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Influence of Green Supply Chain on Performance of Mining and Extraction Firms in Kenya

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Abstract

Purpose: The performance of mining and extraction firms in Kenya have been below par. The industry recorded a decline in production of most of the minerals such as titanium and soda ash and a declining trend towards contribution to the gross domestic product. This study sought to examine the influence of green supply chain on the performance of mining and extraction firms in Kenya.

Methodology: The research employed a descriptive design and targeted a sample of 201 respondents from registered mining and extraction firms in Kenya. The study used stratified random sampling techniques for respondent selection. Data were gathered using structured questionnaires. Pilot study was carried out to determine the reliability and validity of the research instrument. Statistical package for social sciences version 27 was used to analyze the data. Descriptive, correlation and regression statistics were used to evaluate the relationship between green supply chain and firm performance.

Findings: The study found that green supply chain have a statistically significant and positive effect on firm performance. These practices were associated with reduced operational costs, enhanced regulatory compliance, improved stakeholder relationships, and greater environmental responsibility. The regression analysis confirmed a strong positive correlation between green supply chain adoption and improved organizational outcomes.

Unique Contribution to Theory, Practice, and Policy: The study extends the application of the Natural Resource-Based View (NRBV) by empirically validating the strategic value of green supply chain management practices in the mining and extraction sector, a context that has been underexplored in sustainability literature. The findings provide actionable insights for industry practitioners on how adopting green supply chain strategies can yield operational and competitive benefits, including efficiency gains and enhanced market reputation. The study underscores the need for supportive regulatory frameworks and targeted capacity-building initiatives to foster broader adoption of green supply chain practices in Kenya's mining sector. It advocates for policy instruments that incentivize eco-innovation, stakeholder engagement, and long-term environmental stewardship.

Keywords: *Green Supply Chain Management, Firm Performance, Mining and Extraction, Environmental Sustainability*

JEL Codes: *Q32, L72, Q55, Q52*

INTRODUCTION

Amid escalating environmental degradation and the global pursuit of sustainable development, Green Supply Chain Management (GSCM) has emerged as a critical strategy for aligning economic activities with environmental stewardship. GSCM entails integrating ecological considerations across all stages of supply chain operations—including product design, material sourcing, production, distribution, and end-of-life management (Govindan et al., 2020). While the global discourse on GSCM is well established, its relevance within the Kenyan context, particularly in the mining and extraction sector, demands greater scholarly attention. The mining and extraction industry is intrinsically resource-intensive and environmentally disruptive. Activities such as mineral exploration, extraction, processing, and transportation contribute significantly to land degradation, water contamination, biodiversity loss, and greenhouse gas emissions (Igogo et al., 2021). These impacts are especially pronounced in Kenya, where the sector has experienced renewed growth driven by discoveries of oil, gas, and strategic minerals (Mdasha et al., 2022). Major firms such as Tata Chemicals Magadi, Kenya Fluorspar, and Base Titanium dominate this landscape, yet their operations have raised legitimate concerns regarding environmental sustainability and social accountability (van Zyl et al., 2020).

Kenya's policy framework provides a foundation for promoting sustainable resource exploitation. Article 69 of the Constitution of Kenya (2010) obligates both state and citizens to protect the environment and ensure the sustainable use of natural resources. Furthermore, Kenya's Vision 2030 and National Green Economy Strategy emphasize environmental sustainability as a catalyst for economic transformation (Republic of Kenya, 2017). Despite these commitments, evidence suggests that environmental safeguards are inconsistently enforced, and gaps persist between policy aspirations and operational realities within the mining sector.

Corporate responses to these challenges have been mixed. Some leading firms in Kenya have adopted GSCM practices to comply with regulations and enhance performance. For instance, Safaricom reports significant reductions in operational costs and greenhouse gas emissions through its sustainable procurement strategy (Wanja & Achuora, 2020). Similarly, East African Portland Cement has embraced eco-efficient production methods, improving resource utilization and reducing environmental harm. However, such examples remain isolated, and systematic adoption of GSCM within Kenya's mining and extraction industry is limited.

The disconnect between sustainability rhetoric and measurable outcomes is not unique to Kenya. Globally, while 72% of firms reference the United Nations Sustainable Development Goals (SDGs) in corporate reports, only 1% rigorously track progress towards these goals (PwC, 2019). In Kenya, this gap is evident in the mining sector's continued environmental challenges, despite policy pronouncements. The PwC (2019) finding underscores the need to move beyond symbolic commitments to actionable, data-driven sustainability practices that yield demonstrable benefits. Empirical research from other sectors in Kenya highlights the potential of GSCM to drive both environmental and organizational performance. For example, Mutuku (2018) demonstrated that eco-design and cleaner production significantly improved Unilever Kenya's operational efficiency. However, such studies predominantly focus on manufacturing, leaving a notable knowledge gap regarding the mining and extraction sector.

Given the sector's environmental footprint and economic potential, understanding how GSCM influences firm performance in Kenya's mining industry is both timely and critical. GSCM

practices—including eco-design, green procurement, reverse logistics, and sustainable distribution—offer opportunities to reduce ecological harm while enhancing cost efficiency, regulatory compliance, and corporate reputation (Bennett et al., 2019; Guo et al., 2019). Yet, empirical evidence on their adoption and impact in Kenya's extractive industries remains scarce. This study addresses this gap by exploring the influence of green supply chain practices on the performance of mining and extraction firms in Kenya. By focusing on a sector central to Kenya's economic development and environmental sustainability agenda, this research provides context-specific insights that can inform policy, industry practice, and academic discourse. It also contributes to advancing the application of the Natural Resource-Based View (NRBV) theory in the underexplored context of Kenya's extractive industries, illustrating how environmental capabilities can translate into competitive advantage.

Statement of the Problem

The mining and extraction sector remains a vital component of Kenya's economic development agenda, yet its contribution to national growth has been consistently underwhelming. According to the Kenya National Bureau of Statistics (2024), mineral production has declined significantly, with key resources such as titanium and soda ash recording a 6.5% reduction. The sector's contribution to Gross Domestic Product (GDP) illustrates a troubling downward trajectory—declining from 0.9% in 2022 to 0.7% in 2023. Over the past three years, the industry's growth pattern has similarly weakened, falling from 18.3% in 2021 to 9.3% in 2022, and further plummeting to negative 6.5% in 2023. Despite its immense resource potential, the mining sector contributes less than 1% to Kenya's GDP, far below the estimated 4%–10% contribution projected as attainable by industry experts (KNCCI, 2020). These figures highlight both underperformance and significant untapped potential, underscoring the need for strategic interventions to unlock sustainable growth within the sector.

Beyond its economic shortcomings, the mining industry in Kenya faces increasing scrutiny due to its adverse environmental and social impacts. Unregulated and poorly monitored mining operations have contributed to widespread land degradation, water contamination, deforestation, loss of biodiversity, and displacement of local communities (Fayiah, 2020). These environmental and social costs often overshadow the economic gains from resource extraction, fueling public discontent and raising questions about the long-term viability of current operational models. This dual challenge—stagnant economic performance coupled with escalating environmental and social externalities—demands a paradigm shift towards more sustainable business practices.

Green Supply Chain Management (GSCM) offers a strategic framework capable of addressing these multifaceted challenges by integrating environmental, economic, and social considerations into supply chain operations. Practices such as eco-friendly sourcing, reverse logistics, and sustainable distribution have been shown to reduce ecological harm while enhancing operational efficiency and long-term profitability (Alzubi & Akkerman, 2022; Alghababsheh & Gallear, 2020). However, while the benefits of GSCM are well-documented globally, particularly within the manufacturing sector, empirical evidence on its adoption and performance outcomes in Kenya's mining and extraction industry remains scarce. Studies such as Mutuku (2018) and Ghaithan et al. (2023) demonstrate positive links between sustainable supply chain practices and firm performance in manufacturing, but these findings cannot be readily generalized to the extractive sector, given its distinct operational, environmental, and regulatory dynamics.

Thus, there exists a specific academic gap concerning the extent to which GSCM influences firm performance in Kenya's mining and extraction sector. Addressing this gap is essential for informing policy, guiding industry practices, and supporting the sector's transition towards sustainable, competitive, and environmentally responsible operations.

Research Objective

To establish the influence of green supply chain on performance of mining and extraction firms in Kenya.

Research Hypothesis

H_{01}: Green supply chain has no significant influence on the performance of mining and extraction firms in Kenya.

LITERATURE REVIEW

Theoretical Review

This study is grounded in the Natural Resource-Based View (NRBV) theory, initially conceptualized by Hart (1995). The NRBV extends the traditional Resource-Based View (RBV) by incorporating environmental resources and capabilities as essential determinants of firm performance and competitive advantage. While RBV emphasizes internal resources such as technology, skills, and organizational processes, NRBV argues that a firm's ability to manage its interaction with the natural environment is equally critical for long-term success (Hart & Dowell, 2011). This theoretical lens is particularly relevant for industries like mining and extraction, whose operations are inextricably linked to environmental resources and impacts.

Central to NRBV are three interrelated environmental capabilities: pollution prevention, product stewardship, and sustainable development. Pollution prevention focuses on minimizing waste and emissions at the source, promoting operational efficiency while reducing environmental harm. Product stewardship extends environmental responsibility across the entire product life cycle, from design and sourcing to consumption and disposal. Sustainable development emphasizes the integration of environmental considerations into strategic decision-making to ensure long-term resource availability and ecological balance (McDougall et al., 2022).

These NRBV capabilities closely align with the green supply chain components examined in this study: eco-design, reverse logistics, green distribution, and sustainable packaging. Eco-design, for instance, directly reflects the NRBV's product stewardship capability by integrating environmental criteria into product development. Through eco-design, firms in the mining and extraction sector can minimize resource consumption, reduce hazardous material use, and enhance product durability—thereby lowering environmental impacts and production costs (Li & Sarkis, 2022). This approach not only supports pollution prevention by reducing waste generation but also enhances competitiveness through product differentiation, consistent with NRBV principles.

Reverse logistics, another critical component, embodies both pollution prevention and product stewardship by facilitating the recovery, recycling, and remanufacturing of materials. For mining and extraction firms, implementing reverse logistics can reduce the demand for virgin raw materials, lower disposal costs, and minimize environmental degradation associated with resource extraction. Such practices align with NRBV by promoting resource efficiency and

reducing ecological footprints while contributing to operational cost savings and regulatory compliance (Uddin et al., 2022).

Green distribution practices further operationalize NRBV capabilities by enhancing transportation efficiency, optimizing routing, and adopting low-emission vehicles and technologies. In resource-intensive sectors like mining, inefficient logistics significantly contribute to carbon emissions and environmental degradation. Green distribution strategies reduce these negative impacts, demonstrating a firm's pollution prevention capability while simultaneously improving logistical performance and brand reputation (Yildiz et al., 2019).

Finally, sustainable packaging reflects both product stewardship and pollution prevention by utilizing biodegradable, recyclable, or reusable materials that minimize waste and environmental harm. For mining and extraction firms, adopting sustainable packaging reduces ecological damage linked to product handling and transportation, while meeting increasing regulatory and market demands for environmentally responsible practices (Grape & Salih, 2022). These actions contribute to enhanced corporate image and environmental differentiation, reinforcing the competitive advantage theorized under NRBV.

In summary, the NRBV provides a robust theoretical foundation for understanding how green supply chain practices translate into improved environmental and organizational performance. By leveraging eco-design, reverse logistics, green distribution, and sustainable packaging, mining and extraction firms can develop rare and inimitable capabilities that reduce environmental impacts, improve resource efficiency, and enhance competitiveness. This study applies NRBV to empirically examine whether such alignment between environmental capabilities and operational practices yields measurable performance benefits within Kenya's mining and extraction sector.

Conceptual Framework

A conceptual framework is a structure that present the relationship between dependent and independent variables derived from the theoretical framework (Chukwuere, 2021). Oluwabukunmi et al.(2024) argue that conceptual framework is the set of ideas, presuppositions, hypotheses, and theories that underpin and guide a study. It displays the whole study's logical components. The dependent variable for this study was performance of Mining and Extractions firms in Kenya with independent variable was green supply chain. The conceptual framework adopted for the study is presented in figure 1.

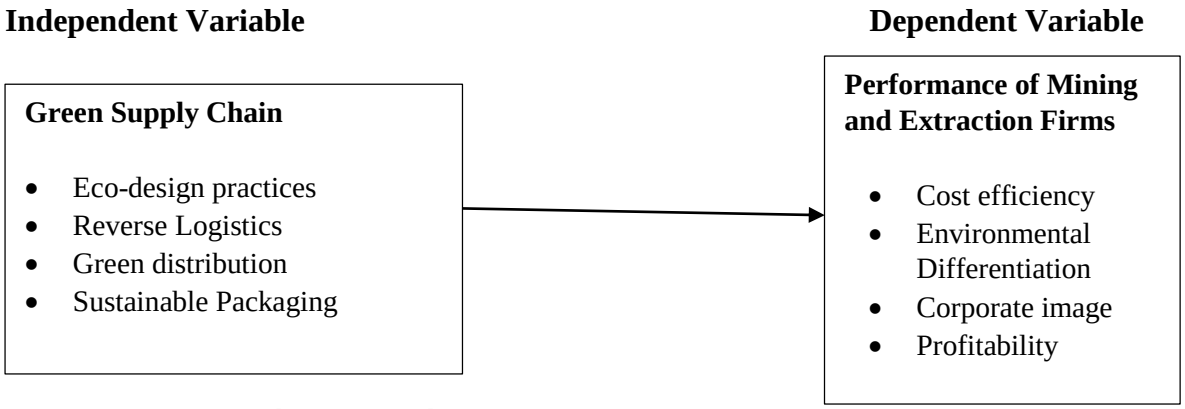

Figure 1: Conceptual Framework

Green Supply Chain

Green supply chain is a strategy that emphasizes the procurement of goods and services with minimal negative environmental implications (Panpatil & Kant, 2022). This approach considers the impact of production, packaging, distribution, use, recovery, and recycling on the environment, human health, and quality of products and services (Tseng et al., 2020).

Eco-design is a novel approach to product design that entails identifying environmental factors associated with the final products and incorporating them into the design process. This strategy evaluates design performance in terms of environmental, health, and human safety elements over the products' life cycle (Horani, 2023). End-of-life practices include system optimization, product reuse, materials recycling, and a clean incineration. The product's end-of-life mechanism describes what occurs after the product's initial lifetime. It seeks to ensure valuable product components reuse and the proper handling and management of wastes. (Li & Sarkis, 2022). Green distribution includes an efficient distribution system, efficient and effective transport method, clean packaging and effective logistics (Yildiz et al., 2019). Additionally, environmentally efficient distribution ensures that the product is efficiently and conveniently conveyed from the factory premises to the retailer, and finally to the end consumer. Grape and Salih (2022) argued that even though the impacts are due to prevalent economic decisions, standardizing the weight and product volume and packaging method has a major impact on decreasing both the environmental impact and transportation costs.

Empirical Review

A considerable body of research has examined the influence of green supply chain practices on organizational performance, competitiveness, and sustainability, particularly within Kenya's manufacturing and service sectors. These studies collectively demonstrate the positive association between environmentally conscious supply chain management and improved firm outcomes. However, they also reveal significant research gaps, particularly concerning the mining and extraction sector, which remains underexplored despite its substantial environmental footprint and economic importance.

For instance, Ummah (2019) conducted a census survey involving 60 managers from Unilever Kenya to assess the impact of green procurement practices on organizational competitiveness. Using a descriptive research design and both descriptive and inferential statistical techniques, the study revealed a statistically significant positive relationship between the adoption of environmentally friendly products, procurement methods, and logistics, and the company's competitive positioning. While this study underscores the value of green procurement in enhancing organizational competitiveness, its focus on a multinational manufacturing firm limits the generalizability of findings to resource-intensive sectors such as mining.

Similarly, Ngunjiri (2019) explored the factors influencing the implementation of green public procurement (GPP) in county governments, using Laikipia County as a case study. The research adopted a descriptive design and relied on self-administered semi-structured questionnaires to collect primary data. The results indicated that knowledge gaps and buyer perceptions significantly affected the implementation of GPP, with knowledge deficiencies emerging as the most critical barrier. While the study provides valuable insights into the challenges of institutionalizing green procurement in the public sector, it does not address how green supply chain practices translate into measurable performance outcomes, particularly in the private sector and high-impact industries like mining.

Sarhaye and Marendi (2017) examined the impact of green procurement on organizational performance using Coca-Cola as a case study. Their descriptive research, which incorporated both qualitative and quantitative data from 642 respondents, recommended the adoption of green procurement practices across all operations due to their demonstrated economic benefits. However, Coca-Cola operates within the beverage manufacturing sector, which differs significantly from mining in terms of supply chain complexity, environmental risks, and regulatory requirements. Thus, the transferability of these findings to the mining and extraction sector remains uncertain.

Furthermore, Mutungi and Ndeto (2023) investigated the effect of procurement cost optimization on the performance of manufacturing firms in Nairobi County. The study, grounded in transaction cost analysis theory, competency theory, and the theory of constraints, established that procurement cost optimization significantly predicts operational and financial performance. Although this research affirms the strategic role of procurement practices in enhancing firm performance, it primarily addresses cost efficiency rather than the broader environmental and sustainability dimensions central to green supply chain management. Collectively, these studies affirm that green procurement and supply chain strategies can improve firm performance. However, the overwhelming focus on manufacturing, public procurement, and multinational corporations highlights a critical academic gap regarding the mining and extraction industry in Kenya. This sector, characterized by high environmental risks, resource dependence, and complex supply chains, demands tailored investigations to determine how green supply chain components such as eco-design, reverse logistics, green distribution, and sustainable packaging influence firm performance.

METHODOLOGY

Research Design

This study used a descriptive survey research design. This approach was applied since it aided collection of standardized data from a large population efficiently, allowing for the generalization of findings (Maxwell, 2020). The study adopted a positivism research philosophy. Positivism research philosophy was employed because it focuses on using an extremely organized method to facilitate replication of statistically measurable, quantified reasons. According to Park et al. (2020) positivism facilitated a structured method for use of both quantitative and qualitative data.

Target Population

The population for this study was the 402 mining and extraction companies (unit of analysis) operating in Kenya as published in the Mining portal (State Department for Mining, 2023). To be precise, the study targeted respondents comprised of the heads of supply chain (one per firm) in the mining and extraction companies forming the unit of observation.

Table 1: Target Population

License category	Number of Firms
Artisanal/Quarry	247
Exploration	72
Mining	83
Total	**402**

Source: State Department for Mining, (2023)

The study applied a stratified random sampling method. This technique was used because the entire population is divided into three separate, non-overlapping categories. According to (Rukmana, 2023), stratification increases sampling efficiency and allow for sufficient data analysis for the various strata. The Mining Cadastre Portal in Kenya categorizes licensed mining and extraction firms into three groups: Artisanal/Quarry, Exploration and Mining.

The study employed Yamane formula to determine, using Equation 1.1, the sample size of 201 participants from a group of 402 licensed enterprises at a 95% confidence level and a 5% precision or error. The Yamane formula was favored due to its scientific validity, ease of use, and suitability for large populations.

$$n = \frac{N}{1+N(e)^2} = n = \frac{402}{1+402\ (0.05)^2} = 201$$

Where e is the required level of precision, where e = 1-Confidence level, and n is the sample size and N is the population size. The stratified simple random sampling technique used ensured that each person in the population was equally likely to be chosen, reducing selection bias and increasing the representativeness of the sample.

Table 2: Sample Size

License category	Target Population	Sample size
Artisanal/Quarry	247	124
Exploration	72	36
Mining	83	41
Total	**402**	**201**

Source: (State Department for Mining, 2023)

Data Collection Instrument

The procedure for collecting data from the chosen investigational subject is known as data collection (Schmidt et al., 2020). The research's primary data came from questionnaires. The questionnaire was structured in the five-point Likert type scale. Likert type scale is an acceptable technique that allowed the use of statistical tools to measure attitudes in a scientific way (Chen & Liu, 2020). Supported by Schmidt et al. (2020), use closed-ended inquiries restricted the responders by only offering appropriate responses, which prevented them from engaging in critical thought. Because it offers less chances for self-expression, this led respondents to select the simplest option. Conversely, open-ended questions allowed individuals to openly share their thoughts and make wise choices (Xiao et al., 2020)

Data Analysis and Presentation

Both qualitative and quantitative data methods analysis was used in this study. Thematic analysis was used to complete the qualitative analysis. The theoretical adaptability of theme analysis is an advantage (Mohajan, 2018). It can be implemented in a variety of contexts and utilized to address a wide range of research questions. It works well for inquiries on the subjective experiences or perspectives of individuals. The analysis was done using statistical package for social sciences version 27. Descriptive statistics results like standard deviations and means and inferential statistics were obtained through Pearson correlation, regression analysis and analysis of variance (ANOVA). The information was presented in an easily digestible style using tables, figures, and other statistical tools. Simple regression analysis, depicted below, was employed in this investigation.

The regression model is illustrated below;

$Y = \beta_0 + \beta_1 X_1 + \varepsilon$

Where: Y = {Performance of Mining and Extraction Firms}

β_θ = {Constant}

X_1= {Green supply chain}

β_1, represent the coefficients of independent variable.

FINDINGS AND DISCUSSIONS

Response Rate

The response rate in any research is very key in determining how well the collected data represents the intended sample. The researcher randomly administered 201 questionnaires (those who took part in the pilot study were excluded from the main study) to the head of supply chain working in the mining and extraction from which 157 were completed and submitted. This was a 78% response rate while the unsuccessful response rate was 22% as indicated in Figure 1. This response rate conforms to (Ebert et al., 2018; Nair & Adams, 2009; Wu et al., 2022) confirmation that 50% of responses is sufficient for evaluation, 60% is acceptable, and 70% or more is remarkable.

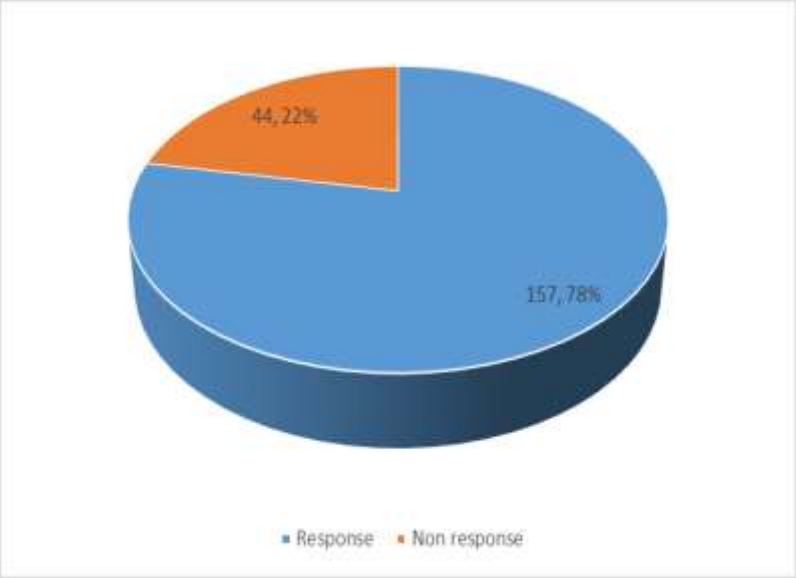

Figure 1: Response Rate

Descriptive Statistics

The research aimed to determine how green supply chain practices affect the performance of Kenyan mining and extraction companies. This goal was evaluated using several key indicators: eco-design practices, reverse logistics, green distribution, and sustainable packaging through provided opinion statements. Participants were requested to specify the degree to which green supply chain management impacted the performance of mining and extraction businesses in Kenya. Within this framework, responses of "not at all" and "small extent" were interpreted as disagreement, while "large extent" and "very large extent" signified agreement. The findings were presented as percentages, means, and standard deviations as shown in Table 3 below.

Table 3: Descriptive Analysis of Green Supply Chain

	NA	SE	ME	LE	VLE	Mean	Standard Deviation
The company uses new cleaner material or new input with less environmental effect	0%	0%	10.2%	28.7%	61.1%	4.51	0.676
The company uses recyclable packaging materials and logistics containers	0%	0%	5.1%	22.9%	72%	4.67	0.570
The company avoids toxic substances as raw materials	0%	0%	17.8%	38.9%	43.3%	4.25	0.742
The company uses product with a longer lifecycle	0%	0%	11.5%	59.9%	28.7%	4.17	0.612
The firm encourages customers to returns used products such as ornaments for recycling	0%	0%	11.5%	34.4%	54.1%	4.43	0.691
The company adopts remanufacturing, reconfigure of equipment and materials with less environmental impacts	0%	0%	10.8%	44.6%	44.6%	4.34	0.666
The firm uses used biodegradable packaging materials	0%	0%	19.1%	29.9%	51%	4.32	0.777
The company uses environmentally friendly transportation plant and machineries	0%	0%	25.5%	24.8%	49.7%	4.24	0.835
The company minimizes the usage of energy in mining practices	0%	0%	28%	33.1%	38.9%	4.11	0.813
Overall	**0%**	**0%**	**5.1%**	**59.2%**	**35.7%**	**4.34**	**0.384**

Key; NA= Not at All, SE=Small Extent, ME=Moderate Extent, LE=Large Extent, VLE=Very Large Extent

Results from Table 3 show that the vast majority of those surveyed concurred that mining and extraction companies use new cleaner material or new input with less environmental effect (Mean=4.51). Mining and extraction companies adopting new, cleaner materials or inputs with reduced environmental impact are likely focusing on sustainable practices to minimize harm to ecosystems, improve energy efficiency and reduce emissions. This shift may involve the use of alternative, environmentally friendly technologies which not only help in meeting regulatory standards but also enhance the company's long-term viability and reputation in a growing sustainability-conscious market. The companies use recyclable packaging materials and logistics containers (Mean=4.67). This reflects a commitment to reducing waste, minimizing environmental impact and promoting a circular economy by reusing resources throughout the

supply chain. Further, the mining and extraction companies avoid toxic substances such as raw materials (Mean=4.25), reducing the risk of environmental contamination, enhancing worker safety and complying with increasingly stringent environmental regulations.

Respondents indicated that the mining and extraction companies use products with longer lifecycle (Mean= 4.17). This reduces the frequency of replacements, minimizes waste and enhances resource efficiency, contributing to both environmental sustainability and cost savings over time. The firm encourages customers to return used products such as ornaments for recycling (Mean=4.43) promoting circular economy, reducing waste, and ensures that valuable materials are reused, thus minimizing environmental impact and fostering customer engagement in sustainable practices. The mining firms adopt remanufacturing reconfigure of equipment and material (Mean=4.34). Moreover, the companies use biodegradable packaging materials (Mean=4.32). By adopting remanufacturing and reconfiguration of equipment and materials, mining companies extend the lifecycle of their assets, reduce waste, and optimize resource usage, which contributes to cost savings and enhances sustainability by minimizing the need for new raw materials.

The companies use environmentally friendly transportation plants and machinery (Mean=4.24). Respondents agreed that the companies reduce carbon emissions and environmental pollution, contributing to more sustainable operations. Lastly the companies minimize the usage of energy in mining practices (Mean= 4.11) helping to lower operational costs, reduce greenhouse gas emissions and By adhering to environmental laws, strengthening their dedication to sustainability

In a nutshell most of the respondents agreed to most of the questions in a large extent as supported by an overall Mean of 4.34 (less than 1.5=Not at All, 1.5-2.5=Small Extent, 2.5-3.5 Moderate Extent, 3.5-4.5=Large Extent and 4.5-5=Very Large Extent). There was consistency in the responses as indicated by very small standard deviations. This implies that there were no outliers in the data. The study's results support Gelmez et al.(2024) assertion that GSCM methods enhance competitive advantage, environmental performance, and green innovation, demonstrating its value in improving both sustainability and profitability. c found that implementing green practices in firms enhanced their environmental sustainability and performance, particularly in the food and beverage sector.

Similarly, Mwangi ,kariuki and muturi (2020) confirm that in the mining and extraction industry, green supply chain practices, such as waste reduction and eco-friendly resource management, have been shown to improve operational efficiency and stakeholder trust. Sharing the same argument is Mwangi (2023)on the effect of adopting green supply chain on performance using a case of building, mining and construction sector in Kenya. Chomachaei and Golmohammadi (2024) argue that while green supply chain management practices improve environmental performance, their effect on financial performance varies depending on regulatory support and industry type. Their study suggests that sectors with strict environmental regulations, such as mining, benefit more from green practices due to compliance incentives. Conversely, Zhu et al. (2018) found that green supply chain initiatives in resource-intensive industries face challenges related to high implementation costs, technological constraints, and supplier resistance. They caution that without strong regulatory enforcement and market incentives, firms may struggle to balance sustainability with profitability. In contrast, (Uddin et al., 2022) emphasize that remanufacturing and reverse logistics positively impact both environmental and economic performance, particularly in industries with high material consumption. Their study in the manufacturing sector found that

companies investing in closed-loop supply chains achieved long-term cost savings and improved brand reputation.

Qualitative findings

Two study instruments were used to investigate supply chain leaders' perspectives on green supply chains. Respondents were asked to explain the common green supply chain management practices adopted by Mining and Extraction firms to make their supply chain activities more sustainable. The findings indicate that mining and extraction firms adopt various green supply chain management practices to enhance sustainability. First, they implement waste management systems**,** focusing on recycling and reducing hazardous by-products. Second, they emphasize energy efficiency by using renewable energy sources and optimizing operations to lower carbon emissions. The adoption of eco-friendly material sourcing ensures the use of sustainable and responsibly extracted resources. Green logistics involving reducing transportation emissions through efficient routing and adopting cleaner fuels and supplier collaboration fostering partnerships with environmentally conscious suppliers to improve overall sustainability across the supply chain were also identified. These practices align operations with environmental conservation goals.

The second item sought to determine the driving forces which make mining and extraction firms to adopt green supply chain management practice. The findings established that Mining and extraction firms adopt green supply chain management practices due to several driving forces. Regulatory pressure from governments and international bodies mandates compliance with environmental standards. Growing consumer awareness and demand for eco-friendly products push firms to align with sustainability expectations. Additionally, reputational benefits encourage companies to demonstrate environmental responsibility. Cost reduction opportunities, such as energy efficiency and waste minimization, make green practices economically appealing. Lastly, corporate social responsibility (CSR) and alignment with global sustainability goals, like the SDGs, compel firms to adopt practices that mitigate environmental impact and promote long-term ecological balance.

These qualitative findings are supported by existing literature. Hervani et al. (2022) argue that green supply chain management (GSCM) practices, such as waste management, energy efficiency, and eco-friendly sourcing, significantly enhance sustainability performance. Their study found that firms prioritizing supplier collaboration and green logistics achieve greater compliance with global environmental standards. Similarly, Dubey et al. (2021) highlight that regulatory pressure and consumer demand are key motivators for firms to adopt sustainable supply chain practices. However, they caution that firms in resource-intensive industries, such as mining, often struggle with high implementation costs and resistance from traditional suppliers, making full adoption of GSCM a challenge. On the other hand, Zhu and Geng (2019) suggest that while regulatory compliance is a strong driver of green supply chain adoption, financial incentives and market-driven initiatives can be even more effective. Their study in emerging economies found that firms adopting GSCM voluntarily, rather than under strict regulations, tend to experience better long-term sustainability and financial performance.

Test for Hypothesis

The aim of the study was to establish the influence of green supply chain on performance of mining and extraction firms in Kenya. The corresponding hypothesis was:

H_{01}: Green supply chain has no significant influence on the performance of mining and extraction firms in Kenya.

The correlation and regression model were applied while evaluating the hypothesis at 0.05 level of significance level. The outcomes were presented as follows:

Correlation of study variables

The nature and the strength of the relationships between independent and dependent variable were obtained. This was done using the Pearson Correlation coefficient which takes values between -1 and +1. Negative values indicate inverse relationships between the variables while positive values indicate direct relationships between the variables. Pearson correlation coefficient values close to -1 or +1 are a sign of a strong relationship while values close to zero indicate weak relationships. The significance of the relationship is determined by using the size of p values of Pearson Correlation coefficient. A p- value less than the specified level of significance (0.05) implies significant relationship. The Pearson correlation coefficient was obtained and the resultant matrix presented in Table 4.

Table 4: Correlation Analysis

	Performance
Green Supply Chain	0.579**
Sig. (2-tailed)	0.000
N	157

The findings indicate a strong positive correlation ($r = 0.579$, $p < 0.01$) between green supply chain practices and the performance of mining and extraction firms in Kenya. The results suggest that adoption of Green Supply Chain practices (e.g., eco-design, sustainable packaging) is associated with improved performance metrics (cost efficiency, profitability, environmental differentiation) in Kenya's mining sector. This suggests that firms that adopt environmentally friendly supply chain strategies such as sustainable sourcing, waste reduction, and green logistics tend to experience better overall performance. These results highlight the importance of integrating green practices within the supply chain to boost operational efficiency, sustainability, and firm competitiveness in the mining and extraction sector. This aligns with global studies showing that environmental sustainability enhances operational efficiency and market competitiveness (Govindan et al., 2020; Sarkis, 2021).

Regression Analysis

The dependent variable performance of mining and extraction firms was fitted against green supply chain using a simple linear regression. The model summary is given by Table 5 below.

Table 5: Model summary for Green Supply Chain

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.579[a]	.336	.331	.3396

a. Predictors: (Constant), Green Supply Chain
b. Dependent Variable: Performance of Mining and Extraction Firms

The summary of the linear regression model used for this specific objective as presented in Table 5 indicates a coefficient of determination, R^2=0.336 which means that about 33.6 percent of the change in the performance of mining and extraction firms in Kenya can be explained by green supply chain.

Table 6 shows the ANOVA result of the regression performance of mining and extraction firms on green supply chain. The result indicates that the significance of the F-statistic is less than

0.05 (F=78.343, p<0.05), an implication that the model was of good fit and green supply chain management has a significant influence on performance of mining and extraction firms.

Table 6: ANOVA for Green Supply Chain

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	9.033	1	9.033	78.343	.000[b]
	Residual	17.872	155	.115		
	Total	**26.906**	**156**			

a. Dependent Variable: Performance of Mining and Extraction Firms
b. Predictors: (Constant), Green Supply Chain

Shown in Table 7 was the coefficients and t-statistic obtained from the model. The constant term $\beta_0 = 1.643$ is interpreted to mean that if green supply chain is held constant, then there will be a positive performance of mining and extraction firms in Kenya by 1.643. The regression coefficient for green supply chain was positive and significant ($\beta_1 = 0.627$, p<0.05), with a t-value of 8.851. This implies that a unit increase in green supply chain is predicted to increase the performance of mining and extraction firms by 0.627 units.

Table 7: Regression Coefficients for Green Supply Chain

		Unstandardized Coefficients		Standardized Coefficients		
Model		**B**	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	1.643	.308		5.329	.000
	Green supply chain	.627	.071	.579	8.851	.000

a. Dependent Variable: Performance of mining and extraction firms

The resulting model is given by equation 1 as

$$Y = 1.643 + 0.627X_1 \quad (1)$$

Equation 1 shows that for every unit change in green supply chain performance of mining and extraction firms increases by 62.7% keeping other factors constant. From the result in Table 5 to 7 above, the decision is to reject the null hypothesis H_{01} that green supply chain has no significant influence on the performance of mining and extraction firms in Kenya and conclude that green supply chain has significant positive influence on performance of mining and extraction firms in Kenya.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The primary objective of this study was to examine the influence of Green Supply Chain Management (GSCM) practices on the performance of mining and extraction firms in Kenya. Based on both descriptive and inferential statistical analyses, the findings provide strong empirical support for the positive and significant relationship between the adoption of GSCM practices and firm performance within this sector.

Specifically, Pearson correlation analysis revealed a statistically significant positive relationship between green supply chain practices and firm performance, with a correlation coefficient of r = 0.579 and a p-value of p < 0.01. This indicates a moderately strong and direct association, suggesting that firms that adopt GSCM practices, such as eco-design, reverse

logistics, green distribution, and sustainable packaging, tend to experience improvements in performance indicators such as cost efficiency, profitability, environmental differentiation, and corporate image.

Furthermore, the regression analysis confirmed these findings, with the regression model showing that green supply chain practices account for 33.6% of the variance in firm performance ($R^2 = 0.336$). The standardized regression coefficient for green supply chain practices was $\beta = 0.579$, with a statistically significant t-value of $t = 8.851$ ($p < 0.001$). This implies that a one-unit increase in the adoption of green supply chain practices is associated with a 0.627 unit increase in firm performance, holding other factors constant. These results underscore the strategic value of GSCM as a driver of enhanced operational efficiency, regulatory compliance, and competitiveness within Kenya's mining and extraction sector.

Qualitative findings further corroborated the quantitative results. Firms reported adopting practices such as the use of cleaner raw materials, recyclable and biodegradable packaging, reverse logistics for product returns and recycling, and the use of environmentally friendly transportation and machinery. These initiatives were perceived to reduce environmental harm, enhance resource efficiency, lower operational costs, and improve brand reputation, thereby aligning with both firm-level sustainability objectives and broader regulatory expectations.

Thus, the study demonstrates that GSCM is not only a regulatory compliance mechanism but also a source of measurable competitive advantage for mining and extraction firms in Kenya. By integrating environmental considerations across their supply chains, these firms can achieve enhanced performance outcomes while contributing to sustainable development goals. However, given the relatively modest explanatory power of the model ($R^2 = 0.336$), future research should investigate additional factors influencing firm performance, such as organizational culture, technological capabilities, and external market conditions, to develop a more comprehensive understanding of sustainability-performance linkages in the sector.

Recommendations

Based on the findings, it is recommended that mining and extraction firms in Kenya should continue to embrace and expand their adoption of green supply chain practices. These companies should prioritize eco-design practices, using cleaner materials and technologies that enhance energy efficiency and lessen the impact on the environment. This can enhance their reputation in an increasingly sustainability-conscious market while ensuring compliance with regulatory standards.

Additionally, firms should further invest in reverse logistics, encouraging product recycling and remanufacturing to promote a circular economy. By incorporating sustainable packaging and environmentally friendly logistics, firms can reduce waste, minimize costs, and contribute to resource efficiency. It is also crucial for companies to focus on extending products and asset lifecycles, which reduces operational costs and environmental contamination, while ensuring worker safety.

Management should implement continuous training and capacity-building programs for employees on sustainable practices and the benefits of green supply chain. This will foster a culture of sustainability across all levels of the organization, leading to better decision-making, efficiency, and long-term growth. Furthermore, mining firms should enhance their collaboration with stakeholders to strengthen their supply chain resilience and align their practices with environmental, social, and economic goals. By doing so, firms can improve their

competitiveness and overall performance while contributing to sustainable development in the industry.

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