Journal of Business and Management Studies
ISSN: 2709-0876
DOI: 10.32996/jbms
Journal Homepage: www.al-kindipublisher.com/index.php/jbms

JBMS
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Harnessing Collaborative Innovation: How Knowledge Sharing Drives Performance in Philippine Hardware MSMEs

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| ABSTRACT

The study examines the mediating effect of knowledge sharing on the relationship between collaborative innovation capabilities and innovation performance within hardware companies in the Philippines. It seeks to fill the gap in local research by exploring how collaborative efforts and knowledge-sharing practices influence the innovation outcomes of micro, small, and medium enterprises (MSMEs) in the hardware sector. A quantitative approach was employed, surveying operational managers from 80 hardware companies in Metro Manila. The study used Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess the relationships between collaborative innovation capabilities, knowledge sharing, and innovation performance. The study found that collaborative innovation capabilities have a significant positive effect on innovation performance. Additionally, knowledge sharing acts as an important mediator, enhancing the effectiveness of collaborative efforts in driving innovation outcomes. This study provides valuable insights into the hardware industry in the Philippines, where there is a lack of local research on the dynamics of collaboration, knowledge sharing, and innovation. It offers practical implications for hardware MSMEs, highlighting the importance of fostering collaboration and implementing effective knowledge-sharing systems to drive innovation and maintain competitiveness in a fast-paced market.

| KEYWORDS

Collaborative Innovation; Philippine Hardware MSMEs; knowledge sharing

| ARTICLE INFORMATION

ACCEPTED: 15 October 2024 **PUBLISHED:** 04 November 2024 **DOI:** 10.32996/jbms.2024.6.6.4

1. Introduction

Hardware is a term used in construction to describe a collection of metal items used for decoration, protection, and convenience (Top-Most Hardware, 2020). Hand and power tools, building materials, fasteners, keys, locks, hinges, chains, electrical supplies, plumbing supplies, cleaning products, housewares, utensils, and paint are common items sold in a hardware store. They're intended for do-it-yourselfers and handypersons who need a place to get project supplies (Wang et al., 2020). While the market's future appears bright, the industry is highly competitive. Almost every organization takes innovation as a top priority. However, to achieve success through innovation, businesses must commit as much energy and investment as possible to market new offerings.

The Philippines recognizes the importance of innovation in sustaining economic growth and improving citizens' quality of life (Lee Yohn, 2019). As Hardware stores evolve to meet new competitive demands and the market continues to consolidate, hardware must reevaluate and look to new methods for efficiency and a broader market through unique offerings (Carr, 2016). Also, as the industry modernizes, hardware stores compete to stay relevant and attract customers. However, problems are still arising within

the industry: the demand for construction materials is rarely constant, and seasonality impacts the construction materials industry, with the summer months seeing the majority of outdoor construction activity. Also, the demand for various products will frequently change in established and emerging markets. Consumer preferences can change as quickly as the direction of the wind. Another emerging trend is the push for sustainability in the construction industry; new products such as solar panels and super-efficient triple-glazed windows see increased demand from environmentally conscious consumers. Therefore, the challenge for the industry is to identify popular trends before the competition does.

High-level communication about market trends is essential for developing insight into the industry. Even having the technology to alert inventory purchasers of changes in demand can give a wholesale distributor a competitive advantage and keep their business relevant (Fritsch, 2016). According to Embley and Sergeeva (2021), Innovation is becoming essential for transformation in the Construction Industry. However, the innovation challenge in the industry is that there is a lack of collaboration across the industry that should share research resources and address significant issues that individuals cannot address. In that case, when collaboration is happening, the challenges will be shared, and new ideas will emerge. The collaborators then evolve the innovation to be brought to market in a more reliable and cost-effective approach. The focus on innovation will improve the industry's reputation by improving the performance of end-user businesses and their customers who use the assets.

As expected, individuals have similar expectations for wanting something more when purchasing the second time and looking for how a particular product will improve their experiences. Therefore, the industry should be innovative to meet customers' expectations and enhance how they live. Another challenge in innovation is the product form in which consumers care about designs (Agger & Sørensen, 2018; Albert et al., 2018; Aquino & Ho, 2020). Hardware needs to focus on its product's properties, physical form, and materials. Another challenge is creating product awareness. It is already challenging enough for most stores to generate buzz over a new product. To create awareness or grab the customer's attention, hardware needs to utilize creative mediums. Knowing and understanding the challenges in the hardware industry allows you to have ideas on what to expect and make a plan (Awwad & Akroush, 2015; Bulsara & Thakkar, 2015; Carter, 2021).

Previous studies have offered considerable evidence for Knowledge Sharing, Innovation Performance, and Collaborative Innovation, but more work needs to be done. The findings were insufficient since there have been limited studies regarding the topic. However, some have studied the relationship between collaborative Innovation and innovation performance (Li et al., 2013; Wang & Hu, 2017, Wang & Ying, 2019). Still, there were no existing local studies about it, and no studies have been conducted during the same period. Others have studied the relationship between collaborative innovation capabilities and knowledge sharing, which also has no existing local studies, and no studies have been conducted during the same period (Wang et al., 2020; Wang & Hu, 2017; Feranita et al., 2017; Franco, 2020; Um & Kim, 2018). Moreover, have studied the relationship between knowledge sharing and innovation performance which also has no existing local studies about it, and no studies have been conducted during the same period (Zhao et al. 2020; Chang et al., 2019; Bagherzadeh et al., 2019; Roper et al., 2017). Lastly, there are those who have studied the mediating effect of knowledge sharing (Schleimer & Faems 2016; Wang & Hu, 2017; Feranita et al., 2017; Zouaghi et al., 2017; Jiao et al., 2020). However, no local studies have been conducted on this, and no studies have been performed during the same period. Additionally, all of these studies about Knowledge Sharing, Innovation Performance, and Collaborative Innovation come solely from different industries, and none of these have yet been applied in the Hardware Industry.

Therefore, this study aims to fill research gaps associated with the lack of local or Philippine-based studies related to the relationship of each variable: Collaborative Capabilities and Knowledge Sharing, Knowledge Sharing and Innovation Performance, Collaborative Innovation Capabilities and Innovation Performance, and the mediating effect of Knowledge Sharing. The study will also fill a gap in previous studies on the hardware industry within the Philippines. The respondents and locale of the study are the managers of hardware companies within Metro Manila.

2. Review of Related Literature and Hypotheses

2.1 Theoretical Framework

The theoretical framework for this study is grounded in several vital theories, focusing on how Collaborative Capabilities enhance Innovation Performance in hardware MSMEs, with Knowledge Sharing as a critical mediator. Drawing from the Resource-Based View (RBV) (Barney, 1991), collaborative capabilities are a valuable organizational resource that allows MSMEs to pool resources with external partners, driving innovation despite their limited internal capacities. Similarly, Dynamic Capabilities Theory (Teece et al., 1997) emphasizes that collaborative capabilities enable MSMEs to adapt to rapidly changing environments and technological advancements, further supporting innovation performance.

The Knowledge-Based View (KBV) (Grant, 1996) positions Knowledge Sharing as the process that turns collaborative efforts into innovative outcomes. By facilitating the flow of knowledge between teams and partners, MSMEs can convert external expertise into new products and improved processes. Additionally, Social Exchange Theory (SET) (Blau, 1964) explains the reciprocal nature

of collaboration, where knowledge exchange builds trust and strengthens innovation. Lastly, Innovation Diffusion Theory (Rogers, 2003) highlights how collaboration and knowledge sharing accelerate the adoption of new ideas, enhancing innovation performance.

2.2. Collaborative Innovation Capability

Collaborative capabilities enable organizations to work effectively with partners to achieve innovation goals. Wang and Hu (2020) highlight that collaborative innovation enhances knowledge sharing in supply chains, boosting innovation performance. Zheng, Yang, and Wang (2019) emphasize its role in improving e-commerce performance, while Kai et al. (2020) show its benefits in cloud-edge computing through task efficiency. Kerdpitak et al. (2019) also note that big data-supported collaboration improves industry trust and performance.

Collaboration is vital for product and service innovation. Wang et al. (2017) stress its importance in developing new products with partners, particularly in hardware companies. De Silva et al. (2017) and Day (2021) highlight that teamwork fosters innovation and operational efficiency, enabling firms to adapt to changing market conditions (Um & Kim, 2018; Ha, 2020).

New product development (NPD) relies heavily on collaborative capabilities. Although NPD can be time-consuming and risky, it is essential for maintaining market competitiveness (Liang et al., 2014). Collaboration helps companies survive and thrive in fast-paced industries by allowing them to develop innovative products that meet unique market demands (Mu et al., 2017; Singh, 2021). Additionally, collaborative efforts between industries, universities, and research institutions enhance regional innovation capabilities (Li & Xing, 2020).

Similarly, new service development (NSD) benefits from collaboration. NSD involves a comprehensive process requiring input from multiple stakeholders, such as service strategy, market research, and customer experience (Spacey, 2017). Employee involvement further increases the likelihood of success by identifying potential challenges early (Rashid et al., 2023). Strong business relationships also play a critical role in successful service innovations, making collaboration vital for staying competitive (Biemans et al., 2016; Lindh & Nordman, 2018; Hong et al., 2019).

Collaborative capabilities are essential for driving innovation in hardware companies. By working closely with partners, companies can navigate complex innovation challenges, whether through new product development or service innovation. These collaborative efforts allow organizations to pool resources, share expertise, and achieve outcomes that would be impossible in isolation, fostering competitiveness and agility in a rapidly changing technological landscape (O'Neill, 2018; Queensland Government, 2017).

2.2.1 Knowledge Sharing

Knowledge sharing is the process of exchanging information, expertise, and experiences within and across organizations, enabling the effective transfer of valuable knowledge. It is a critical factor in enhancing decision-making, promoting continuous learning, and fostering creativity (Postolache, 2017). When employees have access to shared knowledge and resources, they can perform their tasks more efficiently and effectively (Starmind, 2020; Semenets-Orlova, 2019). Moreover, knowledge sharing helps to build a more cohesive and engaged workforce by facilitating collaboration among individuals with diverse skill sets and expertise (Le & Tuamsuk, 2023). This collaborative process is essential for innovation, allowing organizations to adapt and grow in a competitive environment by developing new products, services, and processes (Ganguly, Talukdar, & Chatterjee, 2019).

In hardware companies, knowledge sharing is vital for driving innovation and maintaining competitiveness. According to Ahmed et al. (2019), social media has become a significant platform for sharing knowledge, enabling organizations to disseminate information quickly and effectively. Additionally, Singh et al. (2021) emphasize that knowledge-sharing practices, supported by top management, promote open innovation and improve overall organizational performance. Leadership plays a critical role in fostering a culture of knowledge sharing, which is essential for sustaining long-term innovation (Kremer, Villamor, & Aguinis, 2019).

External collaborations also benefit from knowledge sharing, particularly in supply chain networks. Wang and Hu (2020) highlight that collaborative innovation activities within supply chains, enhanced by knowledge sharing, improve overall innovation performance. This is crucial for hardware companies that rely on complex and dynamic supply chains to stay competitive. Furthermore, tacit knowledge, often exchanged through informal social interactions such as conversations and shared experiences, plays a critical role in fostering creativity and innovation (Bari et al., 2020). The use of enterprise social media platforms also facilitates this exchange, allowing employees to collaborate and generate new ideas (Sun et al., 2019).

Knowledge sharing is a fundamental driver of innovation in hardware companies (Castaneda & Cuellar, 2020). Whether through leadership initiatives, social media, or supply chain networks, knowledge sharing helps companies remain agile and competitive in

rapidly changing markets (Singh, 2021; Phong et al., 2018). This exchange of knowledge not only strengthens internal processes but also creates opportunities for continuous innovation and growth.

2.3. Innovation Performance

Innovation performance is an organization's ability to convert innovation inputs into successful market outputs, driving competitiveness and long-term success (Gal, 2014; Zizlavsky, 2016). It helps assess innovation effectiveness, identify bottlenecks and ensure a focus on both short-term and long-term goals (De Jesus & Fajardo, 2021; Frey, 2008). Process innovation, which improves operational efficiency by reducing lead times and costs, plays a key role (Tang et al., 2013). Creative employees also contribute to developing new products and maintaining a competitive advantage (Jiang et al., 2012). Innovation performance can be measured through the speed and success of product launches, which impact market share (Buenechea-Elberdin et al., 2018) and capture the economic, social, and technological benefits of innovation (Al-Ali et al., 2017).

Social networks influence innovation performance by facilitating knowledge sharing within and between organizations (Muller & Peres, 2019; Garousi Mokhtarzadeh et al., 2020). Open innovation also enhances both economic and sustainability outcomes by enabling firms to introduce new products and address environmental challenges (Rauter et al., 2019; Hameed et al., 2021; Markovic & Bagherzadeh, 2018). Internally, big data and knowledge management practices play a critical role, though excessive reliance on data without proper analysis can hinder innovation (Ghasemaghaei & Calic, 2020). HRM and social capital-supported knowledge-sharing practices further boost innovation performance (Papa et al., 2020; Singh et al., 2021).

Cultural factors are equally important, as cultivating an innovation-friendly culture helps companies adapt to market changes and meet evolving demands, particularly for SMEs (Hanifah et al., 2019; Martín-Rios & Ciobanu, 2019). Absorptive capacity, or the ability to apply external knowledge, also mediates the relationship between resources and innovation in high-tech industries (Duan et al., 2020).

Innovation performance is shaped by a combination of internal capabilities, external collaborations, cultural factors, and leadership (Papa et al., 2020; Shaher & Ali, 2020) . By fostering knowledge sharing, leveraging open innovation, and improving processes, hardware companies can enhance their innovation performance and maintain competitiveness.

2.4. Collaborative Innovation Capabilities link with Knowledge Sharing

Wang et al. (2020) highlight that collaborative innovation is a highly effective form of organizational innovation, as it involves sharing knowledge, ideas, and opportunities across firm boundaries. Successful innovation requires all partners to exchange information and knowledge. Wang and Hu (2017) emphasize that collaborative innovation capability is essential for facilitating knowledge sharing within supply chain networks, which leads to positive innovation outcomes. Effective collaboration relies on sharing knowledge to achieve innovation goals.

Feranita et al. (2017) add that firms strategically use collaborations to access necessary resources, which facilitates knowledge transfer and innovation. Collaborations bring together diverse stakeholders on a shared innovation platform, but companies must have the capability to absorb and transfer knowledge to develop new products . Without this capability, knowledge sharing and learning are hindered. Um and Kim (2018) explain that collaborative innovation allows firms within a supply chain to discover new opportunities and generate products or services by leveraging external expertise.

Xie et al. (2023) further argue that collaborative innovation provides a structure that promotes interaction and contribution among members, enhancing knowledge sharing and making innovation more accessible. Zhou and Li (2012) conclude that such collaboration not only increases a company’s ability to innovate but also expands its knowledge base, improves information exchange, and enhances market knowledge acquisition, driving overall growth and innovation performance.

H1: Collaborative Innovation Capability has significant effect on Knowledge Sharing.

2.5. Knowledge Sharing Link with Innovation Performance

Zhao et al. (2020) found that knowledge sharing enhances organizational innovation performance by fostering a shift in employees' mindset. When employees actively share knowledge, it facilitates better collaboration, allowing them to improve their thinking styles and work methods. This, in turn, enhances individual capabilities and positively influences overall organizational innovation (Stanisławski, 2021). Additionally, employees' knowledge-sharing behaviors have a direct positive impact on innovation performance (Stawiarska, 2020).

Chang et al. (2019) also emphasize that leveraging supplier and customer expertise can significantly boost innovation performance. Effective communication of knowledge, experiences, and preferences between a company and its partners improves innovation

outcomes. When information is shared effectively, the organization benefits from enhanced innovation performance (Ganguly et al., 2019). Similarly, Collins and Smith (2006) describe knowledge sharing as giving teams access to innovative knowledge, which is crucial for improving innovation outcomes.

Roper et al. (2017) highlight that organizations' knowledge-gathering efforts directly impact innovation performance, as innovation is critical to productivity and growth. Sharing knowledge facilitates the generation of solutions and efficiencies, which form the foundation for successful innovation. Zhao et al. (2020) further recommend fostering the knowledge-sharing process to enhance organizational innovation, as efficient and effective knowledge sharing drives improved innovation performance.
H2: Knowledge Sharing has significant effect on Innovation Performance.

2.6. Collaborative Innovation Capabilities Link with Innovation Performance

Li et al. (2013) discovered that in the product design process, collaborative innovation with upstream suppliers can enhance an organization's innovation performance. Thus, the ability to collaborate effectively can significantly improve an organization's innovation outcomes. According to Wang and Hu (2017), strong collaborative innovation capability helps supply chain partners combine complementary expertise, leading to above-average innovation performance. Furthermore, Wang et al. (2019) stated that increased collaborative innovation leads to better innovation performance, as new products and services are developed to boost earnings. Collaboration also enhances an organization's overall innovation capacity by improving product and service quality, thereby increasing profitability.

Wang and Ying (2019) claimed that utilizing new knowledge within the supply chain network provides a better chance of achieving superior innovation performance in partnership with collaborators who possess strong collaborative innovation capabilities. Similarly, Liu et al. (2021) argue that collaborative innovation capability is the foundation upon which collaborative innovation projects are built. Depending on their collaborative innovation capabilities, different organizations will have varying innovation opportunities. Additionally, collaborative innovation capability has a significant impact on collaborative innovation performance, as the success of such projects largely depends on their innovation outcomes.

H3: Collaborative Innovation Capability has significant effect on Innovation Performance.

2.7. Knowledge Sharing as Mediating variable

Knowledge sharing plays a crucial mediating role in enhancing innovation performance, particularly in the context of collaborative innovation. Schleimer and Faems (2016) argue that collaborative innovation facilitates the efficient use of dispersed knowledge, driving the development of new products and services. The stronger a company's involvement in collaborative innovation, especially within supply chain networks, the higher its innovation performance. However, as Wang and Hu (2017) highlight, the positive impact of this collaboration depends on a firm's capacity to absorb and apply new knowledge. Effective knowledge sharing strengthens this capability, enabling firms to adapt more dynamically and innovate more rapidly (Feranita et al., 2017).

Akram et al. (2020) also emphasize that knowledge sharing mediates the relationship between organizational factors, such as justice, and innovative behavior. When employees perceive fairness, they are more likely to engage in knowledge sharing, which, in turn, fosters innovative work behavior. Similarly, Shujahat et al. (2019) argue that knowledge-sharing processes are essential for translating knowledge management efforts into knowledge-based innovation, particularly by enhancing knowledge-worker productivity. This highlights the vital role of knowledge sharing in leveraging collaborative innovation for improved innovation outcomes.

Jiao et al. (2020) add that collaboration with organizations that share a common knowledge base further boosts innovation performance by facilitating the quick adaptation and application of shared knowledge. Sun et al. (2019) support this by stating that knowledge sharing allows diverse supply chain partners to exchange valuable insights, ensuring that collaborative innovation translates into tangible performance improvements. In essence, knowledge sharing acts as a bridge, connecting collaborative efforts with successful innovation outcomes by enhancing organizational adaptability, efficiency, and innovation capacity.

H4: Knowledge Sharing has significant mediating effect on the relationship between Collaborative Innovation and Innovation Performance.

3. Methodology

3.1. Data and Sampling

A **s**urvey was conducted among managers of Hardware stores within Metro Manila in the first quarter of 2024. The minimum number of samples is 55 respondents based on the priori statistical power analysis using G Power software with power = .80(1 –

β), effect size = .15, and α = .05. Statistical power analysis is the appropriate method for computing the sample size if the goal is to accept or reject any hypothesis (Kyriazos, 2018; Barket et al., 2016).

80 hardware companies participated, represented by their operational managers, which is more than the minimum required samples. These hardware companies are considered micro, small, and medium enterprises with a number of employees between 10 and 150.

3.2. Instrumentation

The survey instrument was used to measure each research variable. The Likert scale items were developed based on the meanings provided in the existing literature and were measured as to the degree of agreeableness: 1 – Strongly Disagree to 4 – Strongly Agree. These items were subjected to content validation by three experts. Items were removed or modified based on the suggestions of the experts. A pilot study was also conducted by asking 25 respondents to answer the Google form survey. Validity and reliability tests were performed on the pilot study data. These items were also submitted to an ethics review conducted by a particular university.

The following table shows the items and the construct being measured:

Table 1. Research Constructs and Items

Constructs	Items
Collaborative Capabilities	1. Our organization effectively collaborates with external partners to achieve shared innovation goals." 2. "We actively share knowledge and resources with partners to enhance innovation performance." 3. "Our team adapts well to new ideas and expertise shared by our collaboration partners." 4. "Collaborative efforts within our supply chain improve our product development and market success." 5. "Our organization has the capability to integrate external knowledge and expertise into our innovation processes."
Knowledge Sharing	1. "Employees in our organization willingly share their knowledge and expertise with colleagues." 2. "Our organization has effective systems in place to facilitate knowledge sharing across teams." 3. "Knowledge sharing in our organization helps improve decision-making and problem-solving." 4. "Employees feel encouraged to share information that contributes to innovation and growth." 5. "Our organization actively promotes the exchange of ideas and experiences to enhance performance."
Innovation Performance	1. "Our organization consistently develops and launches new products or services that meet market demands." 2. "The innovations produced by our organization provide a competitive advantage in the industry." 3. "Our organization's innovation efforts lead to significant improvements in operational efficiency." 4. "We successfully transform new ideas into commercially viable products or services." 5. "Our organization's innovation activities contribute to long-term business growth and sustainability."

3.3. Data Analysis

In this study, Partial Least Squares Structural Equation Modeling (PLS-SEM) was utilized to analyze the mediation effect of knowledge sharing on the relationship between collaborative capabilities and innovation performance (Hair et al., 2019).

The measurement model was assessed by conducting a Confirmatory Factor Analysis (CFA) to establish convergent validity, ensuring that a construct's indicators are correlated and measure the same underlying concept. The analysis examined factor loadings and the average variance extracted (AVE) to ensure that the constructs adequately captured the theoretical concepts (Hair

et al., 2014). Factor loadings above 0.50 and AVE values exceeding 0.50 are considered acceptable indicators of convergent validity (Fornell & Larcker, 1981).

In addition to convergent validity, discriminant validity was established to confirm that each construct is distinct from others in the model. This was done by comparing the square root of the AVE for each construct with the correlations between constructs, following the Fornell-Larcker criterion. Discriminant validity is demonstrated when the square root of the AVE for a construct is greater than the correlations of the construct with any other constructs in the model, confirming that the constructs are not overlapping (Fornell & Larcker, 1981).

The reliability of the constructs was assessed using Cronbach's alpha, which measures internal consistency. Cronbach's alpha values above 0.70 indicate that the items consistently measure the intended construct, ensuring that the scale is reliable (Nunnally & Bernstein, 1994).

After validating the measurement model, the structural model was analyzed to assess the hypothesized relationships between collaborative capabilities, knowledge sharing, and innovation performance. PLS-SEM is particularly effective for this type of analysis, as it estimates path coefficients and assesses the significance of direct and indirect effects in the mediation model (Hair et al., 2019). The mediation analysis examined whether knowledge sharing acted as a significant mediator between collaborative capabilities and innovation performance by assessing the direct, indirect, and total effects in the structural model. The significance of the mediation effect was tested using bootstrapping, a resampling method that provides robust estimates of indirect effects (Preacher & Hayes, 2008).

4. Results and Discussion

4.1. Measurement Model Evaluation

Table 2. Convergent Validity Test Results

Construct	Items	Loadings	Square of Standardized Loadings	Ave. Var. Ext.	Sqrt AVE
Collaborative Capabilities	1	0.695	0.483	0.580	0.761
	2	0.801	0.642		
	3	0.725	0.526		
	4	0.76	0.578		
	5	0.819	0.671		
Knowledge Sharing	1	0.618	0.382	0.505	0.711
	2	0.807	0.651		
	3	0.718	0.516		
	4	0.687	0.472		
Innovation Performance	1	0.782	0.612	0.587	0.766
	2	0.747	0.558		
	3	0.787	0.619		
	4	0.793	0.629		
	5	0.719	0.517		

Table 2 shows the results of Confirmatory Factor Analysis (CFA), which demonstrates convergent validity for the Collaborative Capabilities, Knowledge Sharing, and Innovation Performance constructs as factor loadings exceed the 0.50 threshold. However, item 5 of Knowledge Sharing was removed since it causes the AVE to fall below 0.50.

Based on such adjustment, the results show that the items adequately measure the constructs.

Table 3. Discriminant Validity Test Results

Construct Matrix	CC	KS	IP
Collaborative Capabilities (CC)	**0.761**		
Knowledge Sharing (KS)	0.589	**0.711**	
Innovation Performance (IP)	0.753	0.683	**0.766**

Table 3 is a construct matrix which demonstrates discriminant validity as the square root of the AVE for each construct is greater than its correlations with other constructs. Collaborative Capabilities (0.761) exceeds its correlations with Knowledge Sharing (0.589) and Innovation Performance (0.753). Similarly, Knowledge Sharing (0.711) and Innovation Performance (0.766) both have higher AVE square roots than their respective correlations, confirming that the constructs are distinct from one another.

Table 4. Reliability Test using Cronbach's a

Construct	**Items**	**Cronbach's a**
Collaborative Capabilities	1	0.872
	2	
	3	
	4	
	5	
Knowledge Sharing	1	0.808
	2	
	3	
	4	
Innovation Performance	1	0.873
	2	
	3	
	4	
	5	

Table 4 exhibits the Cronbach's alpha values indicate strong internal consistency for all constructs: Collaborative Capabilities (0.872), Knowledge Sharing (0.808), and Innovation Performance (0.873). Since all values are above the acceptable threshold of 0.70, the items for each construct are reliable and provide consistent measurements, making them suitable for further analysis.

4.2. Structural Model Evaluation

Table 5. Direct Effects Analysis

Path	Estimate	SE	Z	p	R^2
Collaborative Capabilities → Knowledge Sharing	0.513	0.0687	7.46	< .001	0.347
Knowledge Sharing → Innovation Performance	0.401	0.0996	4.02	< .001	0.567
Collaborative Capabilities → Innovation Performance	0.511	0.094	5.44	< .001	0.628

Table 5 shows the Direct Effects Analysis which exhibits significant relationships between collaborative capabilities, knowledge sharing, and innovation performance ($p < .001$). The path from Collaborative Capabilities to Knowledge Sharing has a strong positive effect (ß = 0.513, Z = 7.46), which indicates the acceptance of H1 in which collaborative capabilities enhance knowledge sharing. Similarly, Knowledge Sharing positively impacts Innovation Performance (ß = 0.401, Z = 4.02), as stated in H2, emphasizing the role of knowledge exchange in innovation. The direct path from Collaborative Capabilities to Innovation Performance (ß = 0.511, Z = 5.44) also highlights that strong collaborative capabilities lead to better innovation outcomes, which support the acceptance of H3. Overall, both collaborative capabilities and knowledge sharing significantly contribute to innovation performance.

The R-squared values indicate that Collaborative Innovation explains 34.7% of the variance in Knowledge Sharing and 56.7% of the variance in Innovation Performance, suggesting a moderate influence on knowledge sharing and a strong impact on innovation performance. These values demonstrate that collaborative capabilities are essential drivers of knowledge sharing and innovation outcomes, with knowledge sharing also playing a meaningful mediating role in improving innovation performance.

Table 6. Indirect, Direct, and Total Effects Analysis

Effect	Estimate	SE	Z	p	% Mediation
Indirect	0.205	0.0502	4.09	< .001	28.7
Direct	0.511	0.094	5.44	< .001	71.3
Total	0.716	0.0841	8.52	< .001	100

Table 6 The mediation analysis shows that both direct and indirect effects of collaborative capabilities on innovation performance are statistically significant ($p < .001$). The direct impact of collaborative capabilities on innovation performance is 0.511 (71.3% of the total effect), indicating a strong direct relationship. The indirect effect, mediated by knowledge sharing, is 0.205 (28.7% of the total effect), also significant, demonstrating that knowledge sharing partially mediates the relationship between collaborative capabilities and innovation performance. This result supports the acceptance of H4. The total impact is 0.716, showing that collaborative capabilities significantly influence innovation performance, both directly and through knowledge sharing.

These indirect and direct effects are illustrated in Figure 1.

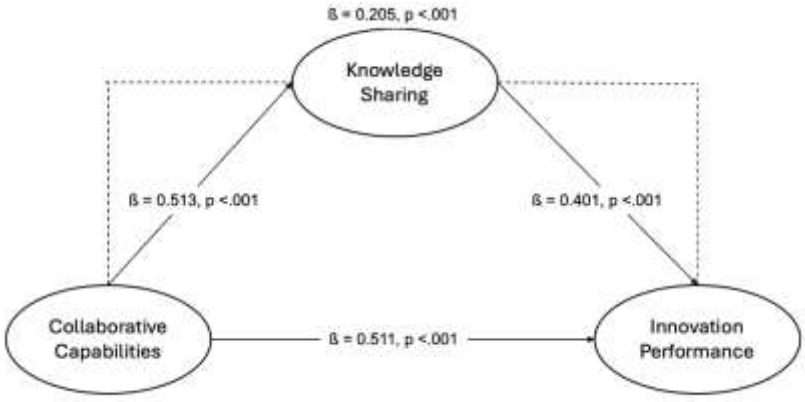

Figure 1. The mediation model with parameter estimates.

5. Conclusions, Implications, and Limitations

5.1 Conclusion

The conclusion of the study highlights the significant impact of Collaborative Capabilities on improving Innovation Performance within the context of hardware companies, with Knowledge Sharing playing a crucial mediating role. In hardware industries, where innovation is driven by rapid technological advancements and complex product development cycles, the ability to collaborate effectively is essential. The mediation model reveals that hardware companies with strong collaborative capabilities, such as strategic partnerships with suppliers, co-development with external stakeholders, and cross-functional teamwork, experience enhanced innovation outcomes. The direct effect of collaboration on innovation performance shows that, even without other factors, effective collaboration leads to better product development and technological advancement in hardware companies.

The indirect effect, mediated by Knowledge Sharing, further demonstrates how collaboration can be transformed into innovation. For hardware companies, sharing knowledge across departments, teams, and external partners allows critical technical insights to be disseminated quickly and efficiently. Knowledge sharing enables firms to leverage external expertise, learn from suppliers, and integrate new technological trends, which are essential for hardware companies operating in competitive and fast-paced environments. By encouraging an open exchange of ideas, hardware companies can more effectively convert collaborative efforts into new products, enhanced processes, and cutting-edge technologies.

The total effect of Collaborative Capabilities on Innovation Performance emphasizes the importance of both direct collaboration and knowledge sharing. In the hardware sector, where innovation cycles often depend on technological breakthroughs and process improvements, the ability to absorb and utilize external knowledge becomes critical. Hardware companies that foster a culture of collaboration and invest in systems that promote knowledge sharing are better positioned to innovate successfully and maintain a competitive edge in the market.

5.2 Implications

Hardware companies must focus on enhancing their collaborative capabilities to drive innovation and remain competitive. By establishing strong partnerships with external stakeholders such as suppliers, customers, and research institutions, these companies can access new ideas, resources, and technological advancements. Effective collaboration allows hardware firms to share expertise and work together toward innovative solutions, speeding up product development and improving innovation performance. Companies that prioritize collaboration can more easily adapt to technological changes and bring new products to market faster.

Investing in knowledge-sharing systems is essential for maximizing the benefits of collaboration. Hardware companies should implement structures and platforms that facilitate the exchange of technical knowledge across teams, departments, and external partners. When knowledge flows efficiently throughout the organization, firms can better leverage insights gained from collaboration and apply them to their innovation processes. Without proper knowledge-sharing mechanisms, the potential benefits of collaborative efforts are limited.

Creating an environment that encourages cross-functional collaboration is another critical implication for hardware companies. Managers should promote teamwork among engineers, designers, and marketing professionals to ensure that diverse perspectives are integrated into product development. This holistic approach not only improves innovation outcomes but also ensures that knowledge shared within the company is used effectively. Cross-functional teams are better equipped to take ideas from concept to market, resulting in more innovative and competitive products.

Furthermore, hardware companies should foster a culture of openness and learning, where employees are encouraged to share their knowledge and learn from one another. By promoting continuous learning and an openness to new ideas, companies can ensure that knowledge sharing becomes ingrained in their organizational culture. This cultural shift will enhance the company's ability to convert collaborative efforts into successful innovation outcomes, improving overall performance.

Investing in flexible processes and training programs can help companies respond effectively to new technologies and market demands. Leveraging collaborative platforms and tools, such as cloud-based systems and real-time information exchange platforms, can further enhance collaboration and knowledge sharing. These tools enable more efficient decision-making and quicker innovation cycles, keeping companies competitive in an evolving market.

Hardware companies that prioritize collaboration and knowledge sharing, while fostering a culture of learning, will be better positioned to drive innovation and maintain a competitive advantage. By investing in the right systems and processes, these companies can accelerate product development, respond to technological changes, and bring innovative products to market more efficiently.

5.3 Limitations of the Study

This study focuses on MSMEs in the hardware industry, limiting the generalizability of findings to larger organizations or other sectors. The cross-sectional design captures data at a single point in time, preventing causal inferences. Additionally, the reliance on self-reported data may introduce bias, and future research could benefit from using objective performance metrics. The study also does not fully account for contextual factors such as organizational culture or leadership, which may influence the results. Lastly, the use of quantitative methods excludes qualitative insights, such as the nuances of interpersonal dynamics and collaboration challenges in MSMEs.

Statements and Declarations

Funding: This research has received no external funding from its conceptualization and completion. However, the APC was funded by the Pamantasan ng Lungsod ng Maynila (University of the City of Manila).

Conflicts of Interest*:* The authors declare no conflicts of interest.

Acknowledgments: The authors acknowledge the help and support of the Pamantasan ng Lungsod ng Maynila.

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