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RESEARCH PAPER

Benchmarking supply chain collaboration dimensions with insights from resource-based theories: a key to manufacturing competitiveness

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ABSTRACT

Goal: Despite the increased attention to the role of supply chain collaboration on firm performance, insufficient evidence exists about the relative importance of each dimension of supply chain collaboration on manufacturing competitiveness. The purpose of this study is to examine the influence and relative importance of supply chain collaboration dimensions on manufacturing competitiveness based on resource-based theories.

Design/methodology/approach: This study employs a deductive approach to derive empirical evidence from the responses of 300 officials of manufacturing firms. The PLS-SEM is used to test the significance of conceptual predictions and IPMA is used to benchmark the most important collaborative dimensions.

Results: It is revealed that manufacturing firms capitalize on all supply chain collaboration dimensions. However, customer collaboration and supplier collaboration have a significant and positive direct influence while internal collaboration exhibits a complementary partial mediation effect. Customer collaboration is the most important dimension followed by internal collaboration and supplier collaboration.

Limitations of the investigation: This study employed a cross-section design lacking the longitudinal effect. Nevertheless, the identification, testing and validation of the conceptual model, backed up by an extensive literature review, could assist researchers in developing meaningful comparative studies.

Originality/value: The study applied PLS-SEM and IPMA to reveal the role and relative importance of supply chain collaborative dimensions on manufacturing competitiveness. Managers of manufacturing firms can emulate this knowledge within their settings and be able to compete amid increased competition and supply chain complexity.

Keywords: Supply chain collaboration; Customer collaboration; Supplier collaboration; Internal collaboration; Manufacturing competitiveness.

1 INTRODUCTION

Manufacturing is a critical vehicle for promoting industrial development, globally. In both developed and developing countries, manufacturing has occupied a front seat on the road to economic growth. In Tanzania, the manufacturing sector is the third most important behind agriculture and tourism (NBS, 2017). However, the increased globalization of manufacturing and supply chain complexity has weakened the ability of many firms to compete, especially in developing countries (Lugina *et al.*, 2022; Rwehumbiza, 2021). Rivalry has increased to the extent that firms are uncertain of what customers will demand in the future and the requirements for fulfilling this demand. Customers are in constant need of quality, innovative and affordable products while uncertainties are threatening the survival of many firms. Unless supply chain resources are effectively utilized, manufacturing firms will barely survive the market turbulence

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that affects their contribution to national economies. Traditional viewpoints on the idea of competitive advantage viewed firms as autonomous bodies (Assensoh-Kodua, 2019; Barney, 1991). However, very few organizations are self-sufficient in strategic resources, thereby leading to dependence on other firms (Peteraf and Barney, 2003). To ensure a constant flow of resources, collaboration among members of the supply chain is inevitable.

Studies investigating the role of supply chain collaboration on various aspects of firm performance are not hard to find. Many scholars strongly support the assertion that supply chain collaboration improves the competitiveness of manufacturing supply chains (Emon *et al.*, 2024). Jimenez-Jimenez *et al.* (2018) analyze the mediating role of supply chain collaboration on information technology and product innovation. Their study emphasizes the role of firm collaboration with external agents in fostering product innovation. Continuous product improvement is key to manufacturing competitiveness, particularly in developing countries like Tanzania, where innovation is a challenge to many firms. Solaimani and van der Veen (2021) explore the role of joint efforts between firms in fostering supply chain innovation. A more recent study by Lotfi and Larmour (2022) analyzes the effect of collaboration on supply chain resilience. Their study finds that the more firms collaborate, the more resilient their supply chains become. Resilience means the ability of the supply chain to prepare, respond and recover from unexpected events that would otherwise devastate the competitiveness position of the firm. Generally, the competitive gains attained through supply chain collaboration go beyond the reach of firms working in isolation. Renko (2011) indicates that individual struggle duplicates efforts, reduces productivity and decreases a firm's ability to compete.

Supply chain collaboration appears in two major divisions: vertical and horizontal (Haider, 2014; Lotfi and Larmour, 2022; Singh *et al.*, 2018). According to Saenz *et al.* (2015), vertical collaboration occurs when manufacturers work closely with suppliers and customers at different levels within the supply chain while horizontal collaboration, on the other hand, occurs when firms operating at the same level with the same customer base, collaborate. Horizontal collaboration includes the sharing of resources, markets and innovation between competing and non-competing firms to improve the operational efficiency of the supply chain (Hosseinnezhad *et al.*, 2023). Many scholars have directed attention to revealing the importance of horizontal collaboration (Karam *et al.*, 2021). However, most manufacturers prefer vertical collaboration because in horizontal collaboration the threat of opportunism is higher, firms can easily be merged or acquired to increase the market base. In the fear of losing autonomy, managers are much more interested in vertical collaboration. Hence, the focus of this study is on vertical collaboration which maximizes the level of autonomy and control over resources among firms.

Researchers have distinguished three dimensions of vertical collaboration: internal, supplier and customer collaboration (Haider, 2014; Melander, 2018). The views on the influence of the aforementioned dimensions on various aspects of firm performance are contradicting. Stank *et al.* (2001) underscore the role of internal collaboration in attaining logistical service performance. Their argument is based on the fact that internal collaboration allows the different functions of the firm to make joint decisions and have collective responsibility for outcomes. They claim that internal collaboration should form the basis for any meaningful external relations. On another hand, Duhamel *et al.* (2016) and Hosseinnezhad *et al.* (2023) argue in favour of supplier collaboration. Others have emphasized customer collaboration which entails all activities aiming at building long-term relationships with customers (Andalib *et al.*, (2023); Tukamuhabwa *et al.*, 2011). Collaboration with customers has been viewed as a key competitive weapon that every firm must possess to be able to compete.

Despite the numerous studies that have examined the roles of internal, supplier and customer collaboration on firm performance, insufficient evidence exists on the contribution of each dimension to manufacturing competitiveness. Given the importance of these dimensions and the contradicting views in the literature, this study seeks to examine the role and relative importance of each dimension on manufacturing competitiveness. Therefore, the key research question is:

To what extent do supplier collaboration, customer collaboration, and internal collaboration influence manufacturing competitiveness?

With insights from the Resource-Based View and Resources Dependence Theory, this study advances knowledge of existing literature in supply chain management by revealing the role and relative importance of each dimension of supply chain collaboration on manufacturing competitiveness. Managers of manufacturing firms can identify areas of improvement within their settings and be able to attain competitiveness amid increased competition and supply chain complexity. The rest of this paper is organized as follows: First, the theoretical framework and hypotheses are presented; Second, the research methodology is presented; Third, the results are provided; and Last, the discussion, conclusion and implications of the findings are presented.

2 THEORETICAL REVIEW

2.1 Resource-based view (RBV)

The Resource-based view is among the dominant theories used to explain firm competitiveness. The theory holds that sustained competitiveness is a combination of firm-specific resources that cannot be easily imitated by rivals (Barney, 1991; Grant, 2001). The theory was developed to explain the competitive differences among firms, based on the differences in possession of resources (Peteraf and Barney, 2003). Resource is everything, it can be tangible or intangible. Tangible resources are assets of the firm that can be seen, touched and quantified such as manufacturing plants, production equipment, technological systems, human resources and organizational structure. Intangible resources are assets that are rooted in the history of the firm and have accumulated over time such as knowledge, managerial capabilities and organizational processes and relations. They are unique and difficult to measure and nurture. With the current state of competition, most firms rely on intangible resources as they are the hardest to imitate or substitute (Ocampo, *et al*, 2017).

The RBV provides a useful theoretical lens for examining the ability of firms to compete based on internal resources. When functions exchange resources, they make use of their internal capabilities (Melander, 2018). Manufacturers practicing internal collaboration are in a better position to develop rare, valuable and intimate relationships that are difficult for competitors to replicate (Soosay, 2016). Manufacturing solutions such as enterprise resource planning, advanced planning and scheduling systems, and integrative inventory management are not without joint resource allocation, product design, and connection among the internal functions of a firm (Errassafi *et al*, 2019). Internal collaboration improves coordination, communication, and concentrated efforts within the firm. However, with increased competition, manufacturers must keep only those relations that address the competitive priorities of the firm (Moran and Meso, 2011). In this study, the RBV has been used to benchmark the overall competitiveness of firms' internal relations as indicated in Figure 1.

The application of RBV is not new in the supply chain management literature. Wu *et al*. (2006) used the RBV to assess the impact of information technology on supply chain capabilities and firm performance. Gligor and Holcomb (2013) used the RBV to analyze the role of logistic capabilities in achieving higher levels of supply chain agility. Roh *et al*. (2014) used the RBV to examine the influence of the responsive supply chain strategy on higher levels of information sharing, collaborative practices and manufacturing efficiency. Myamba and Nguni (2022) used the RBV to explain the effect of the risk-hedging strategy on manufacturing competitiveness. Despite the wide applications of RBV, it has not been used to explain manufacturing competitiveness based on supply chain collaboration in the context of the current study. The RBV is not without criticism. One of the shortcomings is that it does not pay much attention to external relations (Soosay, 2016). This hinders its application to collaborative arrangements involving external relations. The current study draws from the resource dependency theory to address this shortcoming.

2.1 Resource dependence theory (RDT)

The Resource Dependence Theory plays a crucial role in understating the relationship between supply chain collaboration and manufacturing competitiveness. Specifically, RDT recognizes the fact that no single firm possesses all the resources required to attain competitiveness. As a result, firms can obtain exclusive complementary resources from their environment to make them survive and be competitive (Pfeffer and Alison, 1987). More often, this leads to interdependencies as firms acquire essential resources from suppliers, customers and other partners (Mishra *et al.*, 2016). The RDT allows firms to address their resource gap through collaboration. As firms closely work together, they build stronger, more resilient supply chains thus enhancing their competitiveness (Biermann and Harsch, 2017). The RDT plays a major role in the supply chain context because supply chain competitiveness greatly depends on the extent of collaboration practiced among the actors of the entire supply chain.

In this study, RDT has been used to understand firms' external collaborations involving customers and suppliers. Manufacturing competitiveness highly depends on the ability of firms to satisfy customers. However, firms are not equipped with all the resources required to satisfy customers. Hence, collaboration creates access to resources and capabilities essential to make them competitive. Through formal and semiformal links, partners are made accountable for the continued improvement of their product supply chains. In this way, collaborating firms can manage uncertainties and dependencies by pooling resources which leads to improved efficiency, innovation and responsiveness to market needs. Several studies have applied RDT in supply chain management research. Mishra *et al.* (2016) used RDT to examine the moderating role of trust and dependence in maintaining buyer-supplier relationships. Salam (2017) used RDT to examine the alignment of supply chain strategies and supply and demand uncertainties. However, studies in the context of the current study are limited.

3 EMPIRICAL REVIEW AND HYPOTHESES

3.1 Research model and hypotheses

The main objective of this study is to examine the influence of supplier, customer and internal collaboration on manufacturing competitiveness. Also, the study aims to identify priority dimensions of supply chain collaboration influencing manufacturing competitiveness. A better understanding of the role of specific collaborative dimensions on manufacturing competitiveness translates to specific areas in which managers should focus their resources to attain sustainable competitive advantage. Hence, the research model in Figure 1 is established based on the reviewed literature to illustrate the relationship among the variables of this study. The model has four variables: customer collaboration, supplier collaboration, internal collaboration and manufacturing competitiveness. Customer collaboration and supplier collaboration are independent variables while manufacturing competitiveness is a dependent variable. Internal collaboration is a mediator variable.

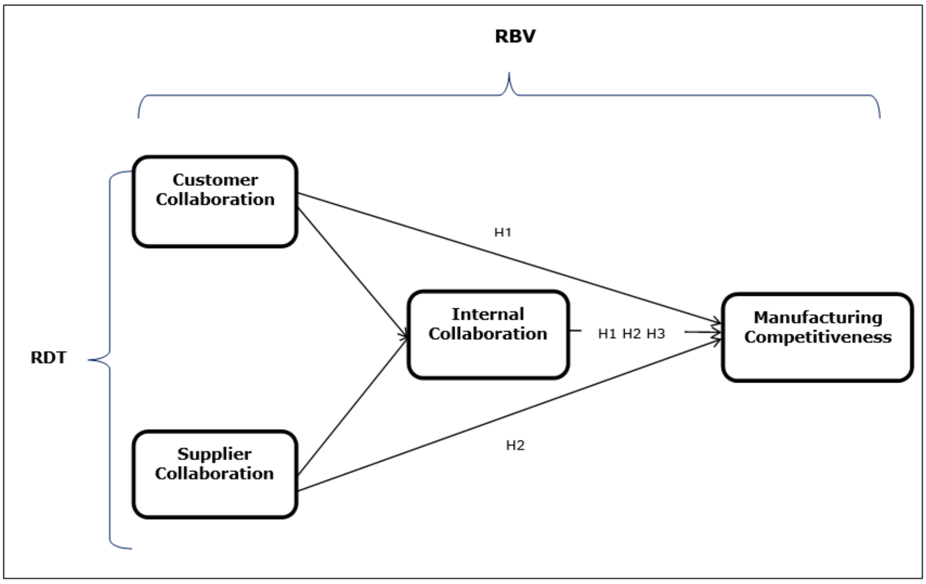

Figure 1 - Research model
Source: Literature review.

3.2 Customer collaboration and manufacturing competitiveness

Customer collaboration entails the entire array of activities taking place at the interface between the manufacturer and the customer to manage customer complaints, build long-term relationships and improve customer satisfaction (Thatte and Rao, 2013). With increased competition, customers are more powerful than manufacturers, hence strong ties with customers including wholesalers, retailers and other intermediaries can be a valuable source of manufacturing competitiveness (Ardakani *et al.*, 2022). Closer customer collaboration synchronizes supply chain activities, reduces lead times and improves the overall quality and flow of materials and products (Andalib *et al.*, 2023; Wong *et al.*, 2021). It is through collaboration that manufacturers truly identify customer needs and obtain feedback on product experience through demand forecasting and inventory management. Collaboration allows manufacturers and customers to share resources, rewards and risks. Customer collaboration has been found to improve customer satisfaction and loyalty (Srivastava *et al.,* 2024), commitment and trust (Min, 2015), product innovation (Solaimani and van der Veen, 2021), supply chain performance (Zhong *et al.*, 2022), and green supply chain performance (Ardakani *et al.*, 2022; Wong *et al.*, 2021).

Without close working with customers, it is difficult for manufacturing firms, for instance, to introduce new products and features that meet the standards of the marketplace. Researchers agree that product innovation, a key competitiveness priority could be attained at a minimum cost with joint efforts between manufacturers and customers (Thatte and Rao, 2013; Wong *et al.*, 2021). Collaboration contributes to joint knowledge creation and product development while sharing costs and responsibility among collaborating members (Solaimani and van der Veen, 2021). During product development, customers may suggest features of new products, quality and delivery time expectations that influence the costs of final products as well as materials from suppliers. Incorporating customers in the designing stage of the product improves awareness and process efficiency thereby increasing the acceptability of the product in the market. Collaboration with customers, enables manufacturers to compete based on time to market, given their ability to introduce new products faster than competitors, taking advantage of well-informed customers.

The relationship between customer collaboration and manufacturing competitiveness has been seldom studied. Despite numerous studies that have approached the performance implications of customer collaboration, little is known about how customer collaboration influences manufacturing competitiveness. Given the difficulty of many firms to attain manufacturing competitiveness and the lack of knowledge on the contribution of customer collaboration, more studies are called for in this regard. According to Solaimani and van der Veen (2021), about 50% of supply chains end up failing, especially in developing countries where firms mostly optimize the supply chains for individual benefits. Based on the identified gap, this study examines the influence of customer collaboration on manufacturing competitiveness. Hence, this study proposes that:

H1: Customer collaboration has a significant positive influence on manufacturing competitiveness

3.3 Supplier collaboration and manufacturing competitiveness

Supplier collaboration is the long-term relationship between the organization and its suppliers (Iranmanesh and Foroughi, 2019). Supplier collaboration enables firms to work more effectively with a few important suppliers who are willing to share responsibility for the success and failure of the product (Thatte and Rao, 2013). As a result, firms gain alternative resources, technologies, skills and process quality which would otherwise be costly to develop internally (Duhamel *et al.*, 2016; Nyaga *et al.*, 2010). Effective supplier collaboration can lead to significant cost improvements, implementation of lean manufacturing practices such as Just in Time, and enhanced supply chain flexibility (Emon *et al.*, 2024; Malik *et al.*, 2024). However, the competitive benefits of supplier collaboration can be realized when parties plan; synchronize decisions; solve problems; measure performance; share resources, skills and IT capabilities; and create new knowledge on products and services jointly (Lotfi and Larmour, 2022). Engaging suppliers in product design contributes significantly to cost-effective design choices which may assist manufacturers in selecting the best components and technologies for their products (Thatte and Rao, 2013). Supplier collaboration can be viewed as a powerful tool to align the interests of companies in product supply chains for better performance.

Traditional supplier relationships have been purely transactional, focusing on price as a key selection criterion for suppliers (Renko, 2011). Supplier collaboration differs from traditional relationships as it is grounded on mutual trust, information sharing, reward and risk sharing, joint problem solving, few suppliers, and multiple selection criteria for suppliers (Lotfi and Larmour, 2022). Firms in developed countries have moved from transactional relationships to more stable and long-term collaborative partnerships. In the USA, it has been found that the best-performing firms turned 75% of their traditional sourcing contracts to long-term collaborative partnerships (Malik *et al.*, 2024; Min, 2015). In China, firms that exercise external collaboration have improved their supply chain performance (Zhong *et al.*, 2022). According to Lotfi and Larmour (2022), firms that implement collaborative practices such as third-party logistics, vendor-managed inventory and collaborative planning, forecasting and replenishment experience high growth, lower operating costs, and greater profitability.

Empirical studies addressing the influence of supplier collaboration on manufacturing competitiveness are highly limited, with contradicting outcomes. The focus has been on establishing the link between supply chain collaboration and some measures of supply chain performance. For instance, Solaimani and van der Veen (2021) establish the role of vertical collaboration in supply chain innovation. Ardakani *et al.* (2022) find a positive influence of supplier collaboration on economic performance and a negative relationship between supplier collaboration and environmental performance. Lotfi and Larmour (2022) find a positive relationship between vertical collaboration and supply chain resilience. Zhong *et al.* (2022) establish a positive relationship between external collaboration and supply chain performance. Emon *et al.* (2024) find a positive relationship between supplier relationship management and supply chain performance. The extant literature highlights the positive impact of supplier collaboration on various aspects of supply chain performance. However, the role of supplier collaboration on manufacturing competitiveness in the context of the current study is not clear. To address this gap, this study examines the influence of supplier collaboration on manufacturing competitiveness. Thus, the following hypothesis is proposed:

H2: Supplier collaboration has a significant positive influence on manufacturing Competitiveness

3.4 The mediating role of internal collaboration

The mediation perspective has a general view that no strategy is universally superior irrespective of environmental and organizational context (Venkatraman, 1989). Hence, mediation tests the existence of an intermediary variable that intervenes between independent and dependent variables, specifying a transitive effect (Boyd *et al*, 2012; Ramayah *et al.*, 2018). In mediated relationships, total effects represent the direct effect of independent variables on dependent variables (including mediation effects) while mediated effects represent indirect effects that intervening variables have on direct effects. This study has two direct relationships involving the effect of customer collaboration and supplier collaboration on manufacturing competitiveness. Internal collaboration mediates the two relationships. Based on the assumptions of mediated relationships (Venkatraman, 1989), this study predicts that internal collaboration provides the mechanism through which supplier and customer collaboration influences manufacturing competitiveness.

Internal collaboration refers to the extent to which decisions are made jointly and collective responsibility for outcomes exists within the firm (Stank *et al.*, 2001). Scholars urge firms to achieve a relatively high degree of internal collaboration before embarking on any external relationships (Min, 2015; Zhong *et al.*, 2022). All supply chain activities start within the firm. Key decisions on the type and number of collaborative arrangements including collaborative terms and key performance indicators are all organized and controlled within the firm. Hence, a firm's cross-functional integration has a strong influence on the success or failure of external collaborative arrangements (Malik *et al.,* 2024). In most supply chains, however, customer collaboration and supplier relationship management have limited communication. This limits the ability of firms to effectively match demand and supply, with consequential effects on their competitiveness. If integrated, internal functions accelerate the attainment of manufacturing competitiveness by seamlessly integrating suppliers' and customers' inputs with the production process, ensuring the benefits of supply chain collaboration are fully realized. Essentially, effective internal collaboration can streamline supply chain processes, reduce redundancies and improve the overall efficiency of a firm.

Internal collaboration not only synchronizes the activities of internal functions but seeks to back up relations through joint goals, shared resources and a common vision that embraces the collaborative approach. Such relations can yield additional benefits as they create a seamless customer value delivery process. Internal collaboration has been found to have a positive influence on logistical service performance (Stank *et al.*, 2001); risk mitigation and monitoring strategies (Duhamel *et al.*, 2016); resource efficiency (Banchuen *et al.*, 2017), organizational performance (Malik et al., 2024) and supply chain performance (Zhong *et al.*, 2022). However, it is the least surveyed aspect of supply chain collaboration. Therefore, this study ascertains that internal collaboration forms the foundation for establishing useful relationships with suppliers and customers and hence, influences manufacturing competitiveness. Thus, the following hypotheses are proposed:

H3: The positive relationship between customer collaboration and manufacturing competitiveness will be stronger when internal collaboration is high
H4: The positive relationship between supplier collaboration and manufacturing Competitiveness will be stronger when internal collaboration is high
H5: Internal collaboration has a significant positive influence on manufacturing competitiveness

4 RESEARCH METHODOLOGY

4.1 Research approach

This study adopted a positivist approach to explain why and how successful firms keep excelling amid the challenges of increased competition and supply chain complexity. The use of the positivist philosophy was justified by the fact that this study is grounded on predefined theories and hypotheses which are used to examine the cause-and-effect relationships among the tested variables (Saunders *et al.*, 2013; Antwi and Kasim, 2015). The study employed an explanatory, cross-section research design with a survey strategy, involving the collection of hard data in the form of numbers and testing of hypotheses while ensuring high levels of validity and reliability of findings. The methodology employed was highly structured, thus facilitating the replication and generalization of the study findings.

4.2 Measurement of variables

Existing literature has operationalized supply chain collaboration in two variables: internal and external collaboration (Duhamel *et al.*, 2016; Solaimani and van der Veen, 2021; Stank *et al.*, 2001; Zhong *et al.*, 2022). And in most cases, supplier and customer collaboration has combined to form a single variable, namely external collaboration. However, given the different roles they play in product supply chains, firms' collaborative requirements with customers differ from those of suppliers. Hence, benchmarking the contribution of each dimension is of paramount importance. Based on Thatte and Rao (2013) and Ardakani *et al.* (2022), this study operationalized supply chain collaboration using three variables, namely customer collaboration, supplier collaboration, and internal collaboration. The research model in Figure 1 presents the relationship among four reflectively measured latent variables namely, customer collaboration, supplier collaboration, internal collaboration and manufacturing competitiveness. Customer collaboration and supplier collaboration are independent variables, manufacturing competitiveness a dependent variable and internal collaboration a mediator variable.

The operational definition of customer collaboration is "the extent to which firms manage customer complaints, build long-term relationships and improve customer satisfaction". Five indicators of customer collaboration were adapted from Thatte and Rao (2013). These include the firm's ability to: frequently interact with customers, frequently measure customer satisfaction, frequently determine future customer expectations, facilitate customers' ability to seek assistance from the firm, and periodically evaluate the importance of its relationship with customers.

Supplier collaboration is defined as "the extent to which firms create long-term relationships with suppliers". Indicators were adapted from Thatte and Rao (2013) and they include the ability of the firm to: select suppliers based on quality, solve problems jointly with key suppliers, help key suppliers to improve product quality, establish long-term beneficial relationships with key suppliers, include key suppliers in goal-setting activities, and involve key suppliers in new product development.

The operational definition of internal collaboration is "the extent to which decisions are made jointly and collective responsibility for outcome exist within the firm". Internal collaboration was measured by the ability of the firm's internal functions to: effectively share operational information, work well together, solve conflicts together, know a great deal about manufacturing, work interactively with each other, coordinate their activities and encourage integration (Stank, Keller and Daugherty, 2001).

Manufacturing competitiveness was operationalized as "the ability of a firm to design, produce and deliver products in such a way that it is difficult for competitors to imitate or substitute based on price and non-price qualities". Five indicators were adapted from Thatte and Rao (2013) and they include the ability of the firm to compete based on: quality of the products, price, on-time delivery, innovation and time to market. To avoid biased computations and enable comparison with existing studies (Myamba and Nguni, 2022), all variables were measured using multi-item indicators of five-point Likert-type scales ranging from 1= strongly disagree to 5= strongly agree.

4.3 Study area, sampling and data collection

This study was conducted in Tanzania. During the study, there were 54,017 manufacturing establishments in Tanzania (NBS, 2017). The units of analysis consisted of manufacturing firms, while units of inquiry comprised CEOs/presidents, directors and managers of manufacturing firms. The units of inquiry were used to represent firms' interests in the study aspects rather than personal views. Thus, in each manufacturing firm, a well-informed high-ranking official was contacted as they are considered the best when accessing corporate strategies and performance data. Sample size was obtained using Yamane's formula, $n = N / [1 + N (e)^2]$ whereby, n = sample size, N = population of the study, and e = acceptable sampling error (Yamane, 1973). Based on the nature of the study, a 5% margin error was assumed and a 95% confidence interval was allowed to obtain the maximum sample size. The sample size of this study was $n=54{,}017 / [1+54{,}017 (0.05)^2]$ = 397 firms. For a meaningful representative sample, manufacturing firms starting with 40 employees were considered for the study as opposed to what is considered as large firms (Qi *et al.*, 2009). The decision was reached because many firms could not attain the criteria for larger firms.

Within the constraints of time and other resources, a two-stage sampling technique, involving cluster and simple random methods, was used to select firms of interest from three regions of Tanzania, namely, Dar es Salaam, Arusha and Mwanza (Bhattacherjee, 2012). The regions were purposively selected, based on the intensity of industrial activities. In each cluster, firms of interest were selected using the fishbowl draw procedure (Kumar, 2011). This involved numbering each firm using a separate slip of paper, putting them into a box and picking them one by one without replacement, while mixing papers each time a sample was drawn. Thereafter, a numbered list of all respondents was prepared, outlining their addresses, telephone numbers, physical location and any other useful information. Three research clearance letters were sought from the relevant authority to introduce researchers to three regions. Primary data were collected using a survey questionnaire and each questionnaire was given a number exactly matching the list of respondents. Data collection involved recruiting three research assistants. Research assistants were trained for two days and oriented with the nature of the study, objectives and questions.

Before large data collection, a pilot study was conducted. Questionnaires were administered to academic staff in the field of logistics and supply chain management to assess content validity. Their feedback helped to refine the instrument by removing ambiguous statements, unnecessary questions, and improving the clarity of questions. During large data collection, questionnaires with cover letters, indicating the purpose of the research, and respondents' roles together with guaranteed confidentiality, were sent to respondents for onsite completion and only a few via email. Completed questionnaires were collected each day after ensuring that they were correctly filled. Collected data were entered into IBM SPSS 21 (.csv) data file each day. Of 397 surveys, 302 were collected, making a 76% response rate. Two questionnaires were discarded on grounds of extremely suspicious response patterns, remaining with 300 usable questionnaires. Based on previous studies: 47% (Salam, 2017), 73% (Rahimnia and Keyvanipoor, 2014) and 77% (Wu *et al.*, 2014) the response rate is considered acceptable and high. Table 1 presents key descriptive statistics of respondents.

Table 1 - Key descriptive statistics of respondents

Descriptive Item		Frequency	Per cent
Firm ownership	Government	23	7.7
	Private	277	92.3
Firm experience	10 years +	43	14.3
	20 years +	175	58.3
	30 years +	82	27.3
Firm Size (employees)	40-100	147	49
	101+	150	50
Occupation	CEO/President	15	5
	Director	21	7
	Manager	146	48.7
	Other	116	38.7
Total number of respondents			**300**

4.4 Data analysis method

There are two major approaches for testing structural models: covariance-based SEM (CB-SEM) and variance-based SEM (PLS-SEM) (Jörg Henseler *et al.*, 2016). This study opted for Partial Least Squares Structural Equation Modeling (PLS-SEM). The PLS-SEM method was selected because it fits the needs of this study. PLS-SEM is capable of explaining variation in the dependent variable based on the direct and indirect effects (Hair *et al.*, 2017). Although most interactive effects lose precision as more independent variables are incorporated into the model (Umanath, 2003; Venkatraman, 1989), the greater statistical capability of PLS-SEM overcomes this problem, making it suitable for mediation analysis. Being a prediction-oriented method, PLS-SEM seeks to understand the increased complexity of study concepts by exploring extensions of established theories (Hair *et al.*, 2019). Hence, PLS-SEM aims to maximize the explained variance, making it suitable for predictive research like this (Hair *et al.*, 2017; Wong, 2016). In addition, PLS-SEM is capable of simultaneously analyzing both direct and mediation effects at once.

For structural models with mediation effects, traditional methods required the independent estimation of models with total effects and mediation effects. To justify the presence of mediation effects, one needed to establish significant effects between: first, the independent and dependent variables; second, the independent and mediator variables; and third, the mediator and dependent variables (Baron and Kenny, 1986). Also, the effect of the independent variable on the dependent variable must shrink after adding the mediator variable (Zhao, Lynch and Chen, 2010; Ramayah *et al.*, 2018). However, with recent developments this procedure has limitations. First, the stepwise analysis reduces the statistical power of the model to detect small mediation effects (Mackinnon, Coxe and Baraldi, 2012). Second, the measurement differences created as new variables are being added to the model could bias the evaluation results (Laosirihongthong, Adebanjo and Choon Tan, 2013). Third, the Sobel test (based on normal distribution) which has been used for testing indirect (non-normal distribution) effects in mediated models has low power (Hair *et al.*, 2017; Laosirihongthong *et al.*, 2013; Mackinnon *et al.*, 2012; Ramayah *et al.*, 2018; Zhao *et al.*, 2010).

The bootstrapping method (nonparametric) has been considered a more rigorous and powerful method for testing mediation effects (Preacher and Hayes, 2008; Mackinnon, Coxe and Baraldi, 2012; Hair *et al.*, 2017; Ramayah *et al.*, 2018). The SEM-based bootstrapping is capable of estimating the traditional steps simultaneously, with the integrated structural model (Ramayah *et al.*, 2018; Zhao *et al.*, 2010). PLS-SEM bootstrapping is much superior to covariance-based as it does not assume the sampling distribution of the statistic thus increasing its power to detect small mediation effects with more confidence (Hair *et al.*, 2017). Bootstrapping with PLS-SEM can detect total, direct and indirect effects using a single PLS path model, reducing measurement errors (Laosirihongthong, Adebanjo and Choon Tan, 2013). In light of modern approaches, this study relied on the PLS-SEM bootstrapping procedure to test for the significance of the hypothesized relationships.

Consistent with Hair *et al.* (2017) Jörg Henseler *et al.* (2016) and Wong (2016), data analysis entailed analysis of the reflective measurement model and structural model. The measurement model delivers empirical results of the relationship between indicators and variables while the structural model gives results of hypothesized relationships. SmartPLS 3.2.7 software was used to estimate both models. The choice was based on its ability to implement many latest PLS-SEM extensions, including mediation, without difficulties (Wong, 2016). Further, SmartPLS 3.2.7 creates a user-friendly environment for features like importance-performance map analysis (IPMA) and advanced bootstrapping (Matthews, 2017). Hence, in the first place, the PLS Algorithm with a path weighting scheme involving 300 maximum number of iterations and a stop criterion of 1.10^{-7} was executed to obtain results of the measurement model. The PLS Algorithm successfully converged after 7 iterations. Second, the structural model was subjected to a 95% bias-corrected and accelerated bootstrapping procedure with 5000 subsamples and 300 bootstrap cases using no sign changes to obtain significance testing results for hypothesized relationships.

Apart from significance testing results, IPMA was executed to benchmark the relative importance of each dimension of supply chain collaboration on manufacturing competitiveness (Tailab, 2020). Since manufacturing competitiveness can only be attained by focusing resources on variables of high importance, the results are of greatest value to manufacturing firms with limited resources (Hock, Ringle and Sarstedt, 2010; Silva and Fernandes, 2011; Ringle and Sarstedt, 2016; Wyrod-Wrobel and Biesok, 2017). The IPMA contrasts the importance of all predecessor variables on the *x*-axis with their performance on the *y*-axis (Ringle and Sarstedt, 2016). Four hypothetical quadrants are used to interpret IPMA results. Priority variables with high performance can be found in the lower right area of the IPMA. The highest competitive gains can be achieved by improving the variables in this area, followed by the higher right, lower left and finally higher left areas (Ringle and Sarstedt, 2016). The computations of IPMA are integrated with SmartPLS 3.2.7.

5 RESULTS

5.1 Assessment of the measurement model

The measurement model comprising four variables, namely customer collaboration, supplier collaboration, internal collaboration, and manufacturing competitiveness was assessed in an integrated manner. Initially, the measurement model consisted of 23 indicators: customer collaboration (5), supplier collaboration (6), internal collaboration (7) and manufacturing competitiveness (5). After subjecting it to reliability and validity tests, the model was refined and five (5) indicators were dropped because they had no significant contribution to composite reliability or average variance extracted (AVE) (Hair *et al.*, 2017). The remaining eighteen (18) indicators were used in subsequent analyses. Measures of internal consistency reliability and indicator reliability were used to test the reliability of the measurement model while validity was assessed using convergent and discriminant validity. Measurement model results are summarized in Figure 2 and Table 2. The results indicate that all variables' measures are reliable and valid. Detailed results are presented in Tables 3, 4, and 5. Consistent with Kock (2015) and Hair *et al.* (2019) common method bias (CMB) was assessed using variance inflation factor (VIF).

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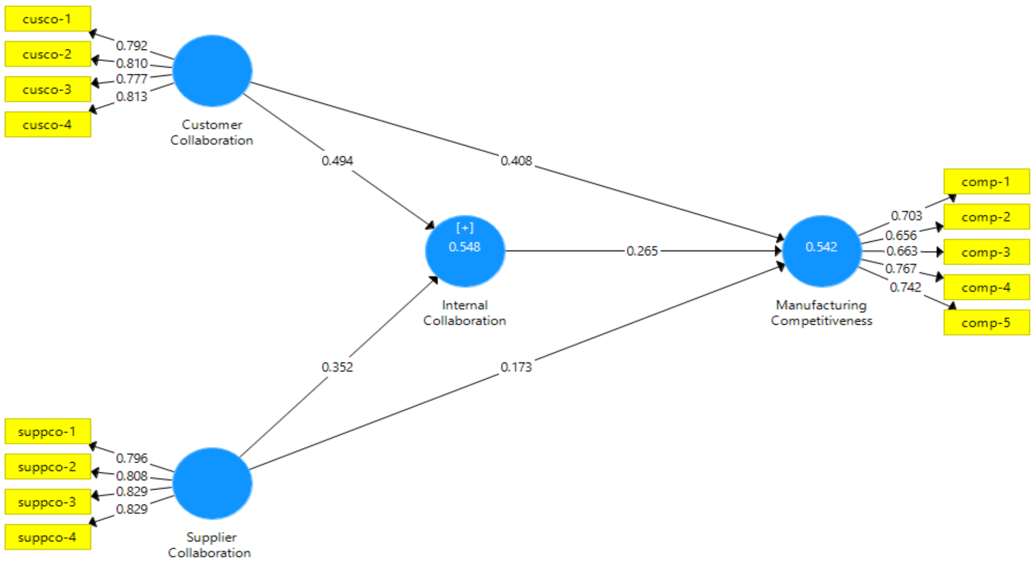


Figure 2 - Evaluation results of the measurement model

Table 2 - Measurement model evaluation results

Criterion	Rule of Thumb	Suggested Reference	Evaluation Results
Indicator reliability	Indicator loadings ≥ 0.40 in an exploratory study	Hulland (1999)	> 0.40; Obeyed
Composite reliability	Composite reliability ≥ 0.60 in an exploratory study	Henseler et al. (2009)	> 0.60; Obeyed
Convergent validity	AVE > 0.50	Bagozzi and Phillips (1982)	> 0.50; Obeyed
Discriminant validity	HTMT significantly < 1	Henseler et al. (2016)	< 0.85; Obeyed
Common Method Bias	VIF ≤ 3	Kock (2015) and Hair et al. (2019)	< 3; Obeyed

Indicator reliability is obtained by squaring the standardized indicator's outer loading. Usually, indicator loadings of above 0.708 are recommended (Hair *et al.*, 2017). Higher outer loadings indicate that the variable's associated indicators have much in common. However, in areas where theory is less developed, indicator loadings of 0.40 are considered adequate (Hulland, 1999). The results in Table 3 indicate that all variables have attained good indicator reliability with only two indicators (comp-2 and comp-3) attaining loadings below 0.70 but above 0.656. Consistent with Henseler *et al.* (2009) and Hair *et al.* (2019), composite reliability was used to assess internal consistency reliability. Composite values of 0.60 and above are considered acceptable, values between 0.70 and 0.90 are good, and values of 0.95 and above are problematic. Looking at Table 3 it is clear that all latent variables have attained a high degree of internal consistency because composite reliability values range from 0.83 to 0.90.

Table 3 - Reliability and convergent validity results

Coding	Latent Variable/Indicator	Composite Reliability	AVE	Outer Loading
	Customer Collaboration			
Cusco-1	My firm frequently measures customer satisfaction	0.875	0.637	0.792
Cusco-2	My firm frequently determines future customer expectations			0.810
Cusco-3	My firm facilitates customers' ability to seek assistance from us			0.777
Cusco-4	My firm periodically evaluates the importance of our relationship with customers			0.813
	Supplier Collaboration			
Supco-1	My firm considers quality as our number one	0.888	0.665	0.796

	criterion in selecting suppliers			
Supco-2	My firm regularly solves problems jointly with key suppliers			0.808
Supco-3	My firm has helped key suppliers to improve their product quality			0.829
Supco-4	My firm establishes long-term beneficial relationships with key suppliers			0.829
	Internal Collaboration			
Interco-1	My firm's functions work well together	0.902	0.649	0.719
Interco-2	My firm's functions know a great deal about manufacturing			0.800
Interco-3	My firm's functions work interactively with each other			0.892
Interco-4	My firm's functions coordinate their activities			0.840
Interco-5	My firm's incentive system encourages integration			0.766
	Manufacturing Competitiveness			
Comp-1	We offer competitive prices	0.833	0.501	0.703
Comp-2	We are able to compete based on quality			0.656
Comp-3	We deliver the kind of products on time and as needed			0.663
Comp-4	We respond well to customer demand for new features			0.767
Comp-5	We have time to market lower than the industry average			0.742

Validity was assessed using two common approaches: convergent and discriminant validity. Convergent validity was assessed using AVE, whereby all variables with values higher than 0.50 provide good support for the variables' convergent validity (Bagozzi and Phillips, 1982; Hair *et al.*, 2017). The results in Table 3 confirm convergent validity because AVE values are beyond the 0.50 threshold. SmartPLS produces three measures of discriminant validity: cross-loadings, Fornell-Larcker Criterion and Heterotrait-Monotrait Ratio (HTMT). HTMT was used to assess discriminant validity because according to Benitez *et al.* (2020) and Hair *et al.* (2019), it is more effective than the other measures. According to Henseler *et al.* (2016), $HTMT_{0.85}$ is a liberal measure of discriminant validity and $HTMT_{0.90}$ is more critical. The results in Table 4 indicate that all HTMT values are within the 0.85 threshold. Moreover, the upper confidence interval (CI) limits obtained from bootstrapping routine involving 5000 subsamples using no sign changes do not include 1, confirming discriminant validity.

Table 4 - HTMT Results

Variable	Customer Collaboration	Internal Collaboration	Manufacturing Competitiveness	Supplier Collaboration
Customer Collaboration				
Internal Collaboration	.803 CI.90[0.722; 0.883]			
Manufacturing Competitiveness	.851 CI.90[0.778; 0.924]	0.789 CI.90[0.709; 0.868]		
Supplier Collaboration	.629 CI.90[0.540; 0.724]	.715 CI.90[0.614; 0.812]	.675 CI.90[0.545; 0.802]	

Structural equation models may pass reliability and validity tests and still be contaminated by CMB (Kock, 2015). The presence of CMB inflates reliability and validity estimates, leading to incorrect results. Thus, it is important to report CMB severity and respective control actions. VIF was used to assess CMB. The VIF is a full collinearity test. Values of VIF exceeding 3.3 reflect CMB problems (Kock, 2015). In VIF analysis, manufacturing competitiveness and internal collaboration were considered dependent variables since they have arrows pointing toward them. As such, two different sets of linear regression models were used to derive VIF values (Wong, 2016). In the first set, manufacturing competitiveness served as a dependent variable, with customer collaboration, supplier collaboration and internal collaboration pointing to it. In the second set, internal collaboration served as a dependent variable with customer collaboration and supplier collaboration pointing to it. Results in Table 5, show no sign of CMB problems between each set of independent variables.

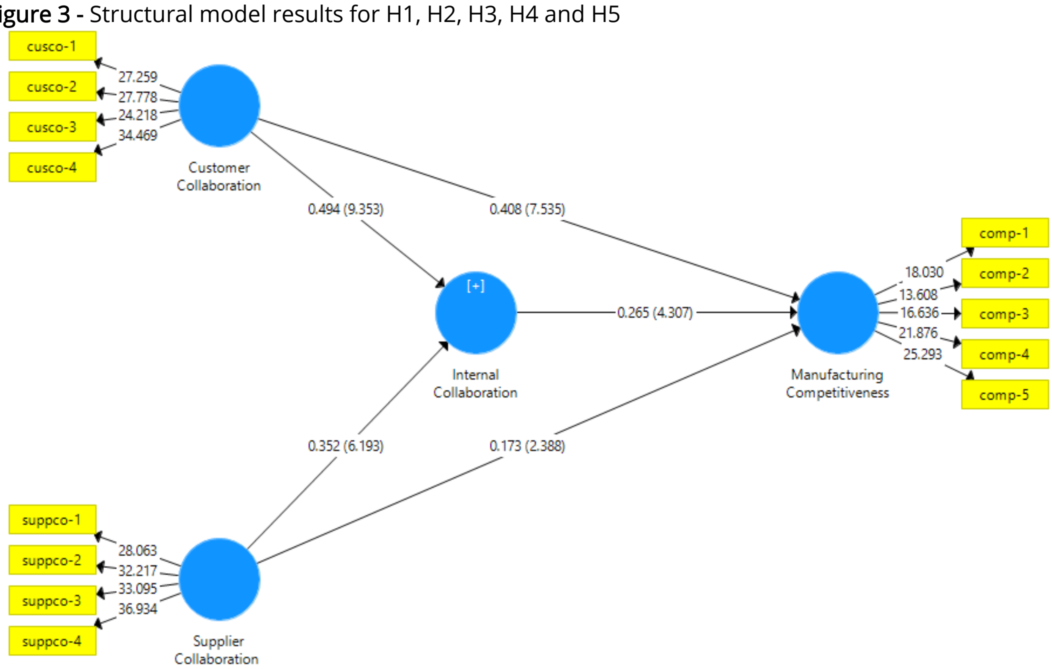
Table 5 - Common method bias results

Independent Variable	Dependent Variable		CMB Problem (VIF > 3?)
	Manufacturing Competitiveness	Internal Collaboration	
Customer collaboration	1.912	1.373	No
Supplier collaboration	1.646	1.373	No
Internal collaboration	2.213		No

5.2 Assessment of the structural model

The structural model was evaluated based on heuristic criteria, determined by its predictive capabilities that include: coefficient of determination (R^2), predictive relevance (Q^2) and significance of the path coefficients (β) (Hair *et al.*, 2019). Structural model results, involving direct and indirect effects, are displayed in Figure 3 and Table 6. The R^2 evaluates the predictive power of the PLS Path model. It accounts for the amount of variance in the dependent variable as explained by all independent variables (Henseler *et al.*, 2009). The R^2 values of 0.67. 0.33 and 0.19 are considered substantial, moderate and weak, respectively (Chin, 1998). The results indicate that R^2 has attained a moderate value of 0.542. This value is above the suggested threshold, confirming the structural model's predictive validity. Hence, customer collaboration, supplier collaboration and internal collaboration, together explain 54% of the variation in manufacturing competitiveness. Further, statistical evidence from the blindfolding procedure indicates that the model has a medium predictive relevance (Q^2 = 0.251) because values of 0, 0.25 and 0.50 respectively depict small, medium and large predictive relevance (Hair *et al.*, 2019). Thus, the structural model has attained moderate predictive power and relevance.

Figure 3 - Structural model results for H1, H2, H3, H4 and H5



After ascertaining the predictive power and relevance of the PLS Path model, path coefficients (β) were used to determine the strength of the hypothesized relationships (Hair *et al.*, 2017). Essentially, β values close to +1 indicate strong positive relationships while values close to -1 indicate strong negative relationships. Path coefficients were obtained from the results of the PLS Algorithm. In addition, significance testing of hypotheses involved analyzing empirical t and p values. The critical t value for two-tailed tests is 1.96 at a 5% (p < 0.05) significance level (Bhattacherjee, 2012). Apart from t and p values, confidence intervals were used to justify significance tests, in which a significant relationship exists when confidence intervals do not include zero (Kock, 2016). Based on *t* and *p* values together with confidence intervals obtained from the bootstrapping procedure, total and mediation effects were assessed. The results of hypothesized relationships are found in Table 6.

Total effects represent the effect of independent variables on dependent variables inclusive of mediation effects. Total effects involved analyzing the significance of H1 and H2. Interestingly, H1 was found significant at $\beta = 0.539$ and $p < 0.000$. This evidence, together with the fact that the confidence intervals [0.441; 0.641] do not include 0, leads to the acceptance of H1. The results indicate that improvement in customer collaboration will most likely improve manufacturing competitiveness by 53.9%, *ceteris Paribas* (Hair *et al.*, 2017). In other words, customer collaboration is positively and significantly related to manufacturing competitiveness. Also, H2 proved significant at $\beta = 0.266$ and $p < 0.000$. Further, confidence intervals [0.133; 0.396] do not include 0, justifying the acceptance of H2. This means improvement in supplier collaboration will most likely improve manufacturing competitiveness by 26.6%. Specifically, the results of the direct relationships indicate that customer collaboration has a stronger effect on manufacturing competitiveness than supplier collaboration.

Table 6 - Hypotheses testing results

No.	Relationship	Path Coefficients	t-Values	p-Values	95% Confidence Intervals	Significance (p < 0.05)?
Hypotheses with Direct Effects						
H1	Cusco → Comp	0.539	10.569	0.000	[0.441; 0.641]	Yes
H2	Supco → Comp	0.266	3.971	0.000	[0.133; 0.396]	Yes
Hypotheses with Indirect Effects (Mediation)						
H3	Cusco → Interco → Comp	0.131	3.809	0.000	[0.067; 0.203]	Yes
	Cusco → Comp	0.408	7.535	0.000	[0.302; 0.516]	
H4	Supco → Interco → Comp	0.093	3.656	0.000	[0.047; 0.145]	Yes
	Supco → Comp	0.173	2.388	0.017	[0.032; 0.318]	
H5	Interco → Comp	0.265	4.307	0.000	[0.140; 0.382]	Yes
	R2	0.542				
	Q2	0.251				

Source: The authors themselves.

The purpose of H3 and H4 was to examine mediation effects involving internal collaboration. The starting point when analyzing mediation effects is to evaluate the significance of the indirect relationship (Cepeda *et al.*, 2017; Errassafi *et al.*, 2019; Preacher and Hayes, 2008). Bootstrapping results in Table 6, indicate that both indirect effects, "Cusco → Interco → Comp and Supco → Interco → Comp" are significant and positive ($\beta = 0.131$, $p < 0.000$ and $\beta = 0.093$, $p < 0.000$), respectively. This indicates the presence of mediation effects. Further, confidence intervals, [0.067; 0.203] and [0.047; 0.145] respectively justify the existence of mediation effects. However, in reporting mediation effects, it is important to determine the type and magnitude of mediation effects. Thus, for each significant indirect relationship, this involved establishing the significance of the direct effects. As indicated in Table 6, results reveal a significant direct relationship between customer collaboration and manufacturing competitiveness ($\beta = 0.408$, $p < 0.000$) with [0.302; 0.516] confidence intervals. According to Cepeda *et al.* (2017), this suggests the existence of a partial mediation effect, indicating that internal collaboration partially explains the influence of customer collaboration on manufacturing competitiveness.

To further substantiate the type of partial mediation effect for H3, the product of path coefficients for indirect and direct effects (0.131*0.408= 0.053) was calculated, giving a positive sign. This indicates that internal collaboration exerts a complementary partial mediation effect on the relationship between customer collaboration and manufacturing competitiveness (Cepeda *et al.*, 2017). By complementary, it means internal collaboration increases the effect of customer collaboration on manufacturing competitiveness. Specifically, this means higher levels of customer collaboration directly increase manufacturing competitiveness, but also increase internal collaboration, which, in turn, increases manufacturing competitiveness (Hair *et al.*, 2017). This evidence leads to the acceptance of hypothesis H3, reinforcing the assertion that "the positive relationship between customer collaboration and manufacturing competitiveness will be stronger when internal collaboration is high".

For H4, the direct relationship (Supco → Comp) was found significant at β = 0.173, p < 0.017, with confidence intervals [0.032; 0.318] not including zero. This justifies the existence of mediation effects. However, this kind of result suggests the existence of a partial mediation effect, indicating that some of the supplier collaboration's effect on manufacturing competitiveness is explained by internal collaboration. Looking at the product of the path coefficients for indirect and direct effects (0.093*0.173= 0.016), it has a positive sign. It can be concluded that internal collaboration exhibits a complementary partial mediation effect on the relationship between supplier collaboration and manufacturing competitiveness (Cepeda *et al.*, 2017). The implication is that internal collaboration increases the effect of supplier collaboration on manufacturing competitiveness. This means higher levels of supplier collaboration directly increase manufacturing competitiveness, but also increase internal collaboration, which, in turn, increases manufacturing competitiveness (Hair *et al.*, 2017). This evidence justifies the acceptance of hypothesis H3, which reinforces the assertion that "the positive relationship between supplier collaboration and manufacturing competitiveness will be stronger when internal collaboration is high".

The final requirement in establishing significant mediation effects is to confirm the significance of the direct relationship between the mediator variable and the dependent variable (H5). Significance testing results in Table 6 indicate that internal collaboration (Interco → Comp) is significantly and positively related to manufacturing competitiveness (β = 0.265, p < 0.000) with confidence intervals [0.140; 0.382] not including zero. These results lead to the acceptance of H3 and H4, specifically indicating that a one-unit increase in internal collaboration (which also depends on improvements in customer and supplier collaboration) increases manufacturing competitiveness by 26.5%, *ceteris Paribus* (Hair *et al.*, 2017). These results confirm that internal collaboration can be a significant mediator in the relationship involving customer collaboration, supplier collaboration and manufacturing competitiveness.

6 RESULTS OF IPMA

Since all independent variables were reflectively measured, the IPMA is limited to the latent variables. The first requirement in carrying out IPMA requires the measurement model to support measures' reliability and validity (Ringle and Sarstedt, 2016). Measurement model results in Tables 3, 4 and 5 confirm that all measures are reliable and valid. The second requirement is the significance of the path coefficients (Ringle and Sarstedt, 2016; Tailab, 2020). Structural model results in Table 6 indicate that all path relationships are positive and significant. The third requirement is to inspect the signs of the outer weights (Ringle and Sarstedt, 2016). The PLS algorithm report indicated that all outer weight signs are positive. The last requirement is to specify each indicator's minimum and maximum values for rescaling data because SmartPLS 3.2.7 does not correctly rescale indicator data (Ringle and Sarstedt, 2016). Based on the fact that some respondents did not use the full range of indicator scales (i.e., 1-5), a minimum value of 1 was manually inserted in the minimum column during the automated derivation of the IPMA.

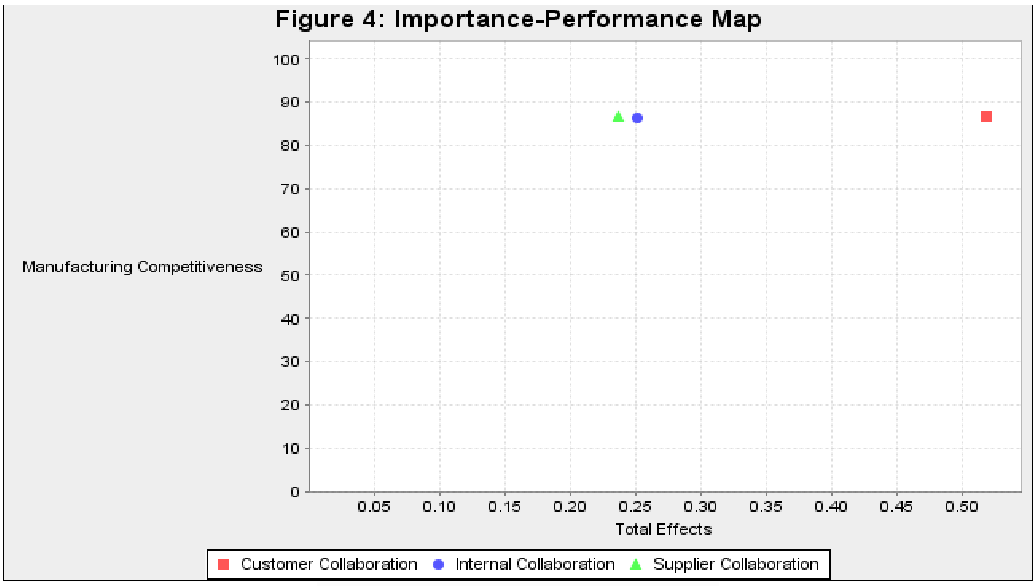


Figure 1 - Importance-Performance Map
Note: The x-axis represents the unstandardized total effects of predecessors (importance). The y-axis represents their average rescaled unstandardized scores (performance).
Source: The authors themselves.

The results in Figure 1 reveal that no variables appear in the lower right area of IPMA. Only one variable appears in the higher right area, and that is customer collaboration. Customer collaboration represents a major opportunity for the improvement of manufacturing competitiveness. Specifically, a unit increase in customer collaboration increases manufacturing competitiveness by 0.519. The managerial action required is to keep up the good work. This is closely followed by internal collaboration and supplier collaboration should be the last priority. The IPMA results widen the scope of manufacturers to improve their competitive position in the markets they serve. Based on IPMA, previous studies (Haider, 2014; Melander, 2018) and in line with RBV and RDT this study argues that manufacturing competitiveness is the result of customer collaboration, followed by internal collaboration. However, with increased competitive pressure and supply chain complexity, supplier collaboration is inevitable. Initiatives ought to be taken on the way that manufacturers relate with their suppliers to improve and sustain manufacturing competitiveness.

7 DISCUSSION

This study was guided by two theories: RBV and RDT, and it involved the testing of five hypotheses, namely H1, H2, H3, H4 and H5, which were all supported. Hypotheses H1 and H2 address direct effects while hypotheses H3, H4 and H5 address mediation effects. In addition, IPMA results were examined to benchmark predecessor variables with relatively high importance to manufacturing competitiveness. The findings confirmed a significant positive influence of customer collaboration and supplier collaboration on manufacturing competitiveness while internal collaboration was found to positively mediate these relationships. On IMPA, customer collaboration was found to be the leading predecessor of manufacturing competitiveness, followed by internal collaboration and supplier collaboration being the last priority. The findings confirm the assertion that the internal resources of a firm are key to manufacturing competitiveness and because no firm possesses all the resources required to sustain competitiveness, collaboration with suppliers and customers through formal and semiformal links, leads to stronger, resilient and competitive supply chains.

This study indicates the existence of a significant positive relationship between customer collaboration and manufacturing competitiveness. This is in line with the findings of Thatte and Rao (2013), Solaimani and van der Veen (2021), Wong *et al*. (2021) and Srivastava *et al.* (2024). By collaborating with customers, firms improve their ability to: assess customer satisfaction, determine future expectations for customers, facilitate customers' complaints process and evaluate their relationship with customers. These measures have substantial contributions to manufacturing competitiveness. In a highly competitive environment, liaison with customers is important at each stage of the supply chain. During product development, manufacturers collaborate with customers to obtain product features that will enhance the product experience. According to Thatte and Rao (2013), the co-creation of marketing strategies with customers improves the time to market new products. Also, manufacturers expand their resource base capacity by making use of customers' resources such as vendor-managed inventory. This significantly reduces costs and improves the delivery times of products.

Also, the study reveals the existence of a significant positive effect of supplier collaboration on manufacturing competitiveness. This echoes studies of Solaimani and van der Veen (2021), Ardakani *et al*. (2022), Lotfi and Larmour (2022), Zhong *et al*. (2022) and Malik *et al*. (2024) who respectively find a positive influence of external collaboration on supply chain innovation, economic performance, supply chain resilience, supply chain performance and organizational performance. Certainly, the ability of the firm to select suppliers based on quality criteria, solve problems jointly with suppliers, help suppliers improve their product quality and maintain long-term beneficial relationships with key suppliers positively impacts manufacturing competitiveness. Myamba and Nguni (2022) found significant improvement in these areas influences the ability of the firm to compete. Manufacturing competitiveness demands manufacturers to offer quality products that embrace innovation, competitive prices, delivery times and time to market. All these require the early engagement of suppliers to contribute towards product design, process improvement, cost-effectiveness and selection of best technologies (Lotfi and Larmour, 2022). Thus, findings support the RDT, that strong ties with suppliers create access to resources and capabilities for improved manufacturing competitiveness.

Further, the study indicates that internal collaboration mediates relationships involving the influence of customer collaboration and supplier collaboration on manufacturing competitiveness. In both relationships, internal collaboration has attained a partial mediation effect, indicating that manufacturing competitiveness is maximized when manufacturers achieve a high degree of fit between internal and external collaboration. The results are consistent with other studies which establish a significant influence of internal collaboration towards risk mitigation and monitoring strategies (Duhamel *et al*, 2016), resource efficiency (Banchuen, Sadler and Shee, 2017) and supply chain performance (Zhong *et al.*, 2022). The results reinforce the claims of Malik *et al.* (2024) that superior performance is a result of manufacturers' synchronization of the drivers of cross-functional activities with the product supply chain. Moreover, this study provides empirical evidence to RBV and RDT that both internal and external resources are crucial. Some managers, fearing to expose their resources to competitors are hesitant about collaborative relations. However, well-thought actions are necessary because according to Mishra *et al.* (2016), collaboration improves trust, commitment and dependence among parties.

The IPMA reveals that customer collaboration has the highest importance on manufacturing competitiveness. Based on previous studies, managers should keep up the good work because dedicating resources to this aspect is worthy (Martilla and James, 1977; Wyrod-Wrobel and Biesok, 2017). Also, this means that managers targeting to improve manufacturing competitiveness should start by improving customer collaboration as it has the highest impact on manufacturing competitiveness. Aspects related to internal and supplier collaboration follow as second and third priorities, respectively. But to improve customer collaboration requires improvement in the predecessor variable with the highest impact on manufacturing competitiveness. This variable is internal collaboration. Hence, supply chain activities focusing on internal collaboration must be handled with great care because they set the basis for improving collaboration with customers. When internal functions work together seamlessly, it leads to more efficient supply chain operations, reduced lead times and increased service reliability. This attracts customer loyalty, building sustained competitiveness.

Findings make theoretical sense in light of RBV and RDT predictions that firms that properly align their collaborative interests with those of supply chain partners are in a better position to attract manufacturing competitiveness beyond the reach of major competitors. Supplier collaboration ensures high-quality materials, innovation and cost optimization are realized throughout the supply chain. Customer collaboration aligns products with market demands, improves quality, and promotes responsiveness. Internal collaboration works with both sides, to streamline operations, enhance problem-solving, and foster continuous improvement.

8 CONCLUSION

This study aimed to examine the influence of supply chain collaboration on manufacturing competitiveness. After testing and validating the PLS path model involving customer collaboration, supplier collaboration, internal collaboration and manufacturing competitiveness, it is confirmed that customer collaboration and supplier collaboration have a significant and positive direct influence on manufacturing competitiveness and internal collaboration partially mediates both relationships. This study provides empirical evidence that manufacturing competitiveness to a great extent relies on the firm's internal resources which are unique and valuable. Furthermore, the environment presents potential opportunities to acquire additional resources through customer and supplier collaboration, which may suppress resource uncertainty and create a pronounced effect on manufacturing competitiveness. In terms of priority, it is revealed that customer collaboration has the highest importance in predicting manufacturing competitiveness, followed by internal and supplier collaboration. Based on the study objectives, findings and discussion thereof, this study concludes that supply chain collaboration through customer, supplier and internal collaboration significantly influences manufacturing competitiveness.

8.1 Implications for research

The findings of this study have theoretical, practical and methodological implications. Theoretically, this study appears to be the first to provide a theoretical framework that examines relationships involving customer collaboration, supplier collaboration, internal collaboration, and manufacturing competitiveness at once. Further, this study operationalized supply chain collaboration with three dimensions, namely customer, supplier and internal collaboration. The tendency has been to operationalize it with two dimensions only: internal and external collaboration. The role of suppliers and customers has been hypothetically captured by external collaboration. The distinct contribution of these variables has been misrepresented by two to four items underlying external collaboration. This study explicitly analyzed the standalone effects of customer and supplier collaboration on manufacturing competitiveness. This could provide a better understanding and guidance to researchers interested in supply chain collaboration studies. Moreover, this study provides empirical support to RBV and RDT by indicating that both internal and external resources are important sources of manufacturing competitiveness.

Practically, results shed light on what makes one firm more competitive than another. This knowledge is useful since it illustrates a way for firms struggling to attain manufacturing competitiveness. Specifically, this study makes managers aware of the key competitive priorities that make them grow and withstand competitive pressures in domestic and foreign markets. This study has identified and validated price, quality, delivery time, innovation and time to market as key competitive dimensions. Since these priorities are customer-driven, once customers know of them, they will be able to differentiate one firm's products from another. Also, this study provides reliable and valid measures of customer, supplier and internal collaboration of which managers could evaluate, benchmark and compare their positions. This exercise can be done at different nodes of the supply chain, from the sourcing of raw materials through conversion to final customers. This could allow early identification of potential collaborative problems in the supply chain. The fact that very few organizations are self-sufficient in strategic resources means collaboration with supply chain partners enhances manufacturing competitiveness. Besides, the results of IPMA could direct managers on priority areas to focus their resources.

Methodologically, this study demonstrates the statistical capability of PLS-SEM in testing an interlinked set of hypotheses simultaneously. Unlike the traditional stepwise analysis of total and mediation effects, the once-off bootstrapping method with PLS-SEM can detect both total and mediation effects using a single PLS path model with a single click in SmartPLS. This significantly reduces the measurement errors resulting from the stepwise method. This practice renders a potential contribution to the scientific world. Also, the capability of PLS-SEM to accommodate both normal and non-normal data distributions, allows researchers to draw significant statistical inferences and reveal the truth as observed from the field. This is in contrast to covariance-based SEM methods which strictly rely on normal distribution, requiring significant data transformation. Lastly, this study provides methodological guidance to researchers interested in mediation using the PLS-SEM approach.

8.2 Limitations and directions for future research

First, because of the limited number of firms considered to be large, several small and medium-sized firms were engaged in this study. Supposedly, this created problems in assessing the reliability and validity of the measurement model, a process that caused the deletion of five (5) measurement items. Future studies ought to consider appropriate ways of addressing this problem. This may include the extension of the geographical coverage of the study to include other neighbouring countries. Involving large firms will reduce errors and increase the reliability and validity of the measurement model. Second, this study employed a cross-section research strategy lacking the longitudinal connection of the effect of supply chain collaboration on manufacturing competitiveness, hence care must be taken in an attempt to generalize findings in other countries. Nevertheless, the identification, testing and validation of the conceptual model, backed up by an extensive literature review, could assist in developing comparative studies that may lead to more generalizable findings. Lastly, this study indicates that customer, supplier and internal collaboration together, moderately explain the total variation in manufacturing competitiveness. Future research ought to investigate the role of control variables that could affect this study such as firm size, experience, type of competitors and number of product lines owned by the company.

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