and Allied
98	MM & RJD Company Ltd	Metal and Allied
99	Walia / Walia Steel	Metal and Allied
100	Devki company	Metal and Allied
101	Afro-precast Ltd	Metal and steel materials
102	Metal Works Solutions	Metal and steel materials
103	ST Simion Metals Company Ltd	Metal and steel materials
104	Afrimico	Metal and steel materials
105	Nansteel Manufacturing Co., Ltd	Metal and steel materials
106	Kicom Ltd — Kigali, Muhima	Metal and steel materials
107	Petrocom Ufametal	Metal and steel materials
108	Manumetal Ltd	Metal and steel materials
109	Kigali Steel & Aluminium Works Ltd (KSAW)	Metal and steel materials
110	Sunpreme Ltd	Metal and steel materials
111	Laminar Technologies Ltd	Metal and steel materials
112	Rwanda Special Materials Ltd	Metal and steel materials
113	Sulfo Rwanda Industries Ltd	Chemical and allied products
114	AfriChem Rwanda Ltd.	Chemical and allied products
115	Petrocom S.a.r.l. / Ufametal	Chemical and allied products
116	Aqua-San Ltd/ Plastic Products	Chemical and allied products
117	Rwanda Foam	Chemical and allied products
118	Alyvo Rwanda Ltd	Chemical and allied products
119	Lubricating Oil Blending Plant	Chemical and allied products

120	Alliance Industries	Chemical and allied products
121	Sigma Industries	Chemical and allied products
122	Amaco Paints	Chemical and allied products
123	Societe Rwandaise Des Batteries	Chemical and allied products
124	Flexi foam	Chemical and allied products
125	Meta Foam	Chemical and allied products
126	Sunrise Overseas	Chemical and allied products
127	Siphar Rwanda Ltd/Biochem Pharmaceutical Industry	Chemical and allied products
128	Dolphin Industry	Chemical and allied products
129	Oxalis	Chemical and allied products
130	Sustainable Health Ventures	Chemical and allied products
131	Trust Industries	Chemical and allied products
132	Sunrise Overseas	Chemical and allied products
133	Siphar Rwanda Ltd/Biochem Pharmaceutical Industry	Chemical and allied products
134	CareMe Bioplastics	Chemical and allied products
135	Kobil Petroleum Rwanda Sarl	Chemical and allied products
136	Mattis Group Company Limited	Chemical and allied products
137	Horizon Sopyrwa Ltd	Chemical and allied products
138	Rwanda Medical Supply Ltd	Chemical and allied products
139	Arth Biobag Ltd	Chemical and allied products
140	Kigali Plastics Ltd	Plastics and rubber
141	Soimex Plastic Ltd	Plastics and rubber
142	Aquasan Ltd	Plastics and rubber
143	Rwanda Plastic Industries Ltd	Plastics and rubber
144	Organic Plastic Industry (OPI) Ltd	Plastics and rubber
145	Sonatubes Ltd	Plastics and rubber
146	Sulfo Rwanda Industries Ltd	Plastics and rubber
147	Rwanda Foam	Plastics and rubber
148	"Depot Kalisimbi Ltd"	Plastics and rubber
149	Aqua-San Ltd/ Plastic Products	Plastics and rubber
150	New Finest Traders Ltd	Plastics and rubber
151	Soft Group	Plastics and rubber
152	Soimex Plastic Industries	Plastics and rubber
153	SRB Investment Ltd	Plastics and rubber
154	Pro-water Rwanda	Plastics and rubber
155	Xie You Company	Plastics and rubber
156	Kigali Plastics	Plastics and rubber
157	ABN Investment Ltd	Plastics and rubber
158	Soft Packaging	Plastics and rubber
159	Alfa Holding Ltd	Plastics and rubber

160	Gorilla Star Ltd	Plastics and rubber
161	Rwanda Plastic Industries	Plastics and rubber
162	Societe Rwandaise Des Batteries	Plastics and rubber
163	Societe Nationale des Tubes	Plastics and rubber
164	Alb Investment Group	Plastics and rubber
165	Harungi	Plastics and rubber
166	Jardin Meubles Co. Ltd	Plastics and rubber
167	Roto Tanks	Plastics and rubber
168	Afritank	Plastics and rubber
169	Ameki Color —	Plastics and rubber
170	Atlas Windows	Plastics and rubber
171	Bonus Enterprises	Plastics and rubber
172	C & D Products Rwanda Ltd	Plastics and rubber
173	Kigali Plastics	Plastics and rubber
174	NPD Cotraco	Plastics and rubber
175	Rotassairwa	Plastics and rubber
176	Viva Products	Plastics and rubber
177	Agro- Plast Ltd	Plastics and rubber
178	Enviroserve Rwanda	Plastics and rubber
179	SWAN Hydrosol Ltd	Plastics and rubber
180	Eco-Plastic	Plastics and rubber
181	RWACOF Export	Coffee and Tea processing
182	Coffee Business Center Ltd (CBC)	Coffee and Tea processing
183	Unguka Muhinzi Ltd	Coffee and Tea processing
184	Rwanda Small Holder Specialty Coffee (RWASHOSCCO)	Coffee and Tea processing
185	Greater International Grain Co. Ltd (GIG)	Coffee and Tea processing
186	Cooperative pour La promotion des Activites Café (COOPAC)	Coffee and Tea processing
187	Caferwa Ltd (Café du Rwanda)	Coffee and Tea processing
188	Misozi Coffee	Coffee and Tea processing
189	Land of a Thousand Hills Coffee Company Rwanda	Coffee and Tea processing
190	Nova Coffee Ltd	Coffee and Tea processing
191	Kigasali Coffee Company Ltd	Coffee and Tea processing
192	Roots Origin Ltd	Coffee and Tea processing
193	Abateraninkunga Ba Sholi	Coffee and Tea processing
194	Rwanda Farmers Coffee Company Ltd	Coffee and Tea processing
195	RFCC (Gorilla Coffee)	Coffee and Tea processing
196	Question Coffee	Coffee and Tea processing
197	Bourbon Coffee	Coffee and Tea processing
198	1000 Hills Products Rwanda Ltd	Coffee and Tea processing

199	Sasa Coffee Ltd	Coffee and Tea processing
200	Rwanda Mountain Tea Ltd (Gatare Tea Factory)	Coffee and Tea processing
201	Rwanda Mountain Tea Ltd (Mata Tea Factory)	Coffee and Tea processing
202	Sorwathe Ltd	Coffee and Tea processing
203	Rwanda Trading Company	Coffee and Tea processing
204	Rwandan Farmers Coffee Company	Coffee and Tea processing
205	Rwanda Farmers Coffee	Coffee and Tea processing
206	Rwashoscco Ltd	Coffee and Tea processing
207	Karungi And Gashyashya Ltd (Murenzi Charles)	Coffee and Tea processing
208	Enas/Ndera	Coffee and Tea processing
209	Masaka/Seven Lakes	Coffee and Tea processing
210	Kigali CWS	Coffee and Tea processing
211	NgambaCws	Coffee and Tea processing
212	MuginaCws	Coffee and Tea processing
213	MusambiraCws	Coffee and Tea processing
214	Karama Coffee	Coffee and Tea processing
215	Kayenzi Cws	Coffee and Tea processing
216	Buf Coffee Kamonyi	Coffee and Tea processing
217	All City Rwanda Ltd	Building and Construction Materials
218	Allied General Traders Ltd	Building and Construction Materials
219	Alpha Cd Technology Nl Ltd	Building and Construction Materials
220	Alpha Media Ltd	Building and Construction Materials
221	Bruce Mcllister Ltd	Building and Construction Materials
222	China Star Construction	Building and Construction Materials
223	Herocean Rwanda Ltd	Building and Construction Materials
224	Insibag Ltd	Building and Construction Materials
225	Kamal Industries Ltd	Building and Construction Materials
226	Metalen Ltd	Building and Construction Materials
227	Mutara Manufacturers Industries Ltd	Building and Construction Materials
228	Sahasra Electronics Rwanda Pvt Ltd/Warehouse	Building and Construction Materials
229	Sinda Group Ltd	Building and Construction Materials
230	Sisay Investment Ltd	Building and Construction Materials

231	Amagerwa Ltd	Building and Construction Materials
232	Safintra Ltd	Building and Construction Materials
233	STRAWTEC Building Solutions Ltd	Building and Construction Materials
234	Tolirwa Ltd	Building and Construction Materials
235	Papyrus Co. Ltd	Building and Construction Materials
236	Upcot Ltd	Building and Construction Materials
237	Univenture Investments Ltd	Building and Construction Materials
238	RayalMabati Ltd	Building and Construction Materials
239	Aigle Construction Ltd	Building and Construction Materials
240	Dynasty Ltd	Building and Construction Materials
241	Luna Smelter Ltd	Building and Construction Materials
242	Aldango Ltd	Building and Construction Materials
243	Amajyambere Industry Co Ltd	Building and Construction Materials
244	Mutara Manufacturers Industries Ltd	Building and Construction Materials
245	Jardin Meubles Co. Ltd	Building and Construction Materials
246	Star Construction Ltd	Building and Construction Materials
247	Kigali Steel and Aluminum Works Ltd	Building and Construction Materials
248	Galf Toles Limited	Building and Construction Materials
249	Metalen Ltd	Building and Construction Materials
250	Rwamaco Ltd	Building and Construction Materials
251	Master Granite Ltd	Building and Construction Materials
252	Esetra Ltd	Building and Construction Materials

Source: National Industrial Research and Development Agency,2024

Appendix V: Recommendation Letter National Institute of Statistics of Rwanda

REPUBLIC OF RWANDA

Kigali, ...24 APR 2023.....

N°. 0457.../2023/10/NISR

NATIONAL INSTITUTE OF STATISTICS OF RWANDA
P.O. Box 6139 Kigali
Tel: +250-788383103 Hotline: 4321
E-mail : info@statistics.gov.rw

Alexis UWAMAHORO
Ass. Lecturer at University of Rwanda
Email:uwamalexis2000@gmail.com
Tel. 0788602414
KIGALI

Dear Sir,

RE: Visa Approval

Reference is made to your letter dated April 11th, 2023 requesting for authorization to conduct the "*Supply Chain Integration and Performance of Manufacturing Firms in Rwanda*" in Kigali city, Musanze, Rwamagana and Muhanga Towns from April 21st to June 21st, 2023.

After examining your request and according to the law N° 45/2013 of 16/06/2013 stating on organization of statistical activities in Rwanda, we have the pleasure to inform you that the visa has been granted, with the conditions that the data and final report (supported by its validation report) will be submitted to NISR before publication.

Details of the visa are attached.

Thank you for your collaboration.

for.

MURANGWA Yusuf
Director General

MURENZI Ivan
Deputy Director General
National Institute of Statistics of Rwanda

Website: http://www.statistics.gov.rw

Appendix VI: University Recommendation Letter

JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

NAIROBI CBD CAMPUS
Department of Entrepreneurship and Procurement

P.O. Box 62000
NAIROBI – 00200
KENYA

TEL: 020-221306
Email: epdncbd@jkuat.ac.ke

Ref: JKU/6/3/17a

Date: 15th February 2023

TO WHOM IT MAY CONCERN

SUBJECT: ALEXIS UWAMAHORO – HD423- C010- 2847/2015

This is to introduce to you **Mr. Alexis Uwamahoro** who is a student pursuing his Doctor of Philosophy in Supply Chain Management at Jomo Kenyatta University of Agriculture and Technology, Nairobi CBD Campus. The student is currently undertaking research thesis entitled **"Supply Chain Integration and Performance of Manufacturing Firms in Rwanda"** in partial fulfillment of the requirement for the degree program.

The purpose of this letter is to request you to give the student the necessary support and assistance to enable him obtain necessary data for the thesis. Please note that the information given is purely for academic purpose and will be treated with strict confidence

Yours faithfully,

DR. SAMSON NYANG'AU (Ph.D)
ASSOCIATE CHAIRPERSON, EPD

JKUAT NAIROBI CBD CAMPUS
P.O. Box 62000-00200, NAIROBI
15 FEB 2023
ACOD, EPD DEPARTMENT

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