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**Teresiah Wairimu Karanja, Dr. Fredrick Waweru Warui &
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¹Teresiah Wairimu Karanja, ²Dr. Fredrick Waweru Warui & ³Dr. Moses Odhiambo Aluoch

¹Doctor of Philosophy in Business Administration (Finance), School of Business, Economics and Tourism, Kenyatta University

^{2&3}Lecturers, Department of Accounting & Finance, School of Business, Economics & Tourism, Kenyatta University

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Abstract

Despite their importance, manufacturing companies continue to encounter ongoing profitability challenges. Over the past decade, listed manufacturing firms in Kenya have experienced a consistent decline in return on assets (ROA), which reflects diminishing efficiency in asset utilization. This study aimed to assess how green investment practices influence the profitability of manufacturing companies in Kenya, while also examining the moderating influence of environmental regulations on this relationship. The research was underpinned by five theoretical perspectives: the Porter Hypothesis, Sustainable Finance Theory, Transaction Cost Economics Theory, Dynamic Capability Theory, and Institutional Theory. The study focused on ten manufacturing companies registered and publicly traded on the Nairobi Securities Exchange (NSE). Findings from correlation and regression analyses indicated that all four categories of green investment were positively and significantly associated with profitability. Among these, energy efficiency investments demonstrated the most substantial positive impact ($r = 0.641$, $B = 0.821$, $p = 0.000$), followed by investments in green supply chain management ($r = 0.241$, $B = 0.447$, $p = 0.013$) and renewable energy initiatives ($r = 0.182$, $B = 0.314$, $p = 0.039$). Sustainable waste management practices also showed a positive relationship with profitability, though the contribution was relatively modest ($r = 0.094$, $B = 0.192$, $p = 0.233$). Collectively, the green investment variables accounted for 38.6% of the variance in firm profitability ($R^2 = 0.386$), indicating considerable explanatory power. When the environmental regulatory framework was incorporated as a moderating variable, the explanatory strength of the model increased to 45.7% (R^2 change = 0.071, F change = 4.189, $p = 0.006$). This suggests that regulatory support amplifies the financial benefits derived from green investments. The study concludes that green investment initiatives significantly contribute to enhanced profitability in manufacturing firms, with regulatory policies providing a supportive, albeit limited, moderating effect. It recommends that policymakers reinforce environmental regulations and introduce incentives that encourage sustainable industrial investment. Manufacturing companies are also encouraged to embed green practices into their core operations as a strategy to boost competitiveness and profitability.

Keywords: *Environmental regulatory framework, green investment initiatives, profitability, manufacturing firms, Kenya*

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1.0 Background of the Study

Over the past decade, the global manufacturing sector has faced considerable financial strain, leading to a decline in overall performance. Rising operational costs, disruptions in supply chains, and shifting market demands have put pressure on profitability, prompting a reevaluation of business strategies. According to the World Bank (2022), global manufacturing output grew by only 3.5% in 2021, a significant slowdown compared to the pre-pandemic annual growth rate of approximately 6%. This slowdown highlights the sector's struggle to recover its previous levels of efficiency and profitability, with many firms rethinking their approaches in response to evolving economic conditions. Profitability serves as a key indicator of a firm's financial well-being, reflecting its ability to generate revenue in excess of expenses. In the manufacturing context, profitability not only signals effective management but also determines a company's potential for growth, innovation, and meaningful contribution to national economic development. Nevertheless, manufacturers around the world are increasingly confronting profitability challenges driven by rising production expenses, stricter environmental regulations, and growing expectations from stakeholders for sustainable business practices.

Green investment initiatives are mechanisms that influence projects, activities, and processes with positive environmental impacts (Taremi and Yusuf, 2017). Investments target renewable energy, efficiency, waste reduction, and resource management, while manufacturers face growing pressure from consumers, regulators, and stakeholders to embrace sustainability. Green investment initiatives offer a practical way to achieve these goals while maintaining financial stability. The United Nations Environment Programme (2019) states that financing for sustainable development plays a key role to mobilize resources needed for a shift to a low-carbon economy. Profitability signals a firm's financial strength and sustainability. Fama and French (2021) describe it as income generated against costs, assets, and equity. It plays a significant role in determining business sustainability, market competitiveness, and overall economic contribution. In the manufacturing sector, profitability fosters job creation, technological innovation, and value addition, making it a crucial aspect of economic development (World Bank, 2022). Firms with sustained profitability can reinvest in research, improve efficiency, and expand operations, further strengthening their market presence. Understanding the drivers of profitability enables firms to implement effective strategies that enhance financial performance.

Environmental regulatory framework is the most important concept in the sustainability and corporate performance research which represents the range and implementation of government rules that are aimed at helping the industrial sector to understand issues of environmental protection. The environmental regulatory framework basically includes all the laws, regulations, permits, and compliance mechanisms that the authorities such as the National Environment Management Authority (NEMA) set up, and it also includes the international agreements that Kenya has agreed upon (Kariuki & Musau, 2021). A powerful environmental regulatory framework puts firms on the path of compliance by setting green production standards, equipping them with cleaner technologies, and motivating them to improve waste management practices (Wambua & Mwangi, 2023). These instruments are the main means of control but they also work as sources of stimulus to innovation through the mobilization of business investments in eco-efficient processes to comply with the regulations (Omondi & Mutua, 2023). In the case of manufacturing, where the nature of operations is the major source of emissions and waste, the implementation of environmental regulations has assumed the position of the pivotal element in strategic decision making.

Kenya's manufacturing sector remains central to industrial growth, job creation, and exports, driving national development (KNBS, 2023; World Bank, 2022). The sector encompasses diverse sub-sectors, including food and beverages, plastics, textiles, chemicals, cement, and pharmaceuticals, all of which operate in resource- and energy-intensive environments (Bogumil, 2023; Ochieng, 2021). Historically, manufacturing firms have required significant capital investments in infrastructure, technology, and environmental compliance to maintain competitiveness and operational continuity (Muriuki & Kamau, 2020). Firms vary in size and ownership structure, with many private enterprises relying on internal financing, institutional partnerships, and retained earnings to support both operational activities and strategic sustainability initiatives (KNBS, 2023). Because the sector is capital-intensive, performance is mainly gauged through asset use, with ROA as the core measure of profitability and efficiency (Mwiti & Gitagia, 2023).

1.1 Statement of the Problem

Manufacturing firms form a critical pillar of Kenya's economy, driving industrial output, employment creation, and export earnings. However, the sector has faced persistent profitability challenges despite extensive policy support. The Big 4 Agenda envisioned raising manufacturing's GDP contribution from about 8% to 15% by 2022 (Republic of Kenya, 2018), yet this target was not achieved, with the contribution stagnating at approximately 9.2% and even contracting by 1.5% in 2022 (Kenya National Bureau of Statistics, 2023; World Bank, 2023). Most existing studies employ cross-sectional designs, which Al-Mulali et al. (2020) critique for failing to capture the long-term financial impacts of green initiatives. Conceptually, prior studies often rely on broad financial indicators, overlooking sector-specific factors such as capital intensity and production volatility that critically shape profitability (Chen & Rogers, 2021).

Three core gaps therefore emerge. First, methodologically, much of the research is descriptive or short-term in nature, failing to apply longitudinal or panel approaches capable of tracking sustained profitability impacts (Al-Mulali et al., 2020). Second, conceptually, few studies incorporate moderating firm-level variables such as governance quality, strategic orientation, or absorptive capacity, which shape the relationship between green investment initiatives and profitability (Chen et al., 2023). Third, contextually, most evidence comes from developed economies or advanced emerging markets, where institutional frameworks, incentives, and ESG reporting structures are more developed (Flammer, 2021; Abbas & Liu, 2022). By contrast, Kenyan firms operate in an environment of weak enforcement, limited financing options, and capital constraints, reducing the applicability of international findings (AFDB, 2020).

This study addresses the gap by empirically analyzing how green investments influence profitability in Kenyan manufacturing, using ROA as the measure. Unlike prior studies, it adopts a longitudinal approach using secondary data spanning five years (2019–2024), thereby addressing methodological shortcomings. It also integrates regulatory frameworks as moderating variables, thereby responding to the conceptual gap identified by Luo and Sun (2022). Contextually, it provides evidence from Kenya's manufacturing sector, where profitability has been declining despite policy support, and where studies remain limited. While much existing literature emphasizes environmental or reputational benefits of green investment initiatives, financial performance remains underexplored in this sector (D'Adamo et al., 2023). This study aimed to fill this gap by investigating the relationship between green investment initiatives and the profitability of manufacturing firms in Kenya.

2.0 Literature Review

2.1 Theoretical Review

There are several theories that are used to give reasons why firms require green investment initiatives. They include Porter Hypothesis, Sustainable Finance Theory, Transaction Cost Economic Theory, Dynamic Capability Theory and Institutional Theory. These theories are looked at below.

2.1.1 Transaction Cost Economics (TCE) Theory

Transaction Cost Economics (TCE) Theory, which is a large part of the work of Oliver E. Williamson (1975), is the main conceptual framework in organizational economics that attempts to account how firms manage their transactions so as to organize them in a way that results in the least costs. The theory is based on the idea of Ronald Coase's (1937) the famous paper "The Nature of the Firm" in which the author argued why firms are in existence if markets are efficient. Williamson expanded Coase's ideas by classifying transaction costs into search, bargaining, and enforcement. TCE argues firms internalize activities when market costs exceed in-house organization.

Green supply chain investments, like eco-friendly procurement, sustainable logistics, and traceability systems, are green. They are strategic responses that are aimed at reducing these transaction costs over a period of time, however, green supply chain investments are such responses. By setting up greener procurement standards and digital monitoring systems compliance firms reduce the exposure to the environmental risks and uncertainty, therefore, they lower the cost of compliance, supply disruptions, and the potential of getting punished. These cost savings eventually lead to more profits through both the operational savings and the reputational value that is being improved.

2.1.2 Porter Hypothesis

The Porter Hypothesis by Porter and van der Linde (1995) disputes the view that environmental rules and green investments only burden firms with costs. Instead, it argues that proactive environmental strategies such as energy efficiency investments can stimulate innovation, enhance resource productivity, and ultimately improve profitability. This theory, with reference to Kenya Manufacturing Firms, is a very convincing account of how sustainability-oriented investments not only meet environmental changes in regulations but also create competitive and financial benefits. The Porter Hypothesis contrasts with stock investment theories by going further to incorporate the dynamic benefits of innovation, efficiency, and market differentiation that come from adopting green energy production systems.

Although the hypothesis has been criticized for simply assuming every firm is capable of translating regulatory pressure into innovation gain, it remains important in fast-moving markets that are just starting to pay attention to sustainability. This study concludes that even modest energy efficiency programs can generate real savings when properly implemented, which supports the theoretical case of the Porter Hypothesis. As a result, well-crafted environmental regulations (or voluntary green investments in the same of energy efficiency) can actually improve firm competitiveness and profitability by stimulating innovation and operational excellence. Econometric models that calculate the effect of environmental investments on firm-level financial outcomes, especially in industrial sectors, have been used to test this idea statistically.

2.1.3 Sustainable Finance Theory

Sandberg (2015) created Sustainable Finance Theory that outlines the key role of the triple aspects of environment, society, and governance (ESG) in the banking sector. Sustainable finance theory sets out in financial markets the harmonization of economic and social activities for environmental purposes (Ngunjiri, 2023). The core idea is that instead of striving for maximum profits in a short period, investments in businesses whose activities are consistent with sustainability should be carried out, while obtaining financial income. The increased global consciousness of environmental issues and CSR commitment has brought about a new look at the role of financial systems in sustainable development. Across the world, manufacturing companies in Kenya have been going greener and are committing themselves more to make sustainability reporting a vital part of the conversation with stakeholders on their environmental, social, and economic performance (Ngunjiri, 2023). This is a reflection of the general trend of embedding sustainability principles into main business strategies in order to improve financial performance.

A manufacturing company that is engaged in renewable energy is bound to find operational cost savings from reduced dependence on the grid, that is, the electricity which is expensive and unstable or the use of fossil fuels hence improving the profit margin. Besides, firms that put sustainable energy as their highest priority will be the winners of reputation, regulatory incentives, and green financing all of which make them more competitive in the market. In Kenyan environment where the price of energy is exorbitant and power interruptions are a common phenomenon, the renewable energy projects are not only the guarantee of reliability but also of resilience, thus they become the drivers of financial stability.

2.1.4 Institutional Theory

Institutional Theory, first outlined by Meyer and Rowan (1977) and expanded by DiMaggio and Powell (1983), argues that firms are shaped not just by economic aims but by institutional norms, rules, and expectations. It holds that organizations adapt to regulatory, normative, and cognitive pressures to secure legitimacy, resources, and survival. Environmental Regulatory Frameworks are a key source of coercive pressure under Institutional Theory. These are institutionalized laws, regulations, and enforcement institutions that compel firms to conform to environmental and sustainability pressures. Strict environmental rules push firms to adopt green technologies, pursue eco-efficiency, and embed sustainability in strategy to ensure compliance and legitimacy (Delmas & Toffel, 2008). This alignment with institutional expectations not only helps avoid penalties but also enhances reputational capital.

It also contributes to sustainable profitability in the long term as well, Sandra pointed out further, noting that aligned institutions make it easier for firms to enter new markets and attract SDG-as-an-impact investors and reduce non-compliance and environmental costs. This makes Institutional Theory a great tool of analysis when it comes to understanding how environmental regulatory frameworks can act as a moderating variable that reinforces the effectiveness of green investment strategies, and in this way increase the value of corporate governance mechanisms. Businesses that operationalize sustainability via governance and convenient tailored compliance are poised to outcompete players and deliver financial longevity, as markets institutionalizing sustainability reflect truer long-term costs.

2.1.5 Dynamic Capabilities Theory (DCT)

Dynamic Capabilities Theory (DCT), introduced by Teece, Pisano, and Shuen (1997) as an extension of the Resource-Based View (RBV), stresses the need for firms to adapt in fast-changing

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environments. While RBV emphasizes VRIN resources for advantage, DCT highlights the ability to renew and reconfigure competencies. These dynamic routines allow firms to actively reshape their resource base, a necessity in volatile and uncertain contexts where static assets lose relevance (Wamba et al., 2021). By enabling innovation and sustaining margins in sectors driven by speed and learning, DCT has influenced fields such as green innovation, strategy, and sustainability (Cepeda & Vera, 2021). Its core idea is that lasting advantage depends not only on resources but on the capacity to continually adapt them. According to Teece (2007), dynamic capabilities are established through three major activities: sensing (recognizing opportunities and threats), seizing (gathering resources to get value), and transforming (changing assets and working).

According to Dynamic Capabilities Theory, sustainable waste management is seen as a strategic competency that improves organizational responsiveness to operational and environmental challenges rather than just a compliance measure. Manufacturing companies that make investments in closed-loop recycling, waste-to-energy systems, or digital waste tracking platforms show that they can reorganize their resource base to meet sustainability goals. These capabilities allow businesses to meet stakeholder expectations for environmental stewardship, innovate cost-effective waste solutions, and increase process efficiency. Over time, these businesses improve their reputation, lower input waste costs, and open up new revenue streams from circular economy models. Hence, DCT supports the premise that sustainable waste management investments are part of a broader adaptive strategy that contributes directly to long-term profitability.

2.2 Empirical Review Literature

Evidence from the Kenyan context is more limited but generally consistent with global findings. Mugambi and Karanja (2021) conducted a cross-sectional survey of 102 manufacturing firms registered with the manufacturing firms and found that firms implementing energy audits and investing in efficient machinery achieved notable reductions in energy costs, which were associated with modest improvements in profitability. However, their study was descriptive and did not adequately control for potential confounding factors, limiting the strength of the causal inference. The Kenya Association of Manufacturers (2020) also documented several case studies of firms implementing efficient lighting, heat recovery, and motor upgrades, reporting cost savings but without systematically analyzing profitability outcomes. These findings highlight the potential of EEI to improve profitability in Kenyan manufacturing firms but underscore the need for more rigorous empirical investigation.

Recently, Le et al. (2020) assessed the effects of the level of financial market development on the endeavor to adopt renewable sources of energy and become corporately sustainable. From their research, it was deduced that good financial systems can make it convenient for organizations to invest in renewable sources of energy through easy access to capital for large-scale energy projects. The research also pointed out that businesses in developed financial markets reported lesser CO₂ emissions and it further amplified the support of financial institutions toward clean energy shifts. But its findings also showed a gap in financial access, for instance by making an observation in which companies from underdeveloped markets found it tough to tap into investments. The authors have advanced a claim that shall not be necessarily interpreted as meaning that increased renewable energy adoption will always follow from the maturity of the financial systems due to regulatory and economic constraints. Future studies should assess how policy interventions can restructure financial support mechanisms for renewable energy projects in emerging economies.

In Tanzania, Mwakalobo and Mwinuka (2022) looked at how environmentally friendly supply chain plans change how much money agro businesses make. The research centered on plans like cutting down on waste, using nature-safe packaging, and using cleaner ways of moving things. The results showed that businesses that spent a fair amount to a lot of money in these areas had much fewer problems with how they worked. Also, businesses saw that more people wanted to buy their products because customers liked brands that cared about the environment more and more. The research made clear that help from the government and tax breaks were very important for getting businesses to spend money in these ways. In general, environmentally friendly supply chain plans were linked to making more money in the agro business field.

Atkinson (2023) looked at breaking environmental rules based on the Clean Air Act, and discovered that in 36% of situations, companies still made money even after paying fines. The research used money information from big factories and checked the money made from controlling pollution against the cost of breaking the rules. The results suggest that the current ways of punishing companies might not be good enough to stop them from breaking environmental rules, because companies often think about how much it costs to follow the rules compared to how much money they could make by not following them. Bigger rule breaking was found to lead to bigger money gains, showing that some companies knowingly break rules to make as much money as possible quickly. Atkinson (2023) says that stronger ways of making companies follow the rules and bigger punishments are needed to take away the money reasons for not following the rules. If these things are not done, companies might keep caring more about money than the environment, hurting efforts to control pollution.

Wang and colleagues in 2021 gave a warning by showing that if environmental rules change a lot or are not consistent, it can make green investments not turn out as expected. Their work, which took place in Asia, showed that when rules change often and without asking those involved, it hurts companies' ability to plan for long-term sustainability. This lack of predictability made investing seem riskier, which made people less likely to put money into green projects. The research determined that keeping rules steady is very important for making investors feel secure and ensuring that environmental investments make money. In Kenya, businesses that have to follow unclear or conflicting instructions from different groups like NEMA, EPRA, and local governments also have these issues, which damages how believable the policies are. Because of this, having environmental rules that are consistent, work together, and look to the future is crucial for helping businesses invest in using energy better, renewable energy, and managing waste in a sustainable way.

3.0 Research Methodology

Research philosophy provides the foundational framework that directs a researcher's approach to conducting a study, encompassing a set of beliefs, assumptions, and principles that inform the entire research process (Collingwood, 2020). The primary philosophical paradigms include positivism, interpretivism, realism, and pragmatism. This study adopts a positivist research philosophy. Grounded in rational and empirical thought, positivism maintains that causes generally produce predictable effects (Cooper, 2017) and supports the notion that the social world can be studied objectively using methods similar to those employed in the natural sciences. A causal research design was utilized in this study. This design is appropriate as it seeks to identify and explain the effect of green investment initiatives on the profitability of manufacturing firms in Kenya.

The study targeted manufacturing companies listed on the Nairobi Securities Exchange (NSE) that had been in continuous operation from January 2019 up to the period of data collection. Firms not listed on the NSE were excluded, as their financial information was either unavailable or lacked the standardization required for comparative analysis. A purposive sampling technique, a non-probability approach, was employed to deliberately select firms most relevant to the research objectives. In this case, the sample comprised all ten manufacturing firms meeting the inclusion criteria. Secondary data were used to facilitate quantitative analysis and enhance the reliability and accuracy of the findings. These data pertained to the performance indicators of the selected manufacturing firms in Kenya. Data were collected using structured data collection sheets, capturing profitability measures over a five-year period (2019–2024). The information was obtained from annual publications issued by the firms.

Upon completion of data collection, the sheets were reviewed for completeness, coded, and tabulated. Statistical Package for Social Sciences (SPSS) Version 26 was used to analyze the data. Tabulation facilitated the orderly arrangement of data, which was then examined through both descriptive and inferential statistical techniques. Pearson’s correlation test was applied to assess the relationships among the research variables, measuring the strength and direction of linear associations between variable pairs. Additionally, a multiple regression model was used to evaluate the predictive capacity of the independent variables. This analytical approach enabled an exploration of how multiple factors collectively influence the outcome, offering a more nuanced understanding of the drivers of profitability. Findings were summarized using visual tools such as frequency tables, frequency distributions, scatter plots, and a correlation matrix. Statistical significance was assessed at the 5% level, corresponding to a 95% confidence interval.

4.0 Data Analysis, Interpretations and Discussions

4.1 Descriptive Statistics

Descriptive statistics summarize and organize data to highlight key features such as central tendency and variability.

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	
	Statistic	Statistic	Statistic	Statistic	Std. Error
Energy Efficiency Investment	50	.005685	.008262	.006746	.0005038
Renewable Energy Investment	50	.004051	.005980	.004958	.0004065
Green Supply Chain Investment	50	.002910	.004482	.003672	.0002084
Sustainable Waste Management Investment	50	.003233	.004777	.004018	.0002601
Environmental Regulatory Framework	50	188,249,000	1,042,713,000	610,331,500	3609595
Profitability	50	.028121	.051270	.038579	.0032184
Valid N (listwise)	50				

Source: **Research data, (2025)**

Table 1 presents the measures of central tendency for green investment initiatives, environmental regulatory framework, and profitability among manufacturing firms in Kenya. The findings indicate that energy efficiency investment recorded a mean of 0.006746, suggesting that, on average, firms allocated approximately 0.67% of their total assets to energy-efficient technologies. The narrow gap between the minimum (0.005685) and maximum (0.008262) values reflects relatively uniform investment behaviour across firms, implying that energy efficiency initiatives are increasingly viewed as a necessary operational strategy rather than a discretionary investment. This moderate level of commitment may be attributed to rising energy costs and the need to improve cost efficiency in production processes.

Renewable energy investment registered a mean of 0.004958, indicating that manufacturing firms devoted about 0.50% of their assets to renewable energy projects such as solar and biomass systems. The relatively small difference between the minimum (0.004051) and maximum (0.005980) values suggests cautious but consistent adoption across firms. This finding points to a gradual transition toward cleaner energy sources, likely influenced by sustainability pressures and policy incentives, although high initial capital requirements may still constrain wider adoption. The mean value for green supply chain investment was 0.003672, implying that firms allocated approximately 0.37% of their assets to environmentally responsible sourcing, logistics, and procurement practices.

The environmental regulatory framework variable exhibited a mean value of KES 610,331,500, with substantial variation between the minimum and maximum values. This indicates significant differences in regulatory compliance costs and environmental obligations among firms, likely influenced by firm size, production scale, and regulatory enforcement intensity. Finally, profitability recorded a mean of 0.038579, suggesting that manufacturing firms earned an average return on assets of approximately 3.86%. Overall, the central tendency results indicate moderate adoption of green investments and modest profitability levels within the sector, consistent with earlier findings by Kibe and Otieno (2021) and Adedoyin et al. (2020), who observed gradual integration of sustainability initiatives in Kenyan manufacturing firms.

4.2 Correlation Analysis

Correlation analysis is used to find the relationship between two or more sets of variables. It also tells the direction as well as how much relationship exist between these variables.

Table 2: Correlation Analysis

		Profitability	Energy Efficiency Investment	Renewable Energy Investment	Green Supply Chain Investment	Sustainable Waste Management Investment	Environmental Regulatory Framework
Profitability	Pearson Correlation Sig. (2tailed)	1.000					
Energy Efficiency Investment	Pearson Correlation	0.641**	1.000				
	Sig. (2tailed)	0.000					
Renewable Energy Investment	Pearson Correlation	0.182**	0.164*	1.000			
	Sig. (2tailed)	0.000	0.031				
Green Supply Chain Investment	Pearson Correlation	0.241**	0.193	0.176	1.000		
	Sig. (2tailed)	0.002	0.167	0.186			
Sustainable Waste Management Investment	Pearson Correlation	0.094**	0.071**	0.214*	0.103	1.000	
	Sig. (2tailed)	0.001	0.000	0.019	0.487		
Environmental Regulatory Framework	Pearson Correlation	.468**	0.158	0.062	0.129	0.141	1.000
	Sig. (2tailed)	0.000	0.123	0.809	0.564	0.167	
	N	50	50	50	50	50	50

The correlation analysis results indicate a strong and statistically significant positive relationship between energy efficiency investment and profitability ($r = 0.641$, $p = 0.000$). This suggests that manufacturing firms that allocate higher proportions of their resources toward energy-efficient technologies tend to record higher profitability levels. The strong correlation implies that energy efficiency investments directly contribute to cost reductions, improved production efficiency, and enhanced resource utilization, which in turn translate into better financial performance. The relationship between renewable energy investment and profitability is positive but relatively weak, with a Pearson correlation coefficient of $r = 0.182$ ($p = 0.000$).

With respect to green supply chain investment, the results show a positive and statistically significant correlation with profitability ($r = 0.241$, $p = 0.002$). This indicates that firms adopting environmentally sustainable supply chain practices, such as green procurement, eco-friendly logistics, and responsible sourcing, tend to achieve better profitability outcomes. The moderate strength of the relationship suggests that the financial benefits of green supply chain investments accrue progressively through efficiency gains, risk reduction, and enhanced corporate reputation. The correlation between sustainable waste management investment and profitability is weak but statistically significant, with a Pearson coefficient of $r = 0.094$ ($p = 0.001$). This suggests that while waste management investments do have a positive influence on profitability, their direct financial impact is relatively limited compared to other green investment initiatives. The weak association may reflect the indirect nature of waste management benefits, which are often realized through cost avoidance, regulatory compliance, and risk mitigation rather than immediate revenue generation. Nonetheless, the statistical significance confirms that waste management practices play a supportive role in sustaining firm profitability.

Finally, the results show a moderate and statistically significant positive relationship between the environmental regulatory framework and profitability ($r = 0.468$, $p = 0.000$). This indicates that a supportive, stable, and well-enforced regulatory environment enhances firms' profitability by promoting compliance, reducing uncertainty, and encouraging sustainable investment behavior. Firms operating under clear environmental regulations are more likely to innovate, attract green financing, and avoid costly penalties, thereby improving their financial performance.

4.3 Regression Analysis

Regression analysis was conducted to examine the relationship between the independent variable(s) and the dependent variable, allowing for the prediction and quantification of their association.

4.3.1 Multiple Regression Analysis

The Regression model summary is presented in Table 3

Table 3: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.621	.386	.352	.00691

a. Predictors: (Constant), green supply chain investments, energy efficiency investments, renewable energy investments, sustainable waste management investment

From Table 3, the coefficient of correlation was 0.621 indicating that green investment initiatives has a positive effect on profitability. Thus, manufacturing firms incorporating green investment initiatives measures in their operations would improve the profitability. The coefficient of determination (R^2) was 0.386 implying that that the regression could explain up to 38.7 percent of the variation in the profitability. The remaining percent of the variation could be due to other predictors not in the model which could include the source of funding for the manufacturing firm, management and specific manufacturing firm factors. The model test of fitness results are presented in Table 4 indicating the reliability of the model in predicting profitability.

Table 4: ANOVA Analysis

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	.001842	4	.001	9.658	.000 ^b
Residual	.002147	45	.001		
Total	.003989	49			

a. Predictors: (Constant), green supply chain investments, energy efficiency investments, renewable energy investments

b. Dependent Variable: Profitability

The model result of model fitness indicates an F-statistic of $9.658 > 0.001$ and a p-value of $0.000 < 0.05$. This indicates that the model is fit for prediction at 95 percent confidence level. Thus, green investment initiatives has significant effect on the manufacturing firm’s profitability. The study multiple regression model coefficients obtained which could be used for prediction are presented in table 5.

Table 5: Model Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
(Constant)	.014	.004		3.498	.001
Energy efficiency investments	.821	.216	.469	3.802	.000
Renewable energy investments	0.314	.148	.183	2.122	.039
Green supply chain investments	0.447	.173	.231	2.583	.013
Sustainable Waste Management Investment	.192	.159	.107	1.208	.233

a. Dependent Variable: Profitability

Table 5 presents the regression coefficients, which provide a detailed understanding of the influence of each green investment variable on profitability. The constant term is 0.014 with a p-value of 0.001, indicating that when all green investment variables are held at zero, the baseline profitability of the firms is approximately 1.4%. This baseline reflects the underlying profitability level of firms before accounting for any green investment interventions. Energy efficiency investment has a regression coefficient (B) of 0.821, with a standardized Beta of 0.469 and a highly significant p-value of 0.000. This indicates that a one-unit increase in energy efficiency investment is associated with a 0.821 increase in profitability, holding other factors constant. The large Beta coefficient and significance level highlight that energy efficiency is the strongest predictor among the green investment initiatives, emphasizing its critical role in reducing operational costs, improving productivity, and enhancing financial performance. Renewable energy investment has a coefficient of 0.314, a standardized Beta of 0.183, and a p-value of 0.039, indicating a positive and statistically significant effect on profitability. Although smaller in magnitude than energy efficiency, the result suggests that renewable energy adoption contributes to financial performance, likely through long-term cost savings and reduced reliance on conventional energy sources.

Green supply chain investment demonstrates a positive and statistically significant impact on profitability, with a coefficient of 0.447, standardized Beta of 0.231, and a p-value of 0.013. This indicates that firms integrating environmentally sustainable practices in their supply chains experience improved profitability outcomes. Sustainable waste management investment, however, has a coefficient of 0.192, a standardized Beta of 0.107, and a p-value of 0.233, indicating a positive but statistically non-significant effect on profitability. This suggests that, while waste management initiatives may contribute to profitability through cost avoidance and regulatory compliance, their direct financial impact is relatively limited compared to other green investment mechanisms. The non-significance may reflect the indirect nature of the financial benefits of waste

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management, as well as potential variability in how different firms implement these practices. Despite the small effect, sustainable waste management remains an important component of environmental strategy, supporting long-term operational resilience and compliance with environmental regulations. From the model coefficients table, the following regression model was fitted.

$$Y_i = 0.014 + 0.821 X_1 + 0.314X_2 + 0.447X_3 + 0.192X_4$$

Whereby; Y_i refers to profitability, X_1 is the energy efficiency investments, X_2 is the renewable energy investments, X_3 is the green supply chain investments and X_4 is the sustainable waste management investment

4.3.2 Moderating Regression Analysis

The study sought to establish the moderated effect brought about by the moderating variable which was the regulatory policies. A comparative regression model was thus conducted with the predictors being green supply chain investments, energy efficiency investments, sustainable waste management investment and renewable energy investments, the moderating variable being regulatory policies and the dependent variable being profitability. The Regression model summary is presented in Table 6.

Table 6: Moderated effect Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. Change
.676b	.457	.401	.00638	.071	4.189	4	41	.006

b. Predictors: (Constant), green supply chain investments, energy efficiency investments, renewable energy investments, Regulatory policies

From The moderated regression model summary presented in Table 6 shows that the inclusion of the moderating variable regulatory policies improved the overall explanatory power of the model. The model produced an R value of 0.676 and an R Square of 0.457, indicating that approximately 45.7% of the variation in profitability among manufacturing firms can be explained by the combined effects of green investment initiatives and regulatory policies. The Adjusted R Square of 0.401 suggests a moderately strong model fit after adjusting for the number of predictors, meaning that the relationship remains substantial even when accounting for model complexity. The model test of fitness results are presented in Table 7 indicating the reliability of the model in predicting profitability.

Table 7: Moderated ANOVA Analysis

Model		Sum of Squares	Df	Mean Square	F	Sig.
2	Regression	.002648	8	.000331	8.135	.000b
	Residual	.001669	41	.000041		
	Total	.004317	49			

b. Predictors: (Constant), green supply chain investments, energy efficiency investments , renewable energy investments, Regulatory policies

Dependent Variable: Profitability

Table 7 presents the ANOVA results for the moderated regression model. The regression sum of squares is 0.002648 with a mean square of 0.000331, while the residual sum of squares is 0.001669. The model produced an F-statistic of 8.135 with a p-value of 0.000, indicating that the moderated regression model is statistically significant and reliably predicts profitability. This confirms that the interaction terms between green investment initiatives and the environmental regulatory framework contribute meaningfully to explaining profitability variations among manufacturing firms. The statistical significance of the ANOVA suggests that the inclusion of the moderating variable enhances the robustness and predictive accuracy of the model relative to the unmoderated analysis. The multiple regression model coefficients for the moderated regression equation are presented in Table 8.

Table 8: Model Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	0.019	.005	—	3.800	.001
	Energy efficiency investments * environmental regulatory framework	.418	.169	.291	2.471	.018
	Renewable energy investments * environmental regulatory framework	.127	.064	.198	1.984	.054
	Sustainable waste management investment * environmental regulatory framework	.366	.141	.322	2.596	.013
	Green supply chain investments * environmental regulatory framework	.083	.091	.097	.912	.367

a. Dependent Variable: Profitability

The regression coefficients for the moderated model, presented in Table 8, provide insights into the specific interaction effects of the environmental regulatory framework on the relationship between each green investment initiative and profitability. Energy efficiency investment moderated by environmental regulatory framework shows a positive and statistically significant effect on profitability, with a regression coefficient (B) of 0.418, standardized Beta of 0.291, $t = 2.471$, and $p = 0.018$. This indicates that the profitability gains from energy efficiency investments are amplified under a supportive regulatory framework. Renewable energy investment moderated by the regulatory framework exhibits a positive effect with $B = 0.127$, $Beta = 0.198$, $t = 1.984$, and $p = 0.054$. Although marginally above the conventional 0.05 significance threshold, this result suggests a potential enhancement of profitability when renewable energy investments are supported by clear and consistent regulatory policies. Sustainable waste management investment moderated by environmental regulatory framework demonstrates a statistically significant positive impact on profitability, with $B = 0.366$, $Beta = 0.322$, $t = 2.596$, and $p = 0.013$. This indicates that firms' waste management efforts translate into higher financial performance when supported by effective regulatory oversight. Strong policies may encourage adherence to best practices, reduce the risk of fines or penalties, and promote efficiency gains through structured compliance mechanisms.

Green supply chain investment moderated by environmental regulatory framework, however, has a positive but statistically non-significant effect on profitability, with $B = 0.083$, $Beta = 0.097$, $t =$

0.912, and $p = 0.367$. This suggests that while regulatory support may slightly enhance the financial returns from green supply chain initiatives, the interaction effect is weak and does not significantly influence profitability in the short term. This may reflect the complex and indirect pathways through which supply chain sustainability affects financial performance, or potential variability in firms' adoption strategies and supply chain structures. Nevertheless, the positive coefficient implies that regulatory policies still have the potential to incrementally support sustainable supply chain gains over time. The moderated model thus adopted is as per below.

$$Y_i = 0.019 + (0.418X_1 + 0.127X_2 + 0.366X_3 + 0.083X_4)Z$$

Whereby; Y_i refers to profitability, X_1 is the energy efficiency investments, X_2 is the renewable energy investments, X_3 is the green supply chain investments and X_4 is the sustainable waste management investment and Z is the environmental regulatory framework.

4.4 Summary of Findings

This study aimed to assess the impact of energy efficiency investments on the profitability of manufacturing firms in Kenya. Correlation analysis revealed a strong positive relationship ($r = 0.641$, $p = 0.000$), indicating that firms directing greater resources toward energy-efficient technologies tend to achieve higher profitability. This finding was reinforced by multiple regression analysis, which showed a significant positive coefficient ($B = 0.821$, $\beta = 0.469$, $t = 3.802$, $p = 0.000$). When moderated by the environmental regulatory framework, the effect intensified ($B = 0.418$, $\beta = 0.291$, $p = 0.018$), suggesting that regulatory policies enhance the financial benefits derived from energy efficiency initiatives.

The study also examined the influence of renewable energy investments on profitability among manufacturing firms in Kenya. The analysis identified a moderate positive correlation between renewable energy investments and profitability ($r = 0.182$, $p = 0.000$). Regression results indicated a positive and statistically significant effect ($B = 0.314$, $\beta = 0.183$, $t = 2.122$, $p = 0.039$), implying that firms investing in renewable energy sources such as solar and biomass achieve improved profitability through reduced long-term energy costs and enhanced sustainability. Under the moderating influence of the regulatory framework, the effect remained positive but only marginally significant ($B = 0.127$, $\beta = 0.198$, $p = 0.054$), indicating that while supportive regulations can boost returns, they may also impose short-term compliance costs.

The study further investigated the effect of green supply chain investments on profitability. A positive and significant correlation was observed between green supply chain investments and profitability ($r = 0.241$, $p = 0.002$). Regression analysis confirmed that such investments contribute meaningfully to profitability ($B = 0.447$, $\beta = 0.231$, $t = 2.583$, $p = 0.013$), reflecting gains from environmentally responsible sourcing, green logistics, and waste minimization practices. In the moderated model incorporating the environmental regulatory framework, the effect remained significant for certain interactions, though the direct moderating influence was weaker ($B = 0.083$, $\beta = 0.097$, $p = 0.367$). These findings suggest that compliance and policy support can enhance the returns from green supply chain initiatives. The consistency of results across models indicates that green supply chain integration is among the most effective green investment strategies for improving profitability.

The study also explored the impact of sustainable waste management investments on the profitability of manufacturing firms in Kenya. A weak but statistically significant positive correlation was found between sustainable waste management investments and profitability ($r =$

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0.094, $p = 0.001$). Regression analysis showed a positive yet relatively modest contribution to profitability ($B = 0.192$, $\beta = 0.107$, $t = 1.208$, $p = 0.233$), while the moderated model revealed a stronger effect when aligned with the regulatory framework ($B = 0.366$, $\beta = 0.322$, $p = 0.013$). This underscores the role of regulatory oversight in enhancing the financial returns of waste management practices by ensuring compliance, reducing penalties, and promoting operational efficiency.

The study further evaluated the moderating role of regulatory policies in the relationship between green investment initiatives and firm profitability. The inclusion of regulatory policies improved the model's explanatory power, with R^2 increasing from 0.386 to 0.457, indicating that regulations serve as an enabling factor. Specifically, the regulatory framework amplified the profitability effects of energy efficiency, renewable energy, and waste management investments. The moderating effect on green supply chain investments was positive but not statistically significant. These findings confirm that firms adhering to environmental policies benefit from improved efficiency, reduced penalties, and greater market acceptance.

Overall, the combined effect of green investment initiatives on profitability was positive and substantial. The multiple regression model explained 38.6% of the variance in profitability ($R^2 = 0.386$), with each green investment dimension contributing positively: energy efficiency ($B = 0.821$), renewable energy ($B = 0.314$), green supply chain ($B = 0.447$), and sustainable waste management ($B = 0.192$). When moderated by the regulatory framework, the explanatory power increased to 45.7% ($R^2 = 0.457$), highlighting the critical role of environmental policies in enhancing financial returns. These results underscore that strategic investments in sustainable technologies, renewable energy, eco-friendly supply chains, and effective waste management can significantly boost profitability within Kenya's manufacturing sector.

5.0 Conclusions of the study

The study concludes that energy efficiency investments significantly enhance the profitability of manufacturing firms in Kenya. Firms that strategically allocate resources toward energy-saving technologies, process optimization, and equipment modernization experience reduced operational costs and improved asset utilization. The study also concludes that renewable energy investments play a vital role in enhancing manufacturing firms' profitability through reduced dependency on fossil fuels and long-term cost stability. By integrating renewable sources such as solar and biomass, firms can mitigate energy price fluctuations and align their operations with global sustainability standards. This strategic shift not only enhances financial resilience but also improves brand reputation and market access, especially among environmentally conscious consumers.

The study concludes that green supply chain investments contribute positively to the profitability of manufacturing firms by improving resource efficiency and reducing operational waste. Firms that embed sustainability into procurement, production, and distribution processes achieve enhanced process integration and cost-effectiveness. The study concludes that sustainable waste management investments positively influence manufacturing firms' profitability through cost reduction, efficiency improvement, and compliance enhancement. The study concludes that regulatory policies moderately enhance the relationship between green investment initiatives and profitability among manufacturing firms in Kenya. The presence of environmental regulations encourages firms to adopt greener technologies and operational practices, aligning profitability goals with sustainability objectives.

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6.0 Recommendations of the study

The study recommends that the Kenyan government strengthen policy frameworks that promote and incentivize green investment initiatives within the manufacturing sector. Establishing fiscal incentives such as tax rebates, low-interest green loans, and subsidies for renewable energy and waste management technologies would encourage wider adoption of sustainable practices. The study recommends the establishment of a national green investment initiatives monitoring framework to track and evaluate the effectiveness of policies in driving profitability and sustainability. This framework should include data-sharing platforms where firms can benchmark performance, access best practices, and engage in peer learning. Continuous policy evaluation and revision would ensure that regulatory measures remain responsive to market dynamics and emerging technologies.

The study recommends that manufacturing firms institutionalize sustainability as a core strategic and operational priority rather than a peripheral initiative. Firms should embed green investment initiatives into their long-term business planning and corporate governance structures to ensure alignment with profitability goals. The study recommends that manufacturing firms adopt energy and resource efficiency audits to identify areas of waste and inefficiency within their production systems. These audits should be conducted periodically to measure the effectiveness of existing green investments and identify emerging opportunities. Implementing energy management systems and lean manufacturing practices can significantly reduce costs and enhance asset utilization.

The study recommends that future theoretical models on sustainability and profitability integrate green investment initiatives as multidimensional constructs rather than isolated variables. Current theories often examine energy efficiency, renewable energy, or waste management independently, overlooking their synergistic effects. A more integrated theoretical approach would capture how these investments interact to create cumulative profitability benefits. This would enhance the explanatory power of existing models such as the Resource-Based View (RBV) and Triple Bottom Line (TBL) theory in explaining firm performance. Expanding these models could guide scholars toward more holistic sustainability-performance frameworks. The study recommends that future researchers apply longitudinal research designs to deepen theoretical understanding of the temporal effects of green investments.

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