



EFFECT OF INFORMATION SHARING ON THE RELATIONSHIP BETWEEN COMMUNICATION INTEGRATION AND PERFORMANCE OF MANUFACTURING SMES IN RWANDA

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ABSTRACT

The purpose of this study was to determine the effect of information sharing on the relationship between communication integration and the performance of manufacturing SMEs in Rwanda. The study adopted an explanatory research design and positivist research philosophy. The study population was 682 managers of manufacturing firms. A stratified random sampling technique was used to select the required sample to select a sample size of respondents from each stratum. This study used the network Theory. The pilot study was carried out in twelve (12) manufacturing firms where 25 questionnaires were distributed. All the variables tested in the pilot study were found to have Cronbach alpha value greater than 0.7. This suggests that all the questionnaires were reliable for the study. Therefore, the questionnaire was valid and reliable and was used to collect data for this study. Inferential statistics, including Pearson correlation and the multiple regression analysis model, were used to test the relationship between study variables. The significance of the model was tested at 5% level of significance. Data was analyzed using Statistical Package for Social Sciences version 26 and the same was presented in the form of tables, figures, and histograms. The pilot results were good for construct validity and reliability tests. The study concluded and recommended that communication integration has a great impact on the performance of manufacturing firms in Rwanda.

Key Words: Information Sharing, Communication Integration, Performance of Manufacturing SMEs in Rwanda, Network Theory

Background of the Study

Since its introduction in the early 1980s, supply chain management (SCM) has drawn more and more interest from the management and operational research field. 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 gives businesses a competitive advantage as a key to attaining 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 helps companies improve their product and material flows through the supply chain. It also helps to reach various resources and capabilities within other supply chains, thus stimulating companies' innovativeness. In the supply chain, the extent to which collaboration with suppliers and customers allows companies to achieve their internal business processes (Zhong et al., 2023).

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

In supply chain management, supply chain integration (SCI) can be divided into two interrelated ways. The first type of integration refers to the cooperation of the forward physical movement of products between manufacturers, suppliers, and consumers. The second is supplier integration, which refers to the backward of information flows from customers to suppliers. Many firms 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 goods distribution and handling the shipment and storage of items for customers. 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 (Suryanto & Mukhsin, 2020).

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 goals by the market and finances. Good operational coordination is necessary for manufacturing companies to establish and preserve a competitive advantage in their goods and services. Manufacturing companies need strong operational coordination to establish and maintain a competitive advantage in goods and services. In this context, monitoring and integrating important components like overall quality management and information into their supply chain; impact supply chain performance. Information sharing does not affect business performance; it only affects operational performance. In Rwanda, the manufacturing sector is still small but steadily growing at an annual rate of 7%. The country targeted to increase industrial contribution to GDP to 26% by the year 2030 (National Bank of Rwanda et al., 2020).

The primary industrial activities of manufacturing are mainly the processing of coffee, tea, bananas, beans, sorghum, potatoes, and other agricultural commodities. Other smaller-scale industrial products include cement, small-scale beverages, soap, furniture, shoes, plastic goods, textiles, and cigarettes contribute to the country's economic development. However, unforeseen disruptions like COVID-19 measures, heavy rains, flooding, fluctuations in the world oil price, and high production costs have recently worsened the sector's GDP contribution. For manufacturing organizations, meeting deadlines for product delivery is a common problem. Given their limited production capacity, manufacturers need to maximize their limited resources to meet the demands of unpredictable markets at a reasonable price (Agricultural & Development, 2022). Therefore, supply chain integration is a well-known concept that enhances businesses in collaborating internally across functional departments and managing the strategic goals and downstream operations to attain business performance. Nonetheless, the primary objective of this research is to determine how supply chain integration specifically communication integration affects SMEs' organizational performance in Rwanda.

Statement of the Problem

More than 75% of the manufacturing sector in Rwanda and Job opportunities come from SME manufacturing industries (NISR, 2022). For the past ten years, the emphasis has been on how SME supply chains could become more competitive. International Finance Corporation (IFC) in 2022 reported Rwandan SMEs to have an average ROI (return on investment) of 20%. Comparing the country to other African countries, the favorable business climate and government support for small and medium-sized enterprises (SMEs) account for the higher return on investment. Meanwhile, the manufacturing sector's contribution is still low compared to other industries like agriculture, energy, ICT, financial service sectors, and transportation. In developing countries, over 70% of registered SME 'firms shut down during the first two years of operations.

Although the manufacturing sector has strong links to other industries and a lot of potential for economic growth, its GDP value-added has been steadily declining at around 5%, and it only makes up a relatively small share of all product exports (IMF(International Monetary Fund), 2022; National Bank of Rwanda et al., 2020). The food and beverage industries, which make up the two largest subsectors of Rwanda's industrial sector, did not do as well as they had the previous year (National Bank of Rwanda et al., 2020). Other tactics that Rwandan manufacturers might employ to increase productivity and competitiveness include supply chain integration, governmental backing for e-commerce projects, legislative actions, and promotion of SME growth (Omwoyo et al., 2020b).

However, studies (Fernando & Wulansari, 2020; Min et al., 2005; Mofokeng & Chinomona, 2019; Omwoyo et al., 2020a; Zhong et al., 2023) show that one of the factors of the inability to compete relies on SMEs' reluctance to work with other businesses. By promoting effective communication and accurate data sharing among the key stakeholders, companies may reduce their expensive transportation expenses while simultaneously improving productivity and setting themselves apart. Given Rwanda's landlocked location and inadequate transportation infrastructure, this is extremely important for the nation. Digital supply chains can help manufacturing organizations with governance, collaboration, performance measurement systems, and integration of customers, which allows flexibility and the development of unique capabilities (Ali et al., 2023; Panahifar et al., 2018). SMEs must actively collaborate, forge solid bonds with various supply chain partners, and make technological investments to improve integration and communication to address these issues. Thus, the purpose of this study was to investigate the relationship between communication integration and industrial system performance and to suggest a model for enhancing the performance of manufacturing firms through information sharing across communication integration parameters.

Objectives of the Study

The specific objectives of this study were:

- i. To determine the effect of communication integration on the performance of manufacturing SMEs in Rwanda.
- ii. To assess the effect of information sharing on the relationship between communication integration and the performance of manufacturing SMEs in Rwanda.

Research Hypothesis

Ho₁. Communication integration has no significant effect on the performance of manufacturing SMEs in Rwanda.

Ho₂. Information sharing has no significant effect on the relationship between supply chain integration and the performance of manufacturing SMEs in Rwanda.

LITERATURE REVIEW

Theoretical Framework

Network Theory

The e-perspective theory was developed Network theory stresses the mechanisms and processes that individuals, groups, and firms 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

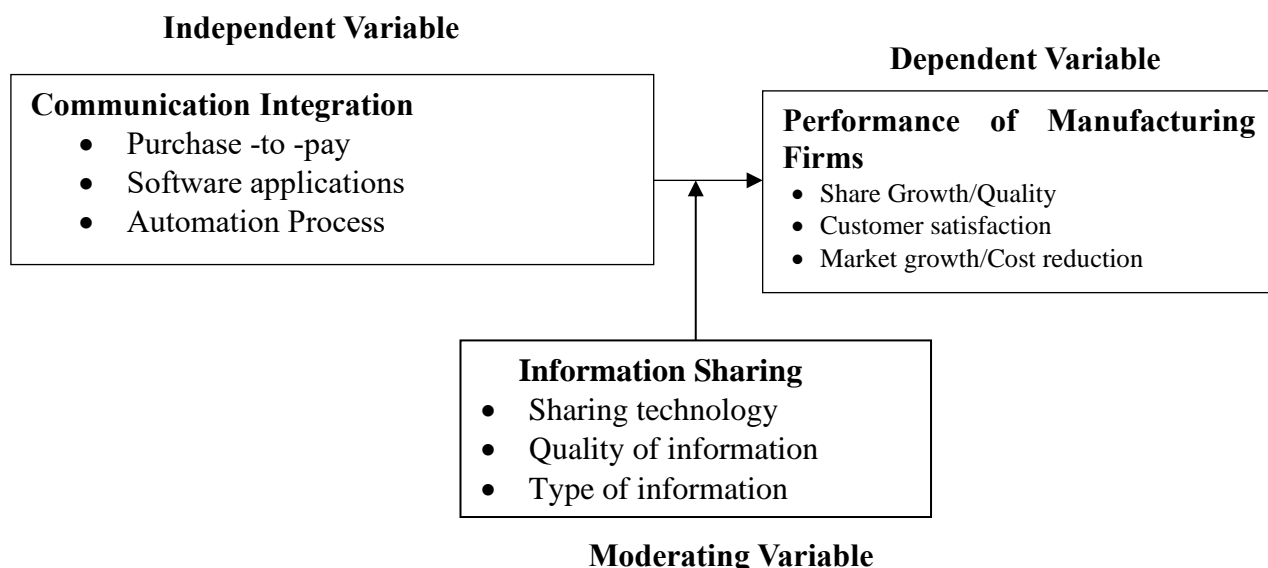
others, even if they each create their own network. Understanding the relationship between the different partners is necessary to comprehend the network (Thoo et al., 2017). The correlations are distinct, varied, and consistent. With mutual respect and trust, the actors in the network progressively build 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 use of 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 or e-perspective 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 gives access to real-time supply chain data, such as scheduling, production planning, delivery status, and inventory counts. These days, manufacturing firms 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 will make it easier to coordinate supply chain operations, which can occasionally prevent temporal and geographic distance. Information technology empowers every integration system and makes it easier for partners to access data across the supply chain. 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 shown, using ICT has made it easier to lower 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 theory of network, SMEs need to understand the connections among supply chain players to become more effective. With network theory, small and medium-sized manufacturing companies can identify important supply chain participants, comprehend their interactions, and leverage these networks to increase productivity.

In the context of this study, the theory helps to understand manufacturing integration with suppliers and customers can reduce costs, acquire the resources they want, and improve the quality of their products. 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. Luo & Zor, 2023). By developing contingency plans based on their understanding of the relationships between the many actors in the chain, small and medium-sized manufacturing enterprises can lower risks and ensure the smooth operation of their supply chain (Chatha & Jalil, 2022).

Conceptual Framework



Integrated Communication

The term "integrated 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). Integrated communication technology in the supply chain typically 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).

Integrated communication 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 there is a constant flow of information. Integrated communication 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 facilitates informed decision-making and prompt change adaptability. Song et al. (2024) asserted that they may collaborate more readily with good communication between departments within a firm, such as sales, production, logistics, and procurement. The total efficiency of the supply chain increases when these processes are well coordinated. Other parties involved in the integration process are manufacturers, distributors, suppliers, retailers, and logistics companies (García-Alcaraz et al., 2020).

García-Alcaraz et al. (2020) argue that communication with the partners is essential for managing inventory, planning events, and responding to changes in the market. To collect and capture data along the supply chain, integrated communication commonly uses modern technologies like sensors, data analytics, and the Internet of Things (IoT). Modern technologies improve visibility, reduce manual error, and support more informed decision-making (Tan & Sidhu, 2022). Integrated communication in the supply chain alerts and warns before any supply chain disruption, hence minimizing the risks. Implementing backup plans and minimizing risks both rely on timely internal communication. The exchange of information becomes consistent when standard communication methods are employed. While working with diverse partners and preventing miscommunications and inaccurate data (Sundram et al., 2020).

Integrated 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 make many systems and devices cooperate effectively, ensuring data can be used and shared throughout the supply chain. This combination reduces the likelihood of errors and increases overall efficiency. Real-time observation of production processes is made possible by the software. 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 makes it easier for suppliers and producers to communicate, guaranteeing the timely delivery of components and raw materials (Asamoah et al., 2015; Sundram 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. Automation of 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 can be used to construct predictive maintenance solutions (García-Alcaraz et al., 2020). By planning maintenance tasks and analyzing equipment data, manufacturers can lower downtime and boost production efficiency. The software helps ensure adherence to industry standards and laws (Tan & Sidhu, 2022). Can Saglam et al., (2022) automated reporting features facilitate the provision of required paperwork, hence 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). Vendors and the procurement process must interact with each other. Integrated systems facilitate communication about product specifications, costs, and delivery schedules, ensuring that the selected vendor meets the company's requirements. The approval of purchase orders is facilitated in part by integrated communication systems. The departments responsible for authorizing and approving purchase orders must communicate with one another to do this (Zsidisin et al., 2015).

The receiving department and the warehouse must communicate when things are received (Tan & Sidhu, 2022). Integrated systems offer real-time data on inventory levels, making stock management more efficient. Both the approval and payment of invoices require communication with the finance department (Tan & Sidhu, 2022),(Fernando & Wulansari, 2020). Integration of systems facilitates communication and ensures prompt authorization of invoices and timely payment. Thanks to linked systems, the entire Purchase to Pay process is visible (García-Alcaraz et al., 2020). It enables performance data-driven decision-making and identifies areas that require improvement. The enforcement of compliance standards and procurement procedures, as well as communication on them, are facilitated by system integration. It guarantees compliance with all internal and external regulations during the Purchase to Pay process. Improved relationships fostered by integrated communication facilitate continuous supplier communication (Zsidisin et al., 2015).

Authors like García-Alcaraz et al. (2020); Song et al. (2024) asserted that automation systems in manufacturing SMEs are essential for communication integration in supply chain (SC) management since they enhance production performance. Automation systems increase overall productivity in manufacturing activities by simplifying procedures, increasing efficiency, reducing errors, and so on. While the organization is automated, it enhances the 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). For Song et al. (2024) making better decisions is made possible by the real-time insights, 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, and the relationship reduces downtime and increases overall production (Tan & Sidhu, 2022). Automation systems in manufacturing help to improve 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 sum up, supply chain manufacturers can ensure effective automation system implementation and communication integration to boost operational efficiency, save costs, enhance product quality, and improve overall performance (Shi et al., 2023).

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 that is 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 things like process management within the organization, clear roles and duties, continuous learning, and model success. Takayabu (2024). It is essential to evaluate each supply chain's performance independently in order to consider industry-specific regulations.

There are two types of approaches to measure the performance of manufacturing firms. Financial and non-financial approaches fall under these two categories. Information technology integration, safety stock, feedback, and self-evaluation are some of the techniques (Zhou & Li, 2020). Among the many methods used in modern performance measurement are return on assets, return on investments (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 uses measure ten manufacturing criteria (SCPM). 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 in terms of money and the market (Agyei-Owusu et al., 2022; Z. Ali et al., 2020). Organizations in this context implement appropriate policies and methods to improve their financial performance, encourage innovation, and offer greater consumer pleasure. Flexibility, speed, quality, and cost are used to explain the performance of manufacturing firms 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 is the measure of how quickly a good or service is delivered to a consumer; the faster the delivery, the better the speed performance (Takayabu, 2024).

The supply chain collaboration diagnoses and seeks to comprehend how the company sustains stakeholder relationships. The network is both internal and external, and it goes from upstream to downstream (Panahifar et al., 2018; Saleheen & Habib, 2023b). The more effectively an organization collaborates, the more likely it is to be able to face impending obstacles and uncertainty (Panahifar et al., 2018). Enhancing collaboration reduces the time required to modify the schedule for any operational activity, enabling the business to offer better services to customers who are less likely to break agreements. Similarly, a company can intentionally manage the trust that suppliers and customers have in one another, collaborate to solve issues, encourage ongoing development, and exchange information to reduce inventory and significantly boost the availability of products and services (Saleheen & Habib, 2023b; Shin et al., 2019).

A Swedish study evaluated suppliers to small and medium-sized manufacturing enterprises using structured and unstructured methodologies. The study found critical components of supplier development include senior management involvement, teamwork, communication, trust, and long-term commitment. Price, delivery, and quality are the most significant factors in evaluating a supplier's performance in the same survey. As a result, companies select vendors who can fulfill their needs (Ominde et al., 2022). The study also found that using supplier incentives and rewards as a tactic can influence the behavior of buyer and supplier groups in the future. Organizations can enhance supplier performance and procurement performance by tying procurement goals to specific supplier competence.

Saleheen & Habib (2023) claim that additional research reveals suppliers are prequalified based on provider competence. Businesses have high standards for their suppliers since they know that they have undergone an extensive evaluation process, and they are nevertheless concerned about the quality of the products to be supplied on time (L. Li et al., 2023; Zhou & Li, 2020). Companies know that their suppliers have gone through a rigorous screening procedure, so they have high expectations for them, but they are still worried about the quality of the goods that will be delivered on time. Despite the wealth of study on the topic, the online environment offers new chances for analyzing the management of integrated marketing communications and how advertisers are incorporating new media and formats into their campaigns (Nyile, Shale & Osoro, 2022).

In this context Information sharing through "Collaborative Planning, Forecasting, and Replenishment (CPFR) has been used to identify collaboration in supply chain management. Businesses use collaborative strategies like vendor-managed inventory (VMI) and continuous replenishment programs (CRP) (Asamoah et al., 2015; Panahifar et al., 2018; Saleheen & Habib, 2023b). The term "collaboration" is too broad, the perspective of SC, an additional definition is essential due to an over-reliance on technology and an incapacity to discern between the types of people one should collaborate with (Barratt, 2004).

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 across production sites, distributors, retailers, and third-party organizations like 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). Scholars like 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 produce 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). Decision-making becomes more difficult in the supply chain when participants keep information until they have more precise information (Panahifar et al., 2018).

Scholars such as Nguyen Thi & Nguyen Thi Thu (2022) have underscored the need to share reliable data. They concluded that an information-centered collaborative supply chain should incorporate data on inventory, demand, forecasts, production and shipment schedules, and ongoing activities. Panahifar et al. (2018) asserted that sharing-centered collaboration, like CPFRR, cannot work without a secure IT infrastructure for information sharing. It indicates that working together is essential, and safe information-sharing tools are part of that. Consequently, companies may now offer 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 is ineffective (Panahifar et al., 2018). It can only handle through putting protective measures for all parties.

Panahifar et al. (2018), using secure information sharing protocols in collaboration, argued that adopting a safe IT infrastructure for information sharing is necessary for the implementation of sharing-centered collaboration, such as CPFRR. As a result, businesses may now provide accurate and timely information. Information security needs to become more important at the same time as teamwork and sharing of information (Baah et al., 2022). Despite the advancements in collaborative approaches over the past 25 years, there are still obstacles associated with collaboration. Information sharing is a priority over internal information retention in these collaborative platforms (Baah et al., 2022). As numerous academics and researchers have noted, supply chain collaboration increases agility and flexibility, reduces production costs, shipping costs, and inventory costs, less bullwhip effect, and better coordination for faster reaction times are some benefits of enhanced information sharing (Panahifar et al., 2018).

To help manufacturing firms reduce lead times and inventory costs, suppliers and customers have developed collaborative systems like VMI and CPFRR, 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 better choices regarding transshipment, order replenishment, and where to put 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 the movement of the stock and advises the client on important issues, such as replacing inventory. 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, we agree that accurate information significantly improves trust and collaboration in the supply chains.

Empirical Review

Communication Integration and Performance of Manufacturing Firms

Resources Based View (RBV) theory states that enhanced organizational performance and a persistent competitive advantage can result from distinctive and valued organizational resources and competencies (Barney (1991)). Many organizations are actively adopting ICT alignment to enhance organizational processes and raise customer service standards. This helps the organization to acquire high operational and financial performance in light of the changing competitive environment (Saleheen & Habib, 2023c). 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 that will expand their market share as well as more effectively respond to shifts in consumer demand by utilizing customer demand information (Saleheen & Habib, 2023c).

Integration of 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. By using integrated communication systems, manufacturing organizations can 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 and boosts customer satisfaction and loyalty. 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. When there is 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).

Integrative communication systems encourage smooth communication and openness among staff members, which promotes a cooperative and trustworthy environment (Tan & Sidhu, 2022). When workers feel appreciated and are aware of the organization's objectives, activities, and performance indicators, they become more engaged and positive. Manufacturing businesses may remain flexible and adaptable to changing market conditions and customer expectations by putting integrated communication into practice (Tan & Sidhu, 2022). Organizations can stimulate innovation and quickly adjust to new rules, practices, and situations by encouraging cross-functional cooperation and knowledge sharing. Integrated communication technology can help businesses increase the efficiency, responsiveness, and agility of their supply chains, which will ultimately improve overall performance and customer satisfaction (Jacobs et al., 2016).

Information Sharing and Performance of Manufacturing SMEs

The survival of any organization depends on sharing the right information (Tiwari, 2021). With the advance in technology, information sharing in the supply chain serves as an enabler of long-term collaboration and coordination, ultimately leading to competitive advantage. Effective information sharing in the supply chain increases the efficiency of the 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 right information with their team members can ensure that 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 ultimately, increased business success (Pattanayak et al., 2024b). Therefore, it is important for manufacturing SMEs to prioritize information sharing as a key 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). Lack of information managers cannot know what customers want, how much inventory is in stock, and when more products are produced or shipped (Vafaei-Zadeh et al., 2020). A study conducted using Smart PLS-3 for the analysis of the data gathered from the textile firms of Pakistan found that the levels of information shared between firms have positive and significant effects on supply chain performance and the relationship is mediated by extranet technology applications, namely, EDI, VMI, and POS, respectively (Hamann-Lohmer et al., 2023). Furthermore, information sharing presents a significant amount of advantage to manufacturing companies (Vafaei-Zadeh et al., 2020). Information sharing in supply chains can lead to 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 improve their ability to respond to changing market conditions and 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). Overall, information sharing is essential for manufacturing SMEs to compete effectively in today's global marketplace and to achieve long-term success.

According to Zsidisin et al. (2024), IT tools such as the Internet, VMI, and EDI are popular among manufacturing firms 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 useful if they are used to 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 explain that IoT can optimize how people and systems interact, promote best practices for greater performance, and enhance operational efficiency, safety, security, and customer experience. The use of technology can further reinforce supply chain integration and minimize costs by optimizing supply chain 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). Overall, 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 the advancements in information and communication technologies, information sharing is more accessible than ever before. 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). As the public procurement activity becomes more complex, measuring its impact becomes increasingly difficult. The author has noted that while information-sharing impacts are widespread, there are no systematic measurement frameworks available to demonstrate the benefits or drawbacks of procurement policies (Huo et al., 2021). To measure progress against objectives, high-level indicators may be used. However, data availability and complexity require centralized activity to support the development of a broader measurement framework that considers the entire procurement system (Nkwabi & Fallon, 2020).

RESEARCH METHODOLOGY

This study employed an explanatory research design, focusing on elucidating the relationships between variables through quantitative analysis. The primary objective of this design is to explain why phenomena occur and to predict future outcomes (Osoro et al., 2016). A positivist research philosophy guided the investigation based on theoretical frameworks from which hypotheses were formulated and tested through quantitative methods (Osoro et al., 2016).

The study population comprised managers, chief executive officers, assistant managers, and presidents from 682 manufacturing SMEs in Rwanda, categorized into seven clusters: wood and lumber, leather, food and beverage, rubber and plastic, stationery, textiles, and others. These firms were located in Kigali City, Musanze, Rwamagana, and Muhanga Towns. Managers were considered the most knowledgeable about the interplay between organizational performance and supply chain performance.

Data collection involved a mixed-method approach, utilizing open-ended questionnaires distributed in-person and electronically and semi-structured interviews with twelve purposively selected CEOs/managers. A total of 252 manufacturing SMEs were sampled through random selection, with 227 completed questionnaires analyzed, yielding a valid response rate of 94%. Stratified random sampling was employed to ensure representation across manufacturing sectors, reducing the likelihood of excluding essential population groups (Kotari, 2017).

Primary data were collected via semi-structured questionnaires, which facilitated cost-effective and convenient summarization of responses. The collected data were coded and analyzed using SPSS version 26, employing descriptive statistical techniques such as frequency, mean, and standard deviation, alongside content analysis for qualitative responses. Inferential statistics, including regression and correlation analysis, were utilized to derive insights from the data.

RESEARCH FINDINGS AND DISCUSSION

Two hundred and twenty-seven (227) respondents were given the questionnaires and filled out through the tablets, where 213 respondents fully participated and gave 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.

Descriptive Analysis of the Study Variables

Communication Integration

The study sought to examine the influence of communication integration on the performance of manufacturing firms in Rwanda. This objective was measured using the following indicators: purchase to pay, software integration, and automation process in the opinion statements given. Respondents were asked to indicate how communication integration influenced the performance of manufacturing firms in Rwanda. This was based on a Likert scale of not at all, small extent, moderate, large extent, and very large extent. Therefore, in this study, a scale of not at all and small extent implied disagreement, while a large and very large extent implied agreement. The results were expressed as frequencies, percentages, mean, and standard deviation, as indicated in Table 1 below.

Table 1: Descriptive Analysis of Communication Integration

Statements on Communication integration	1 %	2 %	3 %	4 %	5 %	Mean	Std Dev
Organization’s supply chain evaluates, considers, and covers needs quickly by providing basic essentials to meet the customer needs.	0(0)	2(1)	51(23.8)	110(51.7)	52(24.5)	3.71	0.696
The supply chain has an element of visibility enabling the view of the motion across the entire supply chain	2(1)	0(0)	44(20.7)	118(55.2)	51(24.1)	4.13	0.670
Integration enables reliability of supply chains	0(0)	2(1)	43(20)	104(49.0)	66(31)	4.12	0.713
The ability of manufacturing firms to respond quickly to emergencies might be challenging due to issues of resources, funding and lack of information	0(0)	0(0)	7(3.4)	110(51.7)	95(44.8)	4.42	0.559
A guarantee of the manufacturing process through supply chain to quickly deliver is a real selling point if that order arrives quickly, accurately and complete otherwise its termed as waste.	0(0)	0(0)	29(13.4)	110(51.7)	74(34.8)	4.01	0.664
Our organization has a close partnership with suppliers that enables speedy delivery especially when handling a production or an emergency	0(0)	0(0)	7(3.4)	88(41.4)	118(55.2)	4.42	0.565
Supply chain has high degree of flexibility in terms of assembling and transportation structure to meet the needs of the customer	0(0)	0(0)	37(17.6)	95(44.5)	81(37.9)	4.21	0.715
Organization’s supply chain undertakes activities before productions occur that enhance the readiness of manufacturing firms and the society to counter the emergencies.	0(0)	0(0)	15(6.9)	140(65.5)	59 (27.6)	4.21	.551
Supply chain preparedness is crucial as it minimizes the time spent in undertaking the immediate response and increase the odds of quick recovery	0(0)	0(0)	23(10.7)	123(57.9)	66(31.2)	4.21	.610

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

The majority of the respondents (76.2%) agreed that the manufacturing process through supply chains evaluates, considers, and covers needs quickly by providing essentials to respond to the needs of the customers while 23.8% indicated a moderate extent. A large number of respondents (79.3%) agreed that their supply chains have

an element of visibility enabling the view of the movements across the supply chain, including identity, position, and state of transit alongside the arranged and actual dates and times for the events as 20.7% moderately agreed. Elsewhere, 80% of the respondents agreed that integration enables reliability of the manufacturing process through supply chains, while 20% moderately agreed that reliability is enabled by the integration design of the supply chains. The ability of manufacturing SMEs to respond quickly to emergencies might be challenging due to issues of resources, funding, and lack of information, as indicated by 96.5% of the respondents who agreed and 3.4% of the moderate responses. Most respondents (86.5%) agreed that a guarantee of the manufacturing process through supply chains to quickly deliver is a real selling point if that order arrives quickly, accurately, and completely; otherwise, it is termed as waste, while 13.4% moderately agreed. This aligns with the findings (Zsidisin et al., 2024), who asserted that internal communication in the supply chain improves internal integration, supplier integration, and supplier performance.

These findings align with Ghariani & Boujelbene, (2024) that market orientation has a substantial and favorable effect on manufacturing SME performance. The management responsibility is to maintain supply chain integration in the context of a relationship with market orientation and firms' 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. Zhong et al., (2023), not all firms implementing supply chain integration can attain the desired goal, and enhancement of supply chain collaboration, when not balanced, causes the decline of supply chain performance. Internal integration is subsequently positively related to supplier integration, which partially mediates the relationship with supplier performance. Internal integration is also positively and directly related to supplier performance (Suryanto & Mukhsin, 2020).

Respondents were asked to indicate whether manufacturing firms had a close partnership with suppliers that enables delivery of requested supplies within the requested time and place, especially when handling a production or an emergency; 96.6% and 3.4% agreed and moderately agreed, respectively, to the statement. Further, the majority of the respondents (82.4%) agreed that the supply chain has a high degree of flexibility in terms of assembling and transportation structure to meet the needs of the customers, as 17.6% indicated moderate. This aligns with the findings of Ongeru and Osoro (2021). Respondents agreed that their supply chains undertake pre-production activities that enhance the readiness of manufacturing firms and society to counter emergencies. This was important for supply chain preparedness, which respondents termed crucial as it minimizes the time spent undertaking the immediate response and increases the odds of quick recovery.

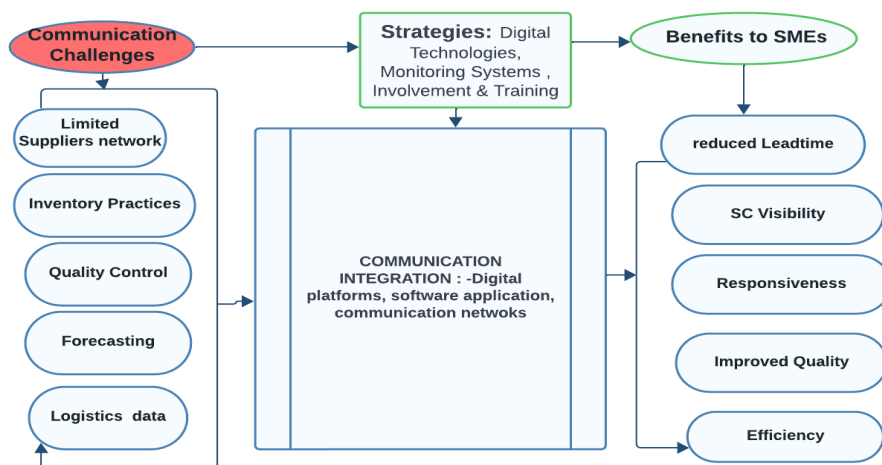
In general, the findings in Table 4.8 found that manufacturing SMEs in Rwanda have supply chains designed to be responsive to the customers' needs. The manufacturing process through supply chains is designed to evaluate, consider, and cover needs quickly while enabling a view of the movements along the supply chain. Further, to increase the element of purchase-to-pay and reactivity, manufacturing firms have established close relationships with suppliers in an effort to improve responsiveness. The manufacturing process through supply chains is also designed to be flexible to meet the customers' needs in aspects of transportation, assembling, and dispatch. This aligns with the findings of Ongeru and Osoro (2021).

However, the ability of manufacturing firms to respond quickly to emergencies and productions is a challenging task influenced by the various challenges facing the manufacturing process through supply chains such as lack of information, insufficient resources, and poor funding (Kospir et al., 2022). This means that despite the supply chains being designed to be responsive to emergencies, there is an element of sluggishness in most manufacturing processes through supply chains in Rwanda, resulting in the challenges faced. This shows a lack of preparedness by manufacturing firms in responding to emergencies and productions. Preparedness entails all the activities undertaken before a production occurs that enhance the readiness of manufacturing firms and society to counter emergencies. Muazu (2019) asserted that preparedness measures are crucial as they minimize the time spent in undertaking an immediate response and increase the odds of quick recovery. During the preparation phase, hazards/risks are acknowledged, and strategies are designated to address response and recovery necessities. The findings of this study concurred with Muazu's (2019) study that identified the manufacturing process through supply chain management challenges as delayed delivery of the appropriate products, lack of production preparedness, faulty information integration, and uncertainty in demand, among others.

Qualitative Analysis

To investigate supply chain managers' viewpoints on communication integration, three study questions were employed. First, various production issues disrupt processes triggering the need for communication integration 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 making manufacturing firms design their supply chains to be responsive to customer's 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 1 below:



Source: Researcher,2024

The findings indicated that Rwanda has been subjected to various productions, which are classified based on origin and cause as either manmade (anthropogenic) or natural. Commonly identified natural productions included disease outbreaks, plagues/invasions, floods, landslides/mudslides, droughts, and famine. Additionally, though utterly devastating but occurring less frequently in Rwanda, other natural productions (geographic) included earthquakes and volcanic eruptions in neighboring countries. Common manmade production issues, as identified in Figure 5 below, include a lack of reliable local suppliers of raw materials, components, and equipment, inconsistency in the supply of raw materials due to transportation issues, import delays, and market volatility. The study finds that there is a lack of modern technology in Manufacturing SMEs in Rwanda. Most organizations still use traditional communication methods in the supply chain for exchanging messages, documents, and updates between stakeholders like suppliers, distributors, and customers. This may lead to delays in decision making, and response time due to internet network and technology infrastructure. It also reveals the issue of the absence of security of integrated communication platforms that pose data security. These findings align with (García-Alcaraz et al., 2020; Song et al., 2024) who asserted that communication through digital platforms enables SMEs to monitor raw materials availability and communicate proactively with suppliers to solve the challenges. This helps to improve supply chain visibility and better reduce disruptions while ensuring the sustainability of production operations (Shi et al., 2023). While Panahifar et al. (2018) stressed that information security in digital communication is crucial to enhance trust between partners.

The study findings also pointed out the challenges of inefficient inventory management practices that 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 understanding of stockout. Modern software and digital platforms can optimize inventory levels, increase inventory turnover rates, and decrease stockouts to assist SMEs in cutting costs and improving 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) who asserted 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 is in line with (Shin et al., 2017), who asserted that effective communication between partners reduces unnecessary arguments and positively increases the outcomes even when actors experience disputes.

The results show that SMEs can use communication integration to automate and streamline various operational operations (Mo et al., 2023), including scheduling, inventory control, production planning, and quality

assurance (Tan & Sidhu, 2022). SMEs can increase overall productivity, reduce the rate of human error, and enable smooth data sharing and communication across various departments and stakeholders by utilizing 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 concerning the strategies adopted in increasing communication integration. The findings show that manufacturing SMEs can use digital technologies such as enterprise resource planning (ERP) systems to integrate business processes. The cloud-based collaboration platforms for team communication regardless of their location. The study findings also find the use of supply chain software 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 (ERP, inventory management, production planning, etc.) with their suppliers, distributors, and logistics partners to provide an efficient flow of information throughout the 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 the network theory, manufacturing SMEs through networks can develop contingency plans based on the relationship between many 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), that effective communication identifies and minimizes biases causing misattribution and avoids unintentional deterioration of relationships that later 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 it 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 from the views of supply chain managers to increase responsiveness in manufacturing supply chains is shortened lead times. Asamoah, Agyei-Owusu, Andoh-Baidoo, and Ayaburi (2021) asserted that analyzing lead times is of high significance, especially in the supply of critical items as time values are more vital in manufacturing SMEs. The sensitiveness of the time factor is the need to deliver goods in time so they can be availed to the customers at the right time in perfect condition (Porcu et al., 2019). This could be achieved by utilization of local sources of supply or through having strategic suppliers ready to deliver when the need arises.

Transport and capacity planning emerged as a strategy used by manufacturing SMEs to respond quickly to production. Unidentified circumstances and, at times, ruined infrastructure make planning for transportation and volume capability challenging. Muazu (2019) arrived at a similar conclusion terming transportation as a significant link between agencies as it facilitates the flow of goods among them. Organizations can take advantage of 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 main sectors that are responsible for capacity planning on matters about manufacturing firm distribution logistics are warehousing, transport, material handling devices, and human resources.

The postponement strategy decrees that organizations should postpone the creation or delivery of the product for as long as they possibly can. Onger Oloro (2021) agreed that the postponement strategy aims at reducing inventory obsolescence and eliminating the risks and uncertainty costs that may arise from having unwanted products. It, however, requires an integrated and agile supply chain to effectively generate and develop the most recent demand prognoses along the supply chain to produce or allocate suitable products for individual clients. The conditions where postponement becomes the only option are scarce but may occur for particular classes of products or channels in an organization. The driving forces making manufacturing firms design responsive

supply chains emerged as the need to rescue lives, pressure from partners, and the increased number of productions and emergencies in the contemporary period.

Test of Hypothesis 1: Communication integration and Performance of Manufacturing firms in Rwanda

A correlation analysis for the construct of communication integration was conducted to determine how communication integration correlated with the performance of manufacturing firms 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 variables being tested. This is in line with the findings of Kang et al. (2021). Table 3 shows that the Pearson correlation coefficient was 0.769. These findings indicate that there is a strong positive linear relationship between communication integration and the performance of manufacturing firms in Rwanda.

Table 3: Correlation Analysis for Construct Communication Integration

Variables		Performance of Manufacturing firms	of Communication integration
Performance of Manufacturing firms	Pearson Correlation	1	.769**
	Sig. (2-tailed)		.000
	N	213	213
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 influence of communication integration on the performance of manufacturing firms. The hypothesis to test for this specific objective was:

$$H_0: \text{Communication integration does not significantly influence the performance of manufacturing firms in Rwanda.}$$

The histogram in Figure 2 indicates that the data was normally distributed. The residual describes the error in the model's fit to the i^{th} observation y_i and is used to provide information about the adequacy of the fitted model. According to Muazu (2019), analysis of 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.

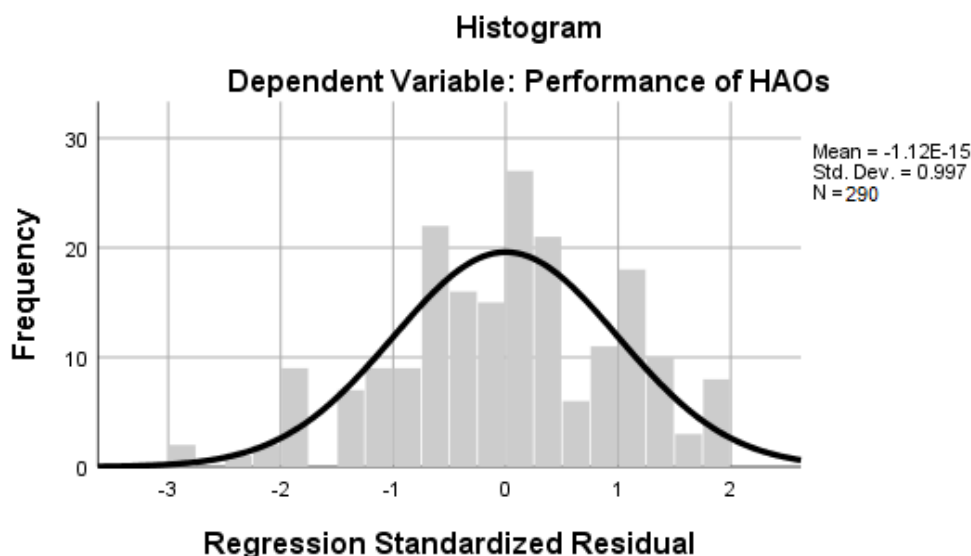


Figure 2: Histogram communication integration on the performance of manufacturing firms

The linear regression model shows $R^2=0.585$ which means that about 58.5 percent of the total variance in the performance of manufacturing firms in Rwanda can be explained by communication integration. The result is shown in Table 4.41 below.

Table 4: Model Summary of Communication integration

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

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

Further test 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 5. This implies that communication integration has a significant influence on the performance of manufacturing firms.

Table 5: ANOVA of Communication integration

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	7.439	1	7.439	12.440	.000 ^a
	Residual	162.081	212	0.598		
	Total	169.520	213			

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

Presented in Table 6 are the coefficients and t-statistics of the resulting model. The constant term $\beta_0 = 5.77$, implies that if communication integration is held constant, then there will be a positive performance of manufacturing firms in Rwanda 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 firms is predicted to increase by 0.224 units.

Table 6: 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	0.234	0.073	0.765	3.556	0.000

- a. Dependent Variable: Performance of Manufacturing firms

$$\text{Performance of Manufacturing firms} = 5.781 + 0.234 \text{ Communication integration}$$

From the results in Table 5 to Table 6 above, the null hypothesis that communication integration does not significantly influence the performance of manufacturing firms in Rwanda is rejected. The results revealed that communication integration contributes positively to the performance of manufacturing firms in Rwanda. The findings are in harmony with Omunde et al. (2022) argument that manufacturing firms' operation in unstable environments necessitates strategies that enhance their responsiveness to the customers' needs. This calls for supply chain readiness, swift disposition of the needed resources, and capacity to cope proficiently in different settings. Sharing the same view are the extant researchers Kang, Lee, Hwang, Wei, and Huo (2021), who argued that the operational performance of the manufacturing process through supply chains relies on their ability to respond swiftly to the 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 Ongeru and Osoro (2021) findings that proper supply chain response to the manufacturing needs in case of production is considered to be mitigation and satisfying the initial and vital needs of the customers. Thus, it ought to be done in the shortest time using the least amount of resources to reduce the terrible effects of the production.

Moderating Effect of Information Sharing

The study hypothesis was;

H₀₂: Information sharing does not moderate the relationship between communication integration and the performance of manufacturing firms in Rwanda.

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

Models:

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

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

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

Upon regressing the variables and as shown in Table 7, the Coefficient of Determination (R²) for the first model was 0.585, meaning that communication integration, on its own, contributes 58.5% to the performance of manufacturing firms in Rwanda. Nevertheless, when information sharing was introduced, the relationship between communication integration and the performance of manufacturing firms in Rwanda changed significantly. Table 4.50 indicates that the R² 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 firms in Rwanda. Upon adding the interaction term X₁*Z, the model improved to R² of 0.733, an increase of 7%.

Briefly, the R² increased by 7.8 percent when the information sharing was considered in addition to the communication integration and increased by 7.0 percent when the interaction between the moderator and the communication integration was considered. This concurs with the findings of Ali et al. (2020) who asserted that through resource-based theory, digital information sharing improves manufacturing SMEs' performance. These findings conform with Li et al. (2019), that the performance of manufacturing firms 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 implied that information sharing as a predictor adds value to the model and moderates the relationship between communication integration (X₁) and the performance of manufacturing firms in Rwanda (Y).

Table 7: The moderating effect of information sharing on the relationship between communication

Model	R	R Square	Adjusted Square	R	Std. Error of the Estimate	R Square Change
1	.765 ^a	.584	.579	.74484	.585	
2	.814 ^b	.665	.661	.33453	.078	
3	.856 ^c	.732	.731	.29801	.070	

a. Predictors: (Constant), Communication integration
 b. Predictors: (Constant), Communication integration, Information sharing
 c. Predictors: (Constant), communication integration, information sharing, interaction between communication integration and information sharing
 d. Dependent Variable: Performance of Manufacturing firms

Integration and performance of manufacturing firms in Rwanda

Table 8 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 firms in Rwanda. The results, Model 1 (F-statistics=12.440, p<0.05), Model 2 (F-statistics=9.119, p<0.05), and Model 3 (F-statistics=9.611, p<0.05), indicate that all the three models remained significant despite the use of the different predictors.

Table 8: 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 firms

Table 9 presents the regression coefficients, the t-statistic, and the significance of the coefficients obtained from the three models used to investigate whether information sharing moderates the relationship between communication integration and the performance of manufacturing firms in Rwanda. The result indicates that when communication integration considered in this study was used in multiple linear regression, the constant term $\beta_0 = 5.77$, implies that if communication integration is held constant, then there will be a positive performance of manufacturing firms in Rwanda by 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 firms in Rwanda is predicted to increase by 0.224 units. This concurs with the findings of Panahifar et al. (2018); Ongeru and Osoro (2021) asserted that effective collaboration has a positive and significant impact on the performance of manufacturing SMEs. Based on the network theory, the present study highlights that secure information sharing is the most critical factor that fosters information-sharing-centered collaboration among supply chain partners. This underscores the importance of supply chain integration in enhancing the competitiveness of firms in Rwanda's manufacturing sector.

When the moderator is included, the results of model 2 show that 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 firms in Rwanda. Model 3 investigated the interaction effect between communication integration and the moderator (information sharing). The result indicated that there was a significant positive influence on the performance of manufacturing firms in Rwanda from the interaction between information sharing and communication integration ($\beta = 2.209$, $t = 5.055$, $p < 0.05$).

Table 9: Coefficients for the Models Used to Test for Moderating Effect

Coefficients a		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
Model		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 firms

Thus, the regression models after moderation become:

$$\text{Model 1: } Y = 5.770 + 0.224X_1$$

$$\text{Model 2: } Y = 2.493 + 0.450X_1 + 0.244Z$$

$$\text{Model 3: } Y = 2.130 + 0.518X_1 + 0.305Z + 2.209X_1Z$$

The study hypothesized that information sharing does not moderate the relationship between communication integration and the performance of manufacturing firms 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 influence on the dependent variable from the interaction between the moderator and the independent variable. Otherwise, the moderation is not supported. From the results in Table 4.50 to Table 4.52, the null hypothesis is rejected, and the study concludes that information sharing moderates the relationship between communication integration and the performance of manufacturing firms in Rwanda.

Conclusion

Communication Integration

From the study findings, it could be concluded that communication integration positively influenced the performance of manufacturing SMEs in Rwanda. The study showed that there was a strong relationship between 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 cover the customers' needs quickly while enabling a view of the flow of materials along the supply chains. However, the ability of the manufacturing process through supply chains to respond quickly to emergencies and productions 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 through supply chains in Rwanda resulting from the challenges faced. This shows a lack of preparedness by manufacturing firms to respond to emergencies and productions. Communication integration reduces the time taken to respond to disruptions, respond to customers' needs, and improve operational performance.

From the findings, there is a need for supply chains to be responsive as triggered by the various productions and situations disrupting communities at large in Rwanda. The findings indicated that Rwanda has experienced many forms of production, categorized based on basis of the cause/origin as manmade (anthropogenic) or natural. Frequently experienced natural productions 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. Common manmade productions identified included structural/building collapse, chemical leaks, oil spillovers, manmade 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 rising recently, increasing the number of people affected. Manufacturing firms have adopted various strategies to increase communication integration, such as modularization, postponement, shortened lead times, and prior transport and capacity planning. The driving forces making manufacturing firms design responsive supply chains emerged as the need to reduce stakeholders' pressure and the increased number of production and disruption risks.

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 important aspect in the realization of swift production response. This means that a frail structure impedes effective, efficient, and well-timed production response. It is, therefore, essential to ensure that the organization structure in manufacturing SMEs is flexible to attain easy coordination among the bureaucrats in the case of an emergency. Age and size of manufacturing SMEs were also found crucial in establishing networks, resource mobilizations, and maneuverability giving organizations an operational advantage to respond fast to disruptions. This makes the manufacturing SMEs reach many hard-to-reach areas and populations. 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 still witnessed elements of poor information sharing and poor coordination, sluggish response, wastage in the supply chains, and disruptions of the chains, all affecting the efficient and effective handling of customer needs.

Recommendations

Communication Integration

The findings of this study established that most manufacturing SMEs had knowingly or unknowingly partially implemented integration design in their supply chains. Therefore, this study recommends that supply chain managers fully adopt integration design in their manufacturing process through supply chains. The supply chain professionals should establish strategic collaborative working partnerships and agreements with industry players and experts ranging from seasoned global freight forwarders, ocean carriers, airlines, and overland transporters to critical suppliers and all other manufacturing processes through supply chain actors to allow expertise and near precision responsiveness to needs of the customers in an efficient and coordinated manner. Each of these players applies their operational expertise, assets, and networks to what they do best, creating an integrated supply chain that is responsive to the customer's needs.

The study also established that the culture of production preparedness in Rwanda is lacking despite the increasing resource allocations for the same. It is paramount that Rwanda stays prepared to minimize the effect of calamities on people and sources of livelihood. There is the absence of a legal framework and clear coordination across different types of production or actors. Importantly, there are key things that Rwanda is getting right. Links exist between Rwanda's preparedness and international processes. This indicates there is a level of commitment by the Rwandan government to establish preparedness activities and this should be viewed as a perfect starting point to build on. Developing Standard Operating Procedures containing many types of productions is a vital approach that should be prioritized by the Rwandan government operating hand in hand with implementing agencies to ensure all parties benefit from preparation. Once formulated, these procedures should be restructured occasionally to replicate new observations and internal and external changes. International, national, and subnational actors have a role to play. They should join hands with the manufacturing process through supply chains to establish a culture of preparedness, which is long overdue in Rwanda.

The study established that manufacturing firms operate in a volatile, uncertain, complex, and ambiguous environment due to the customers' changing needs. To achieve and sustain a supply chain that is resilient and responsive to the changing needs and volatile environment, the study recommends the need for organizations to design and implement a supply chain that incorporates lean and agility operations across the value chain. Furthermore, manufacturing SMEs should explore a hybrid supply chain approach that allows them to switch between lean and agile depending on the dynamics and environment.

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