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Collaborative Capability, Green Manufacturing and Performance of Manufacturing Firms in Kenya: A Moderation Approach.

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Abstract:

Purpose: *The study examined the moderating effect of collaborative capability on the relationship between green manufacturing and the performance of manufacturing firms in Kenya.*

Material/methods: *The study adopted a descriptive survey research design using both quantitative and qualitative approaches. The target population comprised 943 manufacturing firms registered under KAM, from which 330 firms were selected through stratified random sampling. Data were collected using structured questionnaires and analyzed using SPSS through descriptive statistics, correlation, regression, and hierarchical multiple regression.*

Findings: *The findings revealed that collaborative capability had a positive and statistically significant moderating effect on the relationship between green manufacturing and firm performance. Firms with stronger collaborative capability gained greater performance benefits from green manufacturing practices.*

Conclusion*: The study concluded that collaborative capability strengthens the relationship between green manufacturing and firm performance. Collaborative capability enables manufacturing firms to improve the effectiveness of green manufacturing practices by promoting cooperation with suppliers, customers, and internal departments. This enhances resource utilization, environmental sustainability, operational efficiency, and overall organizational performance.*

Value: *The study contributes to the literature on green supply chain management by demonstrating the moderating role of collaborative capability in the relationship between green manufacturing and firm performance. It provides practical insights for manufacturing firms, supply chain managers, policymakers, and industry stakeholders on the importance of collaboration in maximizing the benefits of green manufacturing practices.*

Keywords*: Green Manufacturing, Collaborative Capability, Firm Performance, Manufacturing Firms, Green Supply Chain Management, Environmental Sustainability*

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1. Introduction

The increasing pace of globalization and industrialization has significantly contributed to economic growth and improved living standards across the world. However, this progress has also resulted in serious environmental challenges, including climate change, ozone layer depletion, biodiversity loss, pollution, and depletion of natural resources (World Bank, 2012; United Nations Environment Programme, 2012). As a result, stakeholders such as governments, customers, investors, employees, and environmental organizations are increasingly demanding that firms adopt environmentally responsible business practices (Carter & Easton, 2011). In response to these pressures, Green Supply Chain Management (GSCM) has emerged as a strategic approach that integrates environmental considerations into supply chain activities with the objective of achieving both sustainability and competitiveness (Seuring, 2013). The focus of environmental management has gradually shifted from the individual firm level to the broader supply chain level, where collaboration among supply chain partners is essential for achieving sustainable outcomes (Brandenburg et al., 2014).

Among the various dimensions of GSCM, green manufacturing has gained considerable attention due to its potential to reduce environmental impacts while improving organizational efficiency and competitiveness. Green manufacturing refers to the integration of environmental considerations into product design, production planning, and manufacturing processes with the aim of minimizing waste, reducing pollution, and maximizing resource efficiency (Melnyk et al., 2009). The approach emphasizes the use of environmentally friendly inputs, energy-efficient technologies, waste minimization techniques, and eco-innovations that enhance both environmental and economic performance (Ninlawan et al., 2010). Green manufacturing practices also encourage manufacturers to design products that facilitate reuse, recycling, and recovery of materials while minimizing the consumption of energy and other resources throughout the product life cycle (Newman & Jensen, 2013). Consequently, organizations that effectively implement green manufacturing practices can benefit from reduced production costs, enhanced operational efficiency, improved corporate image, and stronger competitive advantage.

Despite the growing recognition of green manufacturing as a source of competitive advantage, empirical findings regarding its effect on firm performance remain inconclusive. While several studies suggest that environmental sustainability initiatives contribute positively to organizational performance through cost reductions, efficiency gains, and improved market reputation (King & Lenox, 2001; Rao & Holt, 2005; Yang et al., 2013; Zhou et al., 2013), other studies have reported mixed or insignificant results (Zhu et al., 2005). These inconsistent findings have prompted researchers to investigate contextual factors that may influence the effectiveness of green manufacturing practices. Scholars argue that the successful implementation of environmental initiatives depends not only on internal organizational capabilities but also on the ability of firms to coordinate and collaborate effectively with supply chain partners (Lopez-Gamero et al., 2009; Sarkis et al., 2010). Therefore, understanding the conditions under which green manufacturing enhances firm performance remains an important area of research.

One factor that has attracted increasing attention in the sustainability literature is collaborative capability. Collaborative capability refers to a firm's ability to leverage resources, knowledge, technology, and expertise from external partners to achieve strategic objectives (Kotabe et al., 2003; Koufteros et al., 2007; Patnayakuni et al., 2006). Effective collaboration enables firms to share information, coordinate environmental initiatives, reduce transaction costs, and respond more effectively to

changing market and environmental requirements (Cao & Zhang, 2011). According to Shi et al. (2012), inter-organizational environmental collaboration creates socially complex resources that are difficult for competitors to imitate, thereby generating sustainable competitive advantage. Furthermore, environmental collaboration with suppliers facilitates access to innovative technologies and environmentally friendly materials, while collaboration with customers enhances the firm's ability to identify and satisfy emerging environmental needs (Hollos et al., 2012; Yang et al., 2013). Consequently, collaborative capability may strengthen the effectiveness of green manufacturing practices and enhance their impact on firm performance.

In Kenya, manufacturing firms are increasingly under pressure to adopt environmentally sustainable practices due to rising environmental concerns, stricter regulatory requirements, and growing stakeholder expectations (Murphy, 2012; Hasan, 2013). The introduction of environmental regulations, including restrictions on plastic packaging and increasing emphasis on sustainable production, has compelled firms to embrace greener manufacturing processes (Mwiti, 2017). Additionally, international green trade barriers and environmentally conscious consumers have heightened the need for firms to improve their environmental performance while maintaining competitiveness (Mwaura, Letting, Ithinji, & Orwa, 2016). Although green manufacturing is increasingly recognized as an important strategy for enhancing firm performance, limited empirical evidence exists regarding the role of collaborative capability in strengthening this relationship within the Kenyan manufacturing sector. Therefore, this study seeks to examine the moderating effect of collaborative capability on the relationship between green manufacturing and the performance of manufacturing firms in Kenya.

2. Empirical and Theoretical Review

2.1. The Natural Resource-Based View

The Natural Resource-Based View (NRBV) Theory was developed by Hart (1995) as an extension of the Resource-Based View (RBV) initially proposed by Wernerfelt (1984). The RBV views firms as bundles of unique resources and capabilities that can be utilized to achieve sustainable competitive advantage. Hart (1995) extended this perspective by arguing that environmental resources and capabilities are increasingly becoming strategic assets that contribute to organizational competitiveness and long-term survival. According to the NRBV, firms can develop valuable, rare, inimitable, and non-substitutable capabilities through environmentally sustainable activities such as pollution prevention, product stewardship, and sustainable development. The theory builds on earlier contributions by Penrose (1959), who emphasized the role of internal resources in firm growth, and Barney (1991), who argued that firm-specific resources are the foundation of sustained competitive advantage. Hart (1995) further contended that environmental capabilities become strategic resources when they are causally ambiguous, socially complex, and difficult for competitors to replicate. In the context of green manufacturing, firms that invest in environmentally friendly technologies, waste reduction systems, energy-efficient production processes, and eco-innovation can develop unique capabilities that improve operational efficiency and organizational performance. The theory has also been enriched by the relational view, which suggests that competitive advantage can be created through the integration of resources and capabilities across supply chain partners (Dyer & Singh, 1998). Environmental collaboration enables firms to access external knowledge, technologies, and competencies that strengthen green manufacturing initiatives and improve performance outcomes (Vachon & Klassen, 2008; Shi et al., 2012). The NRBV is therefore relevant

to this study because it explains how green manufacturing can become a strategic capability that enhances firm performance and how collaborative capability can strengthen this relationship by facilitating access to complementary resources, knowledge, and expertise required for successful implementation of green manufacturing practices (Testa & Iraldo, 2010).

Resource Dependence Theory (RDT) was advanced by Pfeffer and Salancik (1978) and is founded on the premise that organizations depend on external actors for critical resources required for their survival and success. The theory argues that firms operate within a network of interdependent relationships where access to essential resources such as technology, information, raw materials, skills, and financial capital is controlled by other organizations (Awaysheh & Klassen, 2010). According to RDT, organizations seek to minimize uncertainty and secure access to critical resources by establishing collaborative relationships with stakeholders and supply chain partners. The theory further suggests that power within inter-organizational relationships is determined by the degree of resource dependence, with firms controlling scarce and valuable resources exerting greater influence over others (Emerson, 1962; Crook & Combs, 2007). In the context of environmental management, larger firms often influence suppliers to adopt environmentally sustainable practices through contractual requirements, monitoring mechanisms, and collaborative arrangements (Min & Galle, 2001; Caniëls et al., 2013). However, beyond compliance-driven approaches, the theory recognizes that firms lacking specific environmental resources and competencies can enhance their capabilities through strategic partnerships and collaborative initiatives (Sarkis et al., 2011). Collaborative capability therefore becomes an important organizational resource that enables firms to access external knowledge, green technologies, and specialized expertise necessary for implementing green manufacturing practices. Suppliers that actively engage in collaborative sustainability initiatives are more likely to gain access to business opportunities and strategic partnerships with dominant firms (Foerstl et al., 2015). In relation to this study, Resource Dependence Theory explains why manufacturing firms develop collaborative relationships with suppliers, customers, and other stakeholders to acquire the resources, technologies, and knowledge required for green manufacturing. The theory further supports the moderating role of collaborative capability by suggesting that firms with stronger collaborative networks are better positioned to leverage external resources, thereby enhancing the effectiveness of green manufacturing practices and improving organizational performance.

Based on the theoretical review and empirical literature, the conceptual framework illustrates the relationship between green manufacturing and the performance of manufacturing firms in Kenya, with collaborative capability serving as a moderating variable. The Natural Resource-Based View Theory suggests that environmentally sustainable capabilities such as eco-design, green production processes, and green waste management can become strategic resources that enhance organizational performance, while Resource Dependence Theory emphasizes the importance of collaboration in accessing critical resources, knowledge, and technologies necessary for effective implementation of green manufacturing initiatives. The reviewed literature further indicates that green manufacturing contributes to improved profitability, market share, and sales growth, although the magnitude of these benefits may depend on the firm's ability to collaborate effectively with internal and external stakeholders. Consequently, the framework proposes that green manufacturing positively influences manufacturing firm performance, while collaborative capability, reflected through interdepartmental meetings and buyer-supplier meetings, strengthens the relationship between green manufacturing and firm performance. The diagrammatic representation

of the conceptual framework is presented in Figure 2.1.

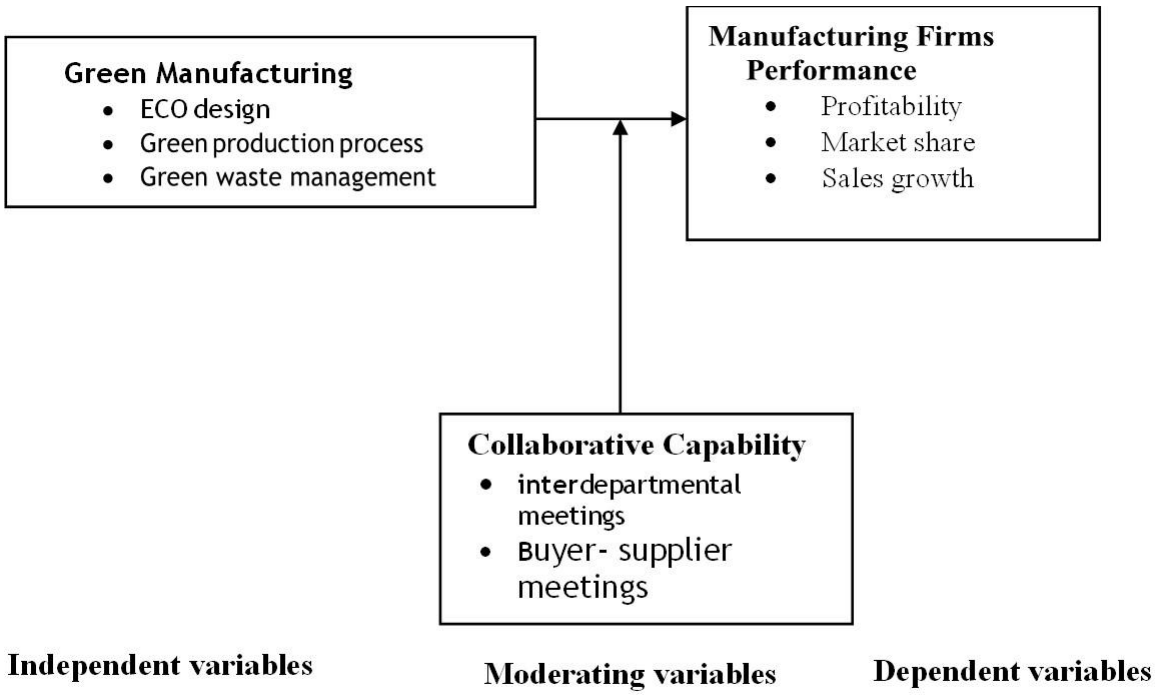


Figure 1: Conceptual Framework

2.2. Empirical Literature (Hypothesis Development)

Green manufacturing has emerged as a critical component of Green Supply Chain Management (GSCM) due to its ability to reduce environmental degradation while enhancing organizational performance. According to Melnyk et al. (2009), green manufacturing integrates product design, manufacturing processes, planning, and control systems to minimize environmental waste and improve resource efficiency. The approach emphasizes the use of environmentally friendly inputs, energy-efficient technologies, waste minimization practices, and pollution prevention mechanisms. Similarly, Newman and Jensen (2013) argue that green manufacturing promotes sustainable production by reducing hazardous substances, improving energy efficiency, and encouraging the reuse, recycling, and recovery of materials. Through these initiatives, organizations can lower production costs, improve operational efficiency, and strengthen their corporate image. Ninlawan et al. (2010) further observed that green manufacturing contributes to lower raw material costs, improved production efficiency, and reduced environmental management expenses. These findings suggest that green manufacturing can positively influence the performance of manufacturing firms.

Several empirical studies have established a positive relationship between green manufacturing practices and organizational performance. Gezen and Cankaya (2013) examined the effects of green manufacturing and eco-innovation on sustainability performance among firms in the automotive, chemistry, and electronics sectors in Turkey. Using regression analysis, the study found that green manufacturing practices significantly improved environmental and social performance, while eco-process innovation positively influenced overall corporate sustainability. Similarly, Deif (2011) developed a system model for green manufacturing and concluded that environmentally sustainable production systems improve manufacturing efficiency and competitiveness. Ghazilla et al. (2015), in their study on green manufacturing practices among Malaysian SMEs, identified stakeholder commitment, environmental regulations, organizational

support, and environmental education as key drivers of successful green manufacturing adoption. These findings demonstrate that green manufacturing can generate both environmental and economic benefits, thereby contributing to enhanced firm performance.

Despite the growing evidence supporting the benefits of green manufacturing, the relationship between environmental practices and firm performance has not always been consistent. Sarkis (2012) notes that while many studies report positive performance outcomes from environmental supply chain strategies, others have found limited or insignificant improvements. Zhu et al. (2005) similarly reported mixed findings regarding the performance implications of environmental management initiatives. These inconsistencies suggest that the effectiveness of green manufacturing may depend on the presence of other organizational capabilities that facilitate the successful implementation of environmental initiatives. Consequently, researchers have increasingly focused on contextual and organizational factors that may strengthen or weaken the relationship between green manufacturing and organizational performance (Lopez-Gamero et al., 2009; Sarkis et al., 2010; Zhu & Sarkis, 2007).

One such factor is collaborative capability, which refers to a firm's ability to effectively leverage the resources, knowledge, expertise, and technologies of internal and external stakeholders to achieve strategic objectives (Kotabe et al., 2003; Koufteros et al., 2007; Patnayakuni et al., 2006). Collaborative capability facilitates knowledge sharing, resource integration, and coordinated decision-making among supply chain partners. Cao and Zhang (2011) argue that collaborative relationships help firms reduce transaction costs and create sustainable competitive advantages in dynamic business environments. Shi et al. (2012) further contend that inter-organizational environmental collaboration creates socially complex resources that are difficult for competitors to imitate and can therefore serve as a source of competitive advantage. Environmental collaboration also enables firms to integrate external knowledge, technologies, and expertise necessary for effective implementation of green manufacturing practices (Yang et al., 2013).

The moderating role of collaborative capability has increasingly attracted attention in sustainability and supply chain research. Hollos et al. (2012) observed that suppliers' sustainability efforts must be complemented by internal initiatives of buying firms to achieve superior organizational performance. Similarly, Vachon and Klassen (2008) found that environmental collaboration facilitates organizational learning and enhances the effectiveness of environmental management practices. Azevedo et al. (2011) also reported that collaboration with customers and suppliers improves profitability through reduced environmental costs, increased efficiency, and enhanced customer satisfaction. Real-world examples such as Coca-Cola's collaboration with suppliers and environmental organizations in the development of Plant Bottle technology further illustrate how collaborative capability can strengthen environmental initiatives and generate competitive advantages. These findings suggest that firms possessing stronger collaborative capabilities may be better positioned to translate green manufacturing practices into improved performance outcomes.

Although previous studies have established direct relationships between green manufacturing and organizational performance, limited empirical evidence exists regarding the moderating role of collaborative capability, particularly within the Kenyan manufacturing sector. Most studies have focused on the direct effects of environmental practices without examining how collaboration influences the effectiveness of such initiatives. Given the increasing importance of strategic partnerships, supplier integration, and interdepartmental coordination in achieving

sustainability objectives, there is a need to investigate whether collaborative capability strengthens the relationship between green manufacturing and firm performance. Therefore, based on the reviewed literature and theoretical foundations, the study hypothesizes that:

H_{01}: *Collaborative capability does not have a significant moderating effect on the relationship between green manufacturing and the performance of manufacturing firms in Kenya.*

3. Methodology

The study adopted the positivist research philosophy, which emphasizes objective measurement, hypothesis testing, and the use of quantitative methods to establish relationships among variables. Positivism was considered appropriate because the study sought to test the effect of green disposal on firm performance using empirical data and statistical analysis. Guided by this philosophy, the study employed an exploratory research design incorporating both quantitative and qualitative approaches. The design enabled the researcher to investigate the relationship between green disposal practices and performance among manufacturing firms while generating comprehensive insights into the phenomenon under investigation.

Sampling Procedures

The target population comprised 757 manufacturing firms located in Nairobi and Kiambu counties and registered under the Kenya Association of Manufacturers (KAM, 2017). These counties were selected because they host over 80% of Kenya's manufacturing firms. The sample size of 386 firms was determined using the Nachmias and Nachmias (2012) sample size formula for finite populations. Geographical cluster sampling was employed to select firms from different manufacturing sectors, with each geographical cluster representing a stratum. The respondents included procurement managers and operations managers who possess adequate knowledge regarding supply chain management practices within their respective organizations.

Data Collection

Primary data were collected using structured questionnaires based on a five-point Likert scale ranging from strongly disagree to strongly agree. The questionnaire was preferred because it facilitated the collection of standardized data from a large number of respondents within a relatively short period. Prior to the main survey, a pilot study involving 5% of the target population (12 manufacturing firms) was conducted to evaluate the effectiveness of the instrument. Reliability of the questionnaire was assessed using Cronbach's Alpha coefficient, where a threshold value of 0.70 and above was considered acceptable. Validity was established through content validity, criterion validity, and construct validity. Content validity was assessed through expert review and pilot feedback, criterion validity was established by aligning questionnaire items with study objectives and previous studies, while construct validity was tested using Confirmatory Factor Analysis (CFA), with factor loadings of 0.40 and above considered acceptable.

Data Analysis

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics, including means and standard deviations, were used to summarize the characteristics of the study variables, while inferential statistics comprising correlation and regression analyses were employed to examine the

relationships among the variables. Prior to hypothesis testing, diagnostic tests such as normality, heteroscedasticity, and autocorrelation tests were conducted to ensure that the assumptions of regression analysis were satisfied. The effect of green manufacturing on firm performance was examined using simple linear regression analysis, while the moderating effect of collaborative capability was tested using hierarchical multiple regression analysis as recommended by Baron and Kenny (1986) and Hayes (2012). The moderation analysis involved three stages: first, assessing the direct effect of green manufacturing on firm performance; second, introducing collaborative capability into the model; and third, incorporating the interaction term between green manufacturing and collaborative capability. Changes in R^2, F-statistics, and p-values were used to determine the significance of the moderating effect. Statistical significance was assessed at the 5% level, where a p-value less than 0.05 indicated a significant relationship. The moderation model was expressed as:1

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 m + \beta_3 x_1 * m + \varepsilon$$

Where Y represents firm performance, X_1 represents green manufacturing, M represents collaborative capability, β_0 is the intercept, β_1–β_3 are regression coefficients, and ε represents the error term.

4. Findings and Discussions

This section presents the analysis, interpretation, and discussion of the study findings. It highlights the key results upon which further analyses and hypothesis testing were conducted. A total of 386 questionnaires were distributed to the respondents, out of which 242 were successfully returned, representing a response rate of 62.7%. However, after data screening, 18 questionnaires were excluded due to missing values and outlier issues, leaving 224 valid questionnaires for analysis, representing a valid response rate of 58.0% of the total sample and 92.6% of the returned questionnaires. According to Sekaran and Bougie (2010), a response rate above 30% is adequate for survey research. Therefore, the achieved response rate was considered satisfactory and sufficient for reliable statistical analysis, interpretation of findings, and testing of the study hypotheses.

Preliminary

The descriptive findings revealed that the performance of manufacturing firms remained relatively low despite the adoption of green supply chain management practices, with an overall mean score of 1.71 (SD = 0.21). Specifically, firms reported minimal improvements in profitability, market share, return on investment, sales volume, earnings per share, and energy resource utilization, suggesting that the benefits of green initiatives had not been fully realized. Similarly, the level of green manufacturing implementation was found to be low, as evidenced by limited use of environmentally friendly inputs, inadequate product designs that facilitate recycling, weak adoption of green procurement policies, low utilization of green technologies, and insufficient efforts to minimize waste generation and resource consumption. Green manufacturing recorded an overall mean score of 2.36 (SD = 0.47), indicating that environmental considerations had not been fully integrated into manufacturing processes. The study also established that collaborative capability was inadequately developed among the firms, with limited attention given to customer concerns regarding green products, weak interdepartmental and interorganizational communication, inadequate collaboration with suppliers and distributors, and low

levels of bilateral communication across supply chain partners. Collaborative capability recorded a mean score of 2.45 (SD = 0.33), implying that firms had not fully leveraged collaborative relationships to support environmental initiatives and performance improvement. Despite the relatively low adoption levels of green manufacturing and collaborative capability, the correlation analysis revealed significant positive relationships among the study variables. Green manufacturing exhibited a strong positive and significant relationship with firm performance ($r = 0.661$, $p < 0.001$), while collaborative capability also had a positive and significant association with firm performance ($r = 0.599$, $p < 0.001$). Furthermore, green manufacturing and collaborative capability were positively related ($r = 0.515$, $p < 0.001$), suggesting that enhanced collaboration may strengthen the effectiveness of green manufacturing initiatives. These findings imply that although manufacturing firms have not fully embraced green manufacturing and collaborative practices, improvements in these areas have the potential to significantly enhance organizational performance.

Table 1: Correlation Results

n=224	Mean	Std. Dev	Firm performance	Green manufacturing	Collaborative capability
Firm performance	1.71	0.21	1		
Green manufacturing	2.36	0.47	.661**	1	
Collaborative capability	2.45	0.33	.599**	.515**	1

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

Hypothesis Testing

Table 2 presents the results of the hierarchical regression analysis conducted to test the moderating effect of collaborative capability on the relationship between green manufacturing and firm performance. Consistent with the recommendations of Aiken and West (1991) and Jose (2008), all variables were standardized into z-scores prior to creating the interaction terms in order to minimize multicollinearity and facilitate interpretation of the moderation effects. The analysis was conducted in stages. Model 1 examined the direct effect of the independent variables on firm performance, Model 2 introduced collaborative capability as the moderating variable, while Model 4 incorporated the interaction term between green manufacturing and collaborative capability (GM*CC). The objective was to determine whether collaborative capability significantly altered the strength of the relationship between green manufacturing and firm performance.

The study tested the following hypothesis:

H_{01}: *Collaborative capability has no significant moderating effect on the relationship between green manufacturing and firm performance.*

The findings indicate that collaborative capability had a positive and statistically significant moderating effect on the relationship between green manufacturing and firm performance ($\beta = 0.92$, $p < 0.05$). The introduction of the interaction term increased the coefficient of determination from $R^2 = 0.69$ in Model 2 to $R^2 = 0.76$ in Model 4, resulting in an R^2 change of 0.03. This implies that the interaction between green manufacturing and collaborative capability explained an additional 3% of the variation

in firm performance beyond the direct effects of green manufacturing and collaborative capability. The positive interaction coefficient suggests that firms with higher levels of collaborative capability derive greater performance benefits from green manufacturing practices than firms with lower levels of collaborative capability. In other words, collaborative capability strengthens the positive effect of green manufacturing on firm performance.

The significance of the interaction term was further supported by the significant F-change statistic ($F = 47.98$, $p < 0.05$), indicating that the inclusion of the moderation term significantly improved the explanatory power of the model. These findings are consistent with the Natural Resource-Based View Theory and Resource Dependence Theory, which posit that collaborative relationships facilitate access to critical resources, knowledge, and technological capabilities necessary for the successful implementation of environmental initiatives. Therefore, the null hypothesis that collaborative capability has no significant moderating effect on the relationship between green manufacturing and firm performance was rejected. The study concludes that collaborative capability enhances the effectiveness of green manufacturing practices in improving the performance of manufacturing firms.

Table 2: Hierarchical Regression for moderating effect of Collaborative Capability on Green Manufacturing and Firm performance

	Model 1 B(Se)	**Model 2 B(Se)**	**Model 4 B(Se)**
(Constant)	0.07(.04)	0.07(.04)	0.02(.03)
Zscore(GM)	0.29(.07)**	0.23(.07)**	(-0.19(.08)*
Zscore(CC)		0.46(.05)**	(-0.27(.08)**
Zscore (GP_CC)			0.21(.13)
Zscore(GM_CC)			0.92(.13)**
Model Summary			
R	0.79	0.83	0.87
R Square	0.62	0.69	0.76
Adjusted R Square	0.61	0.68	0.75
Std. Error of the Estimate	0.81	0.73	0.65
Change Statistics			
R Square Change	0.61	0.08	0.03
F Change	156.18	94.96	47.98
df1	4.00	1.00	1.00
df2	394.00	393.00	391.00
Sig. F Change	0.00	0.00	0.00

*p<0.05, **p<0.01

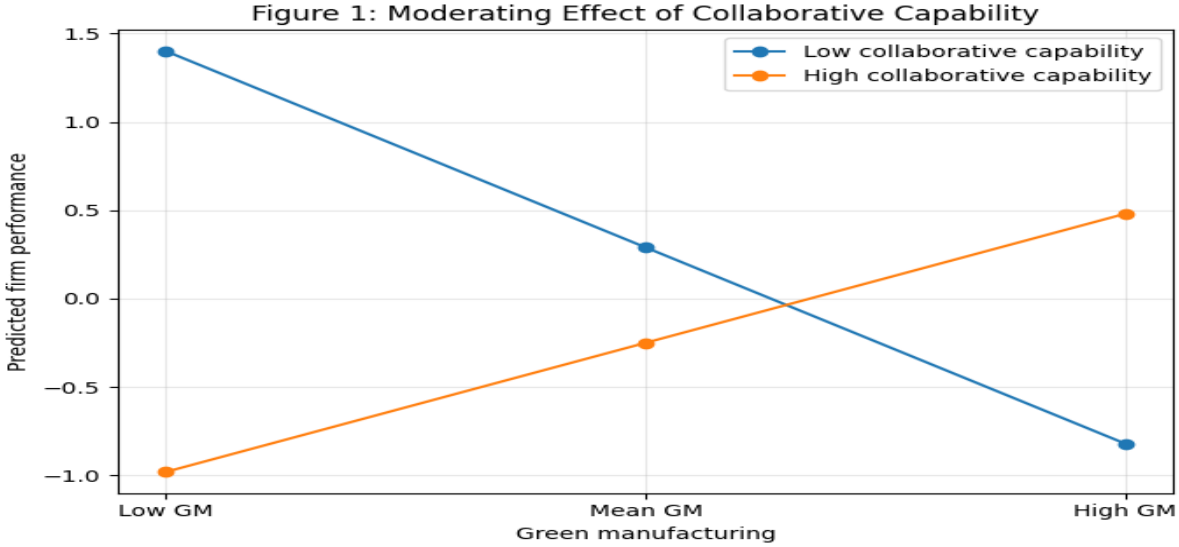
a. Dependent variable: Firm performance

Legend: GM – Green manufacturing, CC – Collaborative capability, GM*CC – Green manufacturing and Collaborative capability

Figure 1 demonstrates that collaborative capability enhances the relationship between green manufacturing and firm performance. The interaction plot indicates that firms with stronger collaborative capability are better positioned to realize the benefits of green manufacturing practices compared to firms with weaker collaborative capability.

Effective collaboration through interdepartmental coordination, information sharing, and close buyer-supplier relationships facilitates the successful implementation of green manufacturing initiatives, enabling firms to improve operational efficiency and overall performance.

Figure 1: Moderating Effect of Collaborative Capability



5. Discussions

The findings revealed that collaborative capability significantly strengthened the relationship between green manufacturing and firm performance, implying that the benefits of green manufacturing are enhanced when firms possess strong collaborative mechanisms. While green manufacturing practices such as eco-design, adoption of environmentally friendly technologies, waste minimization, pollution prevention, and resource efficiency have been widely recognized as drivers of organizational performance (Melnyk et al., 2009; Newman & Jensen, 2013; Ninlawan et al., 2010), the present study demonstrates that their effectiveness is partly dependent on the firm's ability to collaborate with internal and external stakeholders. The results support earlier studies by Gezen and Cankaya (2013), Deif (2011), and Ghazilla et al. (2015), which found that green manufacturing contributes positively to sustainability and organizational performance. However, the findings extend the existing literature by showing that collaborative capability enhances the extent to which firms can convert green manufacturing initiatives into improved performance outcomes. This suggests that firms that effectively coordinate activities, share information, and integrate resources across departments and supply chain partners are more likely to realize the full benefits associated with green manufacturing practices.

The findings are also consistent with studies emphasizing the strategic role of collaborative capability in environmental management. Cao and Zhang (2011) argued that collaborative relationships create competitive advantages through knowledge sharing and resource integration, while Vachon and Klassen (2008) found that environmental collaboration enhances organizational learning and the effectiveness of sustainability initiatives. Similarly, Hollos et al. (2012) and Azevedo et al. (2011) observed that collaboration with suppliers and customers improves environmental and financial performance by facilitating innovation, reducing costs, and improving

operational efficiency. The results further support the propositions of the Natural Resource-Based View Theory and Resource Dependence Theory, which suggest that firms can achieve superior performance by leveraging both internal capabilities and external resources through collaborative relationships. Therefore, the study concludes that collaborative capability serves as an important enabling mechanism through which manufacturing firms can maximize the performance benefits of green manufacturing practices, thereby improving profitability, market share, and overall competitiveness.

6. Conclusion

The study concluded that green manufacturing has a positive effect on the performance of manufacturing firms in Kenya and that collaborative capability significantly strengthens this relationship. Firms that adopt green manufacturing practices such as eco-design, green production processes, and green waste management are more likely to achieve improved performance outcomes. However, the findings revealed that the level of implementation of green manufacturing practices among manufacturing firms remains relatively low. The study further established that collaborative capability enhances the effectiveness of green manufacturing by facilitating information sharing, resource integration, interdepartmental coordination, and collaboration with supply chain partners. Therefore, firms with stronger collaborative capability are better positioned to translate green manufacturing initiatives into improved profitability, market share, and sales growth.

7. Recommendations

Based on the findings, the study recommends that manufacturing firms intensify the adoption of green manufacturing practices by investing in environmentally friendly production technologies, eco-design initiatives, waste reduction programs, and energy-efficient production systems. Firms should also strengthen collaborative capability by promoting effective interdepartmental communication, enhancing cooperation between functional units, and developing strategic partnerships with suppliers and customers. In addition, management should establish mechanisms for knowledge sharing and joint environmental initiatives across the supply chain to ensure that green manufacturing practices are implemented effectively and yield maximum performance benefits

8. Further Research

The study focused on the moderating effect of collaborative capability on the relationship between green manufacturing and firm performance among manufacturing firms in Kenya. Future studies should examine this relationship in other sectors such as agriculture, logistics, and service industries to determine whether the findings can be generalized beyond the manufacturing sector. Further research may also investigate other organizational factors that could moderate or mediate the relationship between green manufacturing and firm performance, including organizational culture, technological capability, environmental leadership, and innovation capability. In addition, longitudinal studies are recommended to assess the long-term impact of green manufacturing and collaborative capability on organizational performance and sustainability outcomes.

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