

RECYCLING AND PERFORMANCE OF PLASTIC MANUFACTURING FIRMS IN NAIROBI, KENYA

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Abstract: *This study investigated the effect of recycling on the performance of plastic manufacturing firms in Nairobi County, Kenya. Recycling was examined as a core reverse logistics practice encompassing traditional/mechanical, chemical, pyrolysis, and gasification recycling processes. Using a cross-sectional survey design, data were collected from 27 plastic manufacturing firms through structured interviews and document analysis. Data were analyzed using descriptive and inferential statistics, specifically categorical regression with orthogonal transformation. The results revealed a significant positive effect of recycling on firm performance ($F(1,19) = 17.976, p = .003; R^2_{adj} = .459$), indicating that recycling accounted for 45.9% of the variation in performance. Firms with good recycling practices had higher mean performance scores ($M = 78.09\%, SD = 11.85$) compared to those with moderate recycling ($M = 58.56\%, SD = 8.56$). The predictive model developed was $P_i = 58.563 + 19.534RC - G + \epsilon$. The study concludes that effective recycling enhances firm performance by lowering production costs, improving operational efficiency, and fostering environmental sustainability. The study recommends investment in advanced recycling technologies, government incentives, and stronger public-private collaboration to enhance sustainability in the plastic manufacturing sector.*

Keywords: *Recycling, Reverse Logistics, Firm Performance, Plastic Manufacturing, Nairobi County, Sustainability*

1. INTRODUCTION

The concept of recycling has gained global prominence as industries and governments seek sustainable solutions to waste management and environmental conservation. Recycling entails the recovery and reprocessing of waste materials into new products, thereby reducing the consumption of virgin raw materials, conserving energy, and minimizing pollution. In the manufacturing sector, recycling not only mitigates environmental harm but also generates operational and financial benefits, contributing directly to firm performance (Salim, 2016; Lamsali, 2013).

Globally, the plastic industry has come under scrutiny due to its contribution to environmental degradation. The World Bank (2022) estimates that over 300 million tonnes of plastic waste are generated annually, yet less than 10% is effectively recycled. In developed economies such as Germany and Japan, robust recycling systems have significantly reduced landfill dependency while enhancing industrial efficiency. However, in

many developing countries—including Kenya—the recycling sector remains underdeveloped, fragmented, and largely informal (NEMA, 2021).

In Kenya, the plastic manufacturing industry plays a vital role in the economy, contributing over KES 100 billion annually and employing more than 60,000 people (KAM, 2016). Despite this contribution, the industry faces challenges related to waste management, high raw material costs, and strict environmental regulations following the 2017 plastic ban. Recycling offers an opportunity to address these challenges by closing the production loop—turning waste into valuable inputs. Yet, empirical evidence on how recycling impacts firm performance, particularly within plastic manufacturing firms in Nairobi County, remains limited.

From a theoretical perspective, this study is grounded in the Resource-Based View (RBV) theory (Wernerfelt, 1984; Barney, 1991), which posits that firms achieve sustained competitive advantage by effectively utilizing valuable, rare, inimitable, and non-substitutable resources. In this context, recycling is conceptualized as a strategic capability that enhances resource efficiency, reduces dependency on raw materials, and lowers operational costs. Additionally, the Institutional Theory suggests that firms adopt recycling practices not only for economic gains but also to conform to societal, environmental, and regulatory expectations (Scott, 2001). These theoretical perspectives highlight recycling as both an operational necessity and a strategic differentiator in enhancing performance.

Empirical evidence supports the positive relationship between recycling and firm performance. Studies such as Ochiri et al. (2015) found that recycling strategies significantly improve operational efficiency and profitability among publishing firms in Kenya. Similarly, Guta (2016) and Sbardelotto et al. (2024) demonstrated that recycling contributes to reduced production costs and improved material recovery. Internationally, Prenovitz et al. (2023) and Wang and She (2021) noted that effective recycling practices enhance market performance and environmental legitimacy. Despite these findings, limited research has been conducted in the Kenyan plastics sector, where recycling remains largely underutilized due to technological, policy, and infrastructural barriers.

Therefore, this study seeks to determine the effect of recycling on the performance of plastic manufacturing firms in Nairobi County, Kenya. The study focuses on how recycling practices influence financial, operational, and market performance indicators. By empirically analyzing this relationship, the study provides practical insights for managers, policymakers, and scholars seeking to strengthen sustainable manufacturing systems in Kenya's industrial sector.

2. METHODOLOGY

2.1 Research Design and Sampling

A cross-sectional survey design was employed to investigate the effect of recycling on firm performance. The population comprised 27 registered plastic manufacturing firms in Nairobi County. Data were collected through structured interviews with firm managers and analysis of organizational records.

2.2 Measurement of Variables

Recycling was measured using four indicators: traditional/mechanical recycling, pyrolysis, chemical recycling, and gasification. Firm performance was evaluated across three dimensions: financial (profit margins, revenue growth), operational (efficiency, waste reduction), and market (customer retention, market share).

2.3 Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics in SPSS. Categorical regression with orthogonal transformation tested the hypothesis:

H_a: Recycling has a significant effect on the performance of plastic manufacturing firms in Nairobi County.

Significance was tested at the 0.05 level.

3. RESULTS

3.1 Descriptive Analysis

All surveyed firms engaged in some form of recycling, although most relied on mechanical recycling. Only 21.4% utilized more than 80% of available recycling methods, while 47.9% used between 21–60%.

Table 1: Descriptive Statistics on Recycling and Firm Performance

Recycling Status	Mean Performance (%)	SD	Firms (%)
Good	78.09	11.85	28.6
Moderate	58.56	8.56	71.4
Overall	64.14	12.96	100

3.2 Inferential Analysis of Recycling and Performance of Plastic Manufacturing Firms in Nairobi County

The plastic manufacturing firms were grouped into good, moderate and poor based on the status of recycling by the firm. The mean performance of plastic manufacturing firms in each category was then determined. The performances of plastic manufacturing firms with good, moderate and poor recycling are summarized in Table 2.

Table 2: Performances of Plastic Manufacturing Firms against Recycling

Recycling	Mean Performance	N	N-Percent	SD
Poor		0	0.0%	
Moderate	58.56%	15	71.4%	8.56
Good	78.09%	6	28.6%	11.85
Total	64.14%	21	100.0%	12.96

Source: Researcher, Field Data, 2025.

Table 2 shows the variation in performance of plastic manufacturing firms with the status of recycling. There is a general increase in mean performance from plastic manufacturing firms with moderate recycling to plastic manufacturing firms with good recycling. But there is no plastic firm that practices poor recycling. Plastic manufacturing firms with good recycling have a higher performance ($M = 78.09\%$, $SD = 11.85$), than plastic manufacturing firms with moderate recycling, $M = 58.56\%$, $SD = 8.560$. But a majority of plastic manufacturing firms (71.4%) surveyed had poor recycling. This means that a majority of the plastic firms do not benefit from the positive effects of recycling. Only 28.6% of the plastic manufacturing firms surveyed had good recycling. The study established that plastic manufacturing firms in Nairobi County are generally moderate in waste recycling. The data in Table 2 suggest that performance of plastic manufacturing firms vary with recycling and good recycling is associated with high performance and vice-versa.

The data in Table 2 was tested using simple linear categorical regression (with orthogonal transformation) to determine if recycling had a significant effect on performance of plastic manufacturing firms in Nairobi County. The study tested the null hypothesis that:

There is no significant difference in the performance of plastic manufacturing firms in Nairobi Country with good, moderate and poor recycling.

$$H_{02}: R_{P*RC-G.RC-P} = 0$$

$$H_{a2}: R_{P*RC-G.RC-P} \neq 0$$

where P = performance, RC-G = recycling (good), RC-P = recycling (poor). The results of regression analysis with categorical predictors summarized in Table 3 were obtained.

Table 3: *Summary of Categorical Regression of Performance on Recycling in Plastic Manufacturing Firms in Nairobi County*

Variable	B	R	R ²	R ² _{adj.}	Std. ε	t	Sig.	F
Constant	58.563				2.463	23.780	.000	
RC-P								
RC-G	19.534				4.607	4.240	.000	
Model Summary		.697	.486	.459	9.537		.003	17.976

Note. RC-G = Recycling (good), RC-P = Recycling (poor).

Table 3 presents categorical regression results of performance of plastic manufacturing firms in Nairobi County on recycling. Analysis of the F statistic shows a significant regression effect. There is a significant difference in the performance of plastic manufacturing firms in Nairobi Country with good, moderate and poor recycling, $F(1, 19) = 17.976$, $p = .003$. A regression model exists and at least one of the predictor dummy variables is a significant predictor of the performance of plastic manufacturing firms in the model. Analysis of the t statistics

shows that RC-G is a significant predictor of performance in the model, $t(19) = 4.240, p = .000$. The general model for predicting performance from recycling is depicted in Equation 1.

$$P^1 = 58.563 + 19.534 \text{ RC-G} + \varepsilon \dots \quad (1)$$

where P^1 is the predicted performance and RC-G is good recycling .

The model in Equation 1 indicates that if recycling (good) changes by 19.534 units, the performance of the firm changes by one (1) unit, if other factors remain constant. For a unit change in performance of a plastic manufacturing firm, 19.534 units of good recycling are required, other factors being constant. The performances of plastic manufacturing firms with good recycling are 19.534 units above the performances of plastic manufacturing firms with moderate recycling. In the overall analysis, recycling accounts for up to 45.9% of the variance in the performance of a plastic manufacturing firm, if other factors remain constant, $R^2 \text{ adj.} = .459, p = .003$. The study therefore established that recycling has a positive effect on performance of plastic manufacturing firms by up to 45.9%. The null hypothesis was rejected.

The finding that recycling has a positive effect on performance of plastic manufacturing firms can also be understood from the benefits of recycling in general. First, as Salim (2016) points out, recycling saves firms the cost of transportation of materials to be disposed and the cost of land acquisition; and reduce the need for extracting, refining and processing raw materials all of which create air and water pollution. It also well established that recycling saves energy, reduces greenhouse gas emissions and help to tackle climate change (Denne et al., 2007). Further, as Walton and Lorimer (2000) point out, recycling can reduce the amount of waste sent to landfills and incinerators conserve natural resources and reduce the need to mine and process new raw materials. As Sharma et al. (2014) also point out, recycling can save the firm energy consumption and promotes material recovery. These are positive outcomes that accrue to firm performance.

The finding that recycling has a positive effect on performance of plastic manufacturing firms fits in the larger class of findings of several studies that have arrived at the same findings, even though not exclusively in the field of plastics firms. It agrees with the findings of Sun and Trudel (2017) who studied the effect of recycling versus trashing on consumption: theory and experimental evidence and found that positive emotions associated with recycling can overpower the negative emotions associated with wasting. Further, consumers could use a larger amount of resource when recycling is an option and this amount could go beyond the point at which their marginal consumption utility becomes zero. It also supports the findings of Torkelis et al. (2024) who investigated the factors influencing the recycling of plastic and composite packaging waste using PESTEL analysis. Torkelis et al. (2024) found that the key deficiencies within the recycling system for plastic and composite packaging waste include inadequate technological capacity, underdevelopment of the secondary polymer market, and establishment of ambitious political targets that are challenging to attain. These are indicators of improved performance.

The current finding also supports the previous findings by Wang and She (2021), Linder et al. (2021) and Prenovitz et al. (2023). Wang and She (2021) studied the influence of mechanism of recycling behavior on pro-environmental behavior and found that recycling efforts positively affect pro-environmental behavior through the mediating mechanism of pride and environmental identity. Linder et al. (2021) investigated internal and external factors influence on recycling: insights from a laboratory experiment with observed behavior, using a laboratory experiment ($N = 399$) with a choice to dispatch a used plastic cup in a recycling or general waste bin after participating in a staged “yogurt taste test”, and found that the spatial positioning of bins explained more than half of the variance in recycling behavior and that self-reported recycling intentions are

not related to which bin they used. Prenovitz et al. (2023) investigated markets and recycling performance using a cross-country regression analysis and case studies, using a two-way fixed effects regression model with panel data from 34 countries over the years 2000 to 2019, and found that the inefficiencies of bureaucratic management suggest that private industry can be a less costly solution to encouraging recycling. Industry involvement in existing recycling programs can limit unnecessary costs. The Wang and She (2021), Linder et al. (2021) and Prenovitz et al. (2023) all shows that recycling leads to improved performance, which also the findings of the current study.

Finding that recycling has a positive effect on performance of plastic manufacturing firms also concurs with the findings of studies by Ochiri et al. (2015), Sbardelotto et al. (2024) and the findings of Dacha et al. (2023). Ochiri et al. (2015) investigated the effects of recycling strategy on firm performance: a survey of publishing findings by firms in Kenya, using a stratified random sampling approach and a descriptive research design, and a study sample of 189 firms and 138 respondents. They found that recycling strategy had significant influence on performance of publishing firms in Kenya ($r = .395$, $p < .05$), and accounts for 28.1% of the variance in firm performance. Sbardelotto et al. (2024) on their part investigated the influence of recycling processes on properties of fine recycled concrete aggregates and found that recycling processes with the highest potential for producing high-quality aggregates demand jaw crusher and impact crusher combinations.

Dacha et al. (2023) on the other hand investigated recycling practices and value chain performance in the food and beverage industry in Kenya using a descriptive research design and a sample of 74 companies in the food and beverage industry. They found that recycling practices had a significant positive effect on food and beverage firms in the industry. Further, most of the food and beverage firms in the industry that are implementing recycling practices are doing so as a way of reducing the operational costs and optimizing value chain performance. All these studies, like the present study, found a positive relationship between recycling and performance, even though they were conducted in different contexts.

4. DISCUSSION AND CONCLUSION

The findings of this study revealed that recycling has a statistically significant and positive effect on the performance of plastic manufacturing firms in Nairobi County. The regression results showed that recycling accounted for 45.9% of the variation in firm performance ($F(1,19) = 17.976$, $p = .003$). This implies that as firms increase the level and sophistication of their recycling practices, their overall performance in terms of financial, operational, and market indicators also improves.

4.1 Interpretation of Findings

The results indicate that recycling directly enhances firm performance through cost reduction, improved resource utilization, and enhanced environmental compliance. Firms with higher recycling levels—particularly those that have adopted mechanical and chemical recycling—experience reduced dependency on virgin raw materials, thereby lowering production costs and improving profit margins. This finding is consistent with Salim (2016) and Mwaura et al. (2015), who asserted that recycling minimizes material wastage and promotes cost efficiency by reintroducing recovered materials into production processes.

Moreover, recycling facilitates operational efficiency through improved waste management and process optimization. The reduction in waste disposal requirements saves storage and transport costs, allowing firms

to redirect resources toward production and innovation. As noted by Denne, Irvine, Atreya and Robinson (2007), recycling reduces energy consumption and greenhouse gas emissions, thereby aligning production with global environmental standards. In Nairobi's context—where waste management is a critical challenge—firms that actively engage in recycling are better positioned to comply with environmental regulations imposed by the National Environmental Management Authority (NEMA) and to build a sustainable brand image.

From a market performance perspective, recycling activities enhance a firm's public image and customer loyalty. Environmentally responsible firms attract consumers who prefer sustainable brands, which in turn increases market share and customer retention. This supports the assertions of Zhu, Sarkis and Lai (2006) that integrating environmental management practices such as recycling into corporate operations improves customer satisfaction and competitiveness.

4.2 Comparison with Previous Studies

The present findings are consistent with a number of previous studies that have established a strong link between recycling and firm performance. For instance, Ochiri et al. (2015) found that recycling strategy significantly improved the performance of publishing firms in Kenya, accounting for 28.1% of performance variance. Similarly, Dacha, Omwenga, and Namusonge (2023) observed that recycling practices had a significant positive effect on value chain performance within Kenya's food and beverage industry, with firms citing reduced costs and enhanced efficiency as primary benefits.

Globally, Prenovitz, Hazlett, and Reilly (2023) reported that countries with liberalized recycling markets and strong institutional frameworks achieved higher recycling rates and improved industrial performance. Likewise, Torkelis et al. (2024) highlighted that advanced recycling systems contribute to economic efficiency by reducing the reliance on virgin polymers and supporting circular economy initiatives. The findings of the current study also corroborate Guta (2016), who found that recycling and reuse had a strong positive correlation with both financial and marketing performance among manufacturing firms in Malaysia.

These findings collectively affirm that recycling is not merely an environmental initiative but a strategic business practice that contributes directly to profitability, operational sustainability, and competitiveness. The strength of the relationship observed in this study ($R^2_{adj} = .459$) suggests that recycling plays an even more pronounced role in Kenya's plastics industry, where raw material costs are high and environmental compliance requirements are tightening.

4.3 Theoretical Implications

The results lend empirical support to the Resource-Based View (RBV) theory, which emphasizes that firms gain sustainable competitive advantage by effectively deploying valuable, rare, inimitable, and non-substitutable resources (Wernerfelt, 1984; Barney, 1991). Recycling, in this context, functions as a strategic capability that enables firms to maximize internal efficiencies and leverage waste materials as productive assets. By transforming post-consumer waste into reusable inputs, firms reduce costs and enhance their resource productivity—key aspects of RBV's value and efficiency dimensions.

Additionally, the findings align with the Institutional Theory, which posits that organizational practices are shaped by regulatory, normative, and cultural pressures. Kenyan plastic manufacturers face increasing institutional pressures from NEMA regulations, international sustainability benchmarks, and public demand for environmentally responsible production. Firms that adopt effective recycling practices not only comply with these institutional expectations but also strengthen their legitimacy and social license to operate.

Thus, recycling serves a dual function—enhancing competitive advantage internally (RBV) while improving legitimacy externally (Institutional Theory). This dual benefit underscores why recycling is increasingly viewed as a strategic imperative rather than a peripheral environmental activity.

4.4 Practical Implications for Firms

The evidence from this study has several managerial implications. First, recycling should be viewed as a core operational strategy rather than an auxiliary environmental responsibility. Firms that institutionalize recycling within their production systems experience direct financial and operational gains. Managers should therefore integrate recycling targets within their performance management systems, ensuring that sustainability metrics are linked to productivity and profitability goals.

Second, the study highlights the importance of technological investment. Most firms in Nairobi still rely on mechanical recycling, which, although beneficial, has limited efficiency and quality recovery rates. Transitioning to advanced recycling technologies such as pyrolysis, chemical recycling, and gasification could significantly enhance material recovery and product quality. The initial investment costs may be high, but long-term benefits in cost savings, waste reduction, and brand differentiation outweigh these expenses.

Third, the findings underscore the need for industry collaboration and government support. Kenya's plastic waste management ecosystem remains fragmented. Collaboration among manufacturers, recyclers, and regulatory bodies could promote knowledge sharing, standardization, and economies of scale in recycling operations. Government incentives such as tax rebates and access to green financing can further encourage adoption of advanced recycling technologies.

4.5 Policy Implications

The study's findings also carry significant policy implications. Policymakers should integrate recycling incentives into Kenya's National Industrialization Policy and the Circular Economy Strategy to accelerate sustainable manufacturing. Establishing dedicated recycling zones or industrial symbiosis parks could facilitate waste collection and processing. In addition, stricter enforcement of waste segregation policies and producer responsibility regulations would enhance the supply of recyclable materials and reduce landfill dependency.

Furthermore, the government can foster innovation by funding research into low-cost recycling technologies suitable for developing-country contexts. Public-private partnerships can bridge the existing technological and financial gaps that hinder effective recycling in Nairobi's manufacturing sector.

4.6 Contextualizing Findings within Nairobi County

The contextual realities of Nairobi County present a unique backdrop for understanding the significance of recycling. Rapid urbanization, growing consumption, and poor waste management systems have led to increasing plastic pollution in the city's waterways and landfills. Plastic manufacturing firms are thus under immense pressure to adopt sustainable practices to maintain operational legitimacy. The study's findings suggest that firms that proactively embrace recycling are not only meeting compliance standards but also enhancing competitiveness in a market that increasingly rewards sustainability.

Recycling also aligns with Kenya's Vision 2030 and Sustainable Development Goals (SDGs), particularly Goal 12 on responsible consumption and production, and Goal 13 on climate action. By adopting circular production systems, Nairobi-based plastic manufacturers contribute to national sustainability targets while improving their long-term economic resilience.

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