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STRATEGIC MANAGEMENT

THE EFFECT OF GREEN MANUFACTURING ON PERFORMANCE OF IRON AND STEEL MANUFACTURING INDUSTRIES IN NAIROBI COUNTY, KENYA

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ABSTRACT

Purpose of Study: The purpose of the study was to assess the influence of green manufacturing on performance of iron and steel manufacturing firms in Nairobi County, Kenya.

Problem of Study: The iron and steel manufacturing sector in Kenya is a substantial contributor to the economic development of the country. However, iron and steel manufacturing firms have been quoted as leaders in the degradation of the environment through primary and secondary waste disposal. Thus green manufacturing that is gaining popularity can help them minimize the negative impact to the environment while benefitting them through aspects such as competitiveness and operational efficiency.

Methodology: The study utilized a quantitative research methodology. Descriptive research design was used for this study. The target population for the study was 31 iron and steel manufacturing industries in Nairobi County, Kenya. The unit of observation represents those in top-level and middle-level management in finance, production, supply chain management, distribution, marketing and research and innovation. Therefore, the study targeted 372 top-level and middle level managers as respondents for the study. The sample size for the study was 213 respondents selected from 18 iron and steel manufacturing industries. Purposeful sampling was used in sample size selection. Inferential statistics utilized simple linear regression to assess the relationship between the dependent and independent variables.

Result: A positive significant relationship between green manufacturing and performance of iron and steel manufacturing companies (p-value = 0.032).

Conclusion: The adoption of green design and production practices in iron and steel manufacturing positively affects performance of iron and steel manufacturing companies by enhancing sustainability and efficiency.

Recommendations: The study recommends that companies should invest in skilled professionals and employee training in green product design to further embed environmentally friendly practices in manufacturing processes. Additionally, government policies such as subsidies and tax incentives can play a crucial role in encouraging more companies to adopt green manufacturing.

Keywords: *Green manufacturing, Industries, Iron and Steel, Manufacturing, Performance*

INTRODUCTION

The global population has been on the rise, living standards been increasing, natural resources being insufficient and the ecosystem being under the threat. Prevailing growth indicators predict the global population to double by the year 2072 (Tremblay & Ainslie, 2021). Considering this rise in population, it is expected that gross domestic product (GDP) per capita will increase five times while consumption of resources and waste generation will increase ten times (Maalouf & Mavropoulos, 2023). The manufacturing industry is expected to be one of the most hit since it consumes resources and generates wastes in bulky despite being one of main drivers of economic growth globally. For instance, statistics show that iron and steel processing sector generates industrial waste in excess of 400 million tons per year (Schoeman *et al.*, 2021).

Though steel is regarded as the most recyclable material in the world, it has also been demonstrated through studying its flows to demonstrate practices in its processing and waste management that are unsustainable (Kshitij *et al.,* 2022). Estimations show that if the current rates of consumption and recycling remain constant, iron ores will be non-existent in the next 100 years (Petersen *et al.,* 2021). In addition, iron and steel manufacturing industries are among the largest contributors to generation of waste (Inayat, 2023). This is evident from global estimates that 14% of the total global solid waste is generated by iron and steel processing industries (Cayumil *et al.,* 2021). This has resulted to regulations such as extended producer responsibility regulation placing some or full accountability, for End-of-Life (EoL) commodities brought to the market, on the manufacturers (Jafari *et al.,* 2022). Taxes on solid waste generation and landfill restrictions have also been put in place worsening the situation (Matheson, 2022).

As a result, iron and steel manufacturing have come up with innovations so as to ensure that they engage in sustainable manufacturing practices. Among the most utilized sustainability practice is green manufacturing practices. However, green manufacturing practices' implementation is more aligned towards responding to the demand for products that are environmentally sustainable in addition to environmental regulations by the government. With green manufacturing concept being still in the early stages among manufacturing firms in Kenya, it is evident that most firms have not fully adopted them owing to lack of awareness and knowledge on the benefits associated with the concept. In Kenya, the demand for green manufacturing calls for researches to sensitize practitioners. This is in consideration of the current situation of affairs where the nation is

experiencing numerous environmental degradation and its consequences. Partly, this is due to unsustainable practices by manufacturing industries. Though there is multiple literature suggesting various benefits of green manufacturing practices to manufacturing firms, such is scarce in Kenya. Most green manufacturing practices' studies have been in established countries and their findings may not be applicable in the context of LMIC such as Kenya. It is therefore clear that a knowledge gap exists that this study seeks to fill. It is against this context that the current study sought to evaluate the influence of green manufacturing on performance of iron and steel manufacturing companies in Nairobi County, Kenya.

PURPOSE OF THE STUDY

To evaluate the influence of green manufacturing on performance of iron and steel manufacturing companies in Nairobi County, Kenya.

EMPIRICAL LITERATURE

Green manufacturing enhances performance of manufacturing firms through integration of strategies that are environmental friendly into product design and production processes. According to Dahmani *et al.,* (2021), green manufacturing involving green design emphasizes on recyclability, disassembly and modularity. This ensures that end-of-life products can be used or recovered efficiently. Green design focuses on waste prevention and improved management of materials which enhances performance since manufacturers reduce costs related to litigation and compliance while at the same time increasing sustainability and competitiveness (Chuang & Huang, 2018). Moreover, green design facilitates market expansion, especially through first-mover advantage, which enables firms penetrate new markets with products that are eco-friendly (Singh *et al.,* 2020). Another major benefit of green design is resource efficiency which helps optimize resources' usage (Khan *et al.,* 2021). Other studies such as Awan *et al.,* (2022) and Ghazali *et al.,* (2021) support a direct link between green product design and performance indicators especially in competitiveness and market share in Pakistan and Malaysia respectively.

On the other hand, green manufacturing involving green production focuses on minimization of environmental impact by reducing wastes and emissions while enhancing efficiency (Ikram *et al.,* 2021). Through green production, innovation, market creation, financial performance and environmental reputation are enhanced (Afum *et al.,* 2020; Andersen, 2021; Baah *et al.,* 2020). Empirical research by Novitasari and Agustia (2021) further supports this claim by demonstrating

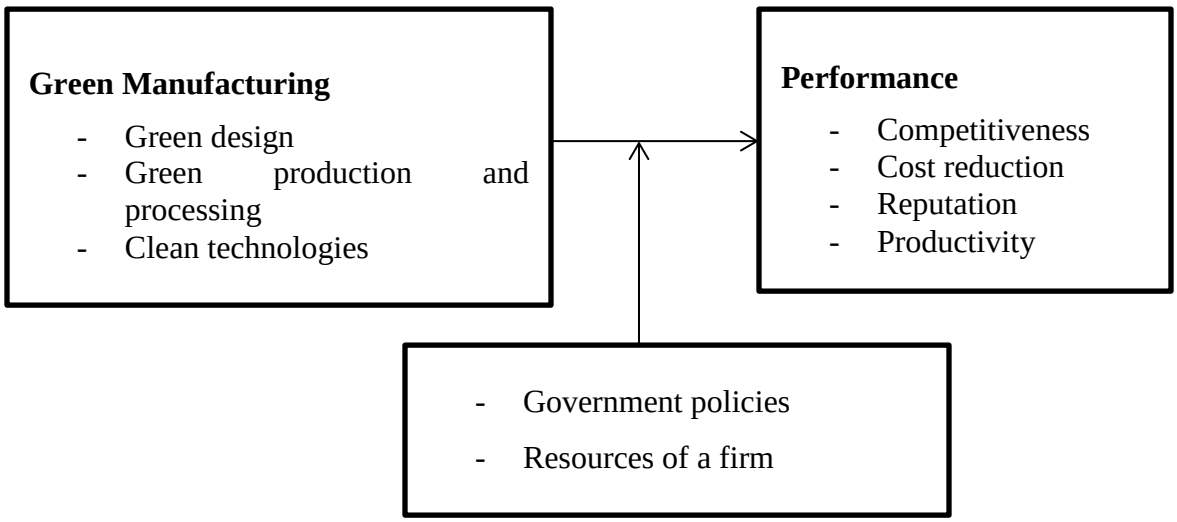
the positive relationship between green production and performance of manufacturing companies in Indonesia. In Saudi Arabia, small and medium enterprises (SMEs) were found to record improved performance due to the impact of green production (Al-Hakimi *et al.,* 2022). In Sri Lanka, firms adopting green production practices recorded improved performance in financial and environmental sustainability indicators (Walisundra *et al.*, 2022). Studies in Kenya also confirm that green manufacturing practices enhance operational performance in the tea and cement industries (Chemutai & Mbeche, 2019; Eshikumo & Odock, 2017).

THEORETICAL FRAMEWORK

The study adopted stakeholder theory by Freeman (1999). The theory asserts that operations of a firm in the current environment for doing business cannot be separated from the society and their stakeholders. The demands of these stakeholders influence business decisions. Therefore, ignoring these demands will be a threat to the survival of a firm (Kassinis & Vafeas, 2006). In the context of green manufacturing, stakeholders such as suppliers, customers, shareholders, employees, regulatory bodies, trade associations and the media exert pressure on firms to adopt environmental friendly practices (Sarkis *et al.,* 2010). Compliance with stakeholder demands for green manufacturing enhances performance of firms.

According to Mittal and Sangwan (2014), response to stakeholder demands enhances competitiveness. Further, Llach *et al.,* (2013) and Shashi *et al.,* (2019) demonstrated that green production implies compliance with industry requirements and therefore fosters trust and loyalty in addition to enhancing financial performance. Baah *et al.,* (2020) established that firms engaging in green manufacturing enjoy better goodwill, stakeholder satisfaction and enhanced competitiveness. Overall, the theory asserts that firms adopt green manufacturing due to stakeholders' demands and failure to comply can harm their reputation and market standing. The theory is relevant in explaining why firms implement green manufacturing practices and the associated benefits.

CONCEPTUAL FRAMEWORK



RESEARCH METHODOLOGY

The study utilized a quantitative research methodology. Descriptive research design was used for this study. The target population for the study was 31 iron and steel manufacturing industries in Nairobi County, Kenya. The unit of observation represents those in top-level and middle-level management in finance, production, supply chain management, distribution, marketing and research and innovation. Therefore, the study targeted 372 top-level and middle level managers (1 top-level and 1 middle level manager in each department) as key respondents for the study. Through Yamane (1967) formula, the sample size for the study was determined as follows:

$$n = \frac{N}{1 + Ne^2}$$

Where: n is the study's desired sample sized, N is the target population and e is the level of precision (0.05). Thus, $n = \frac{372}{1+372(0.05^2)} = 192.7 \approx 193$ respondents. Further, 10% of the study's computed sample size was added to cater for non-responses. This brought the sample size to 213. The respondents were selected from 18 iron and steel manufacturing industries.

Purposeful sampling was used in sample size selection. A total of 18 iron and steel manufacturing industries were purposively selected based on their size. The largest industries were included in the study since they are the most likely to have in place structures related to CLSCM. The study further purposively selected two respondents from each department of the selected industries:

finance, production, supply chain management, distribution, marketing and research and innovation. This comprised of 1 top-level manager and 1 middle-level manager from each department. The study collected data using a structured questionnaire.

After data collection, questionnaires were physically examined for completeness. Duly filled questionnaires were entered into excel and then imported into the Statistical Package for Social Scientists, SPSS, version 26.0 for analysis. The study comprised of quantitative data that was analyzed using descriptive and inferential statistics. Descriptive statistics comprised of frequencies and percentages. Inferential statistics utilized simple linear regression to assess the relationship between the dependent and independent variables. The following regression model will be used:

$$Performance = \beta_0 + \beta_1 \, Green\ manufacturing + \varepsilon$$

Where: $\beta_0 \; and \; \beta_1$ are the regression coefficients while ε is the error term.

FINDINGS AND DISCUSSION

Respondents were asked to indicate their gender, age, highest education level and years they had worked in the company. From the results as indicated in Table 1, majority of the respondents, 61.0% (114) were male; female respondents were also adequately represented. This indicates that the responses reflect opinions from both male and female respondents. Majority of the respondents (90.4%) were in the age bracket of 30-59 years. This represents an active working age bracket of the respondents; the findings therefore demonstrate opinions from respondents who are actively involved in the affairs of iron and steel industries in Nairobi County, Kenya. All the respondents, 100.0%, had college/diploma and above as their highest level of education; majority as shown by 69.0% (129) had a bachelor's degree. This shows that the respondents were literate enough to deliberate on issues related to the study. Cumulatively, 90.9% of the respondents had worked in their respective company for duration of five years and above. This means that respondents were experienced enough on the affairs of the iron and steel manufacturing companies and could respond on practices that affect their performance.

Table 1: General Information of the Respondents

		Frequency	Percent (%)
Gender of Respondents	Male	114	61.0%
	Female	73	39.0%
Respondents' Age	Below 30 years	8	4.3%
	30-39 years	42	22.5%
	40-49 years	67	35.8%
	50-59 years	60	32.1%
	60-69 years	10	5.3%
Highest Level of Education	College Diploma/Certificate	24	12.8%
	Bachelor's Degree	129	69.0%
	Post-Graduate	34	18.2%
Years of Work in the Company	Below 5 years	17	9.1%
	5-9 years	19	10.2%
	10-14 years	84	44.9%
	15-19 years	24	12.8%
	20 years and above	43	23.0%

General Information about Iron and Steel Manufacturing Companies in Nairobi County, Kenya

The study also enquired about the general information regarding the iron and steel industries considered for the study. In terms of ownership, 59.9% (112) of the respondents indicated the industries being foreign owned. Further, 98.9% of the industries had operated in Kenya for five years and above (see Table 2). This is a clear demonstration that the industries have operated in the country for sufficient duration to undergo scrutiny on their sustainability practices.

Table 2: General Information on Iron and Steel Manufacturing Industries

		Frequency	Percent (%)
Company ownership	Local	35	18.7%
	Foreign	112	59.9%
	Both Foreign and Local	40	21.4%
Number of years operated in Kenya	Below 5 years	2	1.1%
	5-9 years	32	17.1%
	10-14 years	59	31.6%
	15 years and above	94	50.3%

Green Manufacturing Practices in Iron and Steel Manufacturing Companies in Nairobi County

Green manufacturing was assessed in terms of product design and the actual products produced. The findings on extent of adoption of green manufacturing practices are as shown in Table 3.

Table 3: Extent of Adoption of Green Manufacturing Practices

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Products in this company are designed while considering recyclability	11 (5.9%)	10 (5.3%)	56 (29.9%)	55 (29.4%)	55 (29.4%)
Products in this company are designed while considering reusability	16 (8.6%)	9 (4.8%)	36 (19.3%)	77 (41.2%)	49 (26.2%)
Products in this company are designed while considering disassembly	15 (8.0%)	5 (2.7%)	45 (24.1%)	74 (39.6%)	48 (25.7%)
Products in this company are designed while considering modularity	15 (8.0%)	17 (9.1%)	25 (13.4%)	59 (31.6%)	71 (38.0%)
Design of products in this company incorporate environmental sustainability while ensuring minimal loss to product performance, functionality and useful life	14 (7.5%)	9 (4.8%)	46 (24.6%)	52 (27.8%)	66 (35.3%)
Product design in this company considers waste management options available	11 (5.9%)	10 (5.3%)	45 (24.1%)	71 (38.0%)	50 (26.7%)
Production processes in this company utilizes clean technologies	6 (3.2%)	21 (11.2%)	26 (13.9%)	90 (48.1%)	44 (23.5%)
The products produced in this company are eco-friendly	9 (4.8%)	2 (1.1%)	32 (17.1%)	63 (33.7%)	81 (43.3%)
Production processes in this company minimize the use of non-renewable natural resources	14 (7.5%)	21 (11.2%)	39 (20.9%)	40 (21.4%)	73 (39.0%)
Production processes in this company avoid wastage of raw materials and consumption of high amounts of energy	13 (7.0%)	9 (4.8%)	31 (16.6%)	69 (36.9%)	65 (34.8%)

Based on the findings in Table 3, 58.8% (110) of the respondents were in agreement that products in their companies are designed in consideration of recyclability. According to 67.4% (126) of the participants, products in iron and steel manufacturing companies in Nairobi County are designed in consideration of reusability. A total of 65.3% (122) of the respondents indicated that products

in the companies are designed while considering disassembly while 69.6% (130) agreed that design of products considers modularity. From the results in Table 3, it is demonstrated by 63.1% (118) of the respondents that products' design in iron and steel manufacturing companies in Nairobi County incorporates environmental sustainability while ensuring minimal loss in terms of product performance, functionality and useful life. The results further indicate that 64.7% (121) of the participants are in agreement that design of products in their respective companies considers waste management options available. According to 71.6% (134) of the respondents, processes of production in iron and steel manufacturing companies utilize clean technologies; 77.0% (144) were in agreement that iron and steel manufacturing companies in Nairobi County produce products that are eco-friendly. Also indicated in the findings is 60.4% (113) of the respondents being in agreement that production processes minimize usage of non-renewable natural resources. Lastly, the findings demonstrate 71.7% (134) of the respondents agreeing that production processes in iron and steel manufacturing industries avoid raw materials' wastage and high energy consumption.

Influence of Green Manufacturing on Performance of Iron and Steel manufacturing Companies

Respondents were also presented with Likert scale items from which they were supposed to indicate their agreement/disagreement level on the effect of green manufacturing practices on performance of iron and steel manufacturing industries in Nairobi County, Kenya. The results are as illustrated in Table 4.

Table 4: Green Manufacturing Practices and Performance

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Better product design while considering remanufacturing options and methods of waste management ensures that products, after reaching their EoL, can be reused or recovered to their highest financial value	15 (8.0%)	43 (23.0%)	29 (15.5%)	51 (27.3%)	49 (26.2%)
Green manufacturing comes with several benefits to the manufacturer such as minimization of litigation and compliance costs	8 (4.3%)	10 (5.3%)	39 (20.9%)	93 (49.7%)	37 (19.8%)
Green manufacturing enhances value creation and reduce the costs associated with environmental investment making organization sustainable and competitive in the long-run	8 (4.3%)	23 (12.3%)	36 (19.3%)	69 (36.9%)	51 (27.3%)
Green manufacturing ensures environmental friendly products are produced thus helping in new markets development resulting to increased market share	17 (9.1%)	15 (8.0%)	36 (19.3%)	70 (37.4%)	49 (26.2%)
Green manufacturing enhances resource efficiency by reducing consumption of unnecessary resources	14 (7.5%)	12 (6.4%)	37 (19.8%)	71 (38.0%)	53 (28.3%)
Green manufacturing enhances innovativeness which comes with multiple benefits to the firm such as new customers' attraction an new market creation	14 (7.5%)	17 (9.1%)	39 (20.9%)	65 (34.8%)	52 (27.8%)
Engagement in green manufacturing enhances good perceptions regarding the environment thus boosting organizational reputation	29 (15.5%)	15 (8.0%)	32 (17.1%)	62 (33.2%)	49 (26.2%)

From Table 4, it can be seen that 53.5% (100) of the respondents were in agreement that better product design while considering remanufacturing options and methods of waste management

ensures that products can be reused or recovered to their highest financial value after reaching their EoL. Also notable from the results is that 69.5% (130) of the respondents agreed and strongly agreed that green manufacturing comes with benefits, such as minimization of litigation and compliance costs, to the manufacturer. From the results, it can be seen that 64.2% (120) of the respondents agreed and strongly agreed that green manufacturing enhances value creation and reduce costs affiliated with environmental investment which makes the industries sustainable and competitive in the long-run. As per 63.6% (119) of the respondents, green manufacturing ensures production of environmental friendly products which helps in development of new markets resulting into increased share of the market. The results also illustrate that 38.0% (71) and 28.3% (53) of the respondents agreed and strongly agreed respectively that green manufacturing enhances resource efficiency by reducing consumption of unnecessary resources. From the Likert scale responses in Table 4, it is evident that 62.6% (117) of the respondents were in agreement that green manufacturing enhances innovativeness which comes with multiple benefits to the firm such as attraction of new customers and creation of new markets. The results also indicate that 58.4% (111) of the respondents were in agreement that when companies engage in green manufacturing, good perceptions regarding the environment are enhanced which boosts the reputation of the company.

Inferential Statistics

A simple regression model for the relationship between performance of iron and steel manufacturing companies (dependent variable) and green manufacturing practices (independent variable) was fitted. The model summary results shown in Table 5 indicate that R-Square = 0.573; an indication that 57.3% of performance is explained by a constant and green manufacturing practices.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.757[a]	.573	.568	.36312

a. Predictors: (Constant), Green Manufacturing Practices

From the ANOVA table, the p-value = 0.032 which is less than 0.05 (see Table 6). The regression model predicting performance from green manufacturing practices is therefore significant and can be adopted.

Table 6: ANOVA Table for Regression Model Significance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.618	1	.618	4.684	.032[b]
	Residual	24.393	185	.132		
	Total	25.011	186			

a. Dependent Variable: Performance
b. Predictors: (Constant), Green Manufacturing Practices

The regression coefficients results are as illustrated in Table 7.

Table 7: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.189	.134		16.352	.000
	Green Manufacturing Practices	.075	.035	.157	2.164	.032

a. Dependent Variable: Performance

From the results on regression coefficients in Table 7, p-value for the relationship between green manufacturing practices and performance is 0.032 which is less than 0.05. The regression coefficient is positive. This indicates that green manufacturing practices has a significant positive effect on performance of iron and steel manufacturing firms in Nairobi County, Kenya. The regression model for the relationship between performance and green manufacturing practices is presented as shown in the equation below:

$$Performance = 2.189 + 0.075\ Green\ Manufacturing$$

Discussion

The study established that green manufacturing (measured in terms of green design and green production) had a significant effect on performance of iron and steel processing industries in Nairobi County, Kenya. In a Pakistan's study by Awan *et al.*, (2022), a significant direct relationship between green product design and sustainability of a firm was established thus supporting the findings of this study. In agreement with the findings of this study are findings in Novitasari and Agustia (2021) who conducted a study in Indonesia to evaluate the effect of

innovative green production on firms' performance. The study, just like in this study found that innovative green production had a significant effect on performance. Similarly, Al-Hakimi *et al.*, (2022) conducted a study in Saudi Arabia on the influence of green production practices on sustainable performance. The study found that green manufacturing practices had a direct and indirect influence on sustainable performance thus concurring with this study. In a study conducted in Sri Lanka, Walisundara *et al.*, (2022) found that green manufacturing practices had a significant effect on sustainable performance of firms.

A study by Baah *et al.* (2021) in Ghana using manufacturing SMEs found that green manufacturing had a significant and positive influence on performance aspects of SMEs especially reputation and environmental performance. In a Kenyan study Chemutai and Mbeche (2019) green manufacturing in tea processing firms was found to have a significant effect on performance of tea processing firms, thus agreeing with the findings in this study. Further, Eshikumo and Odock (2017) conducted a study on green manufacturing and cement manufacturing firms' operational performance in Kenya. The study found a significant relationship between green manufacturing and operational performance of cement manufacturing firms thus conforming to this study's findings.

CONCLUSION AND RECOMMENDATIONS

From the findings, it can be concluded that iron and steel manufacturing companies adopt green design and production practices in their manufacturing processes. Through the adoption of these green manufacturing practices, performance of these companies is significantly affected. The study recommends that companies should recruit product design professionals with skills in green product design. Companies should also facilitate training of their current employees on green product design. This will help entrench green manufacturing in their manufacturing process. The study also recommends that policy makers in government should come up with measures to encourage companies in adopting green manufacturing practices. These measures may include subsidization of green investments and technologies. Policies on tax holidays for green investments and technologies will also help companies in adopting green manufacturing practices in their supply chain.

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