INFLUENCE OF SUPPLY CHAIN ECONOMIC SUSTAINABILITY ON PERFORMANCE OF MINING AND EXTRACTION FIRMS IN KENYA

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ABSTRACT

Purpose of the study: The study investigated the influence of supply chain economic sustainability on the performance of mining and extraction firms in Kenya. This study focused on how practices like cost efficiency, local sourcing, and financial risk management affect both operational and financial outcomes in these firms.

Short introduction of problem statement: Mining and extraction firms in Kenya operate in a challenging environment marked by regulatory uncertainty, inefficiencies, and underperformance. Despite the sector's potential, its GDP contribution remains below expectations. This research addressed the gap in empirical evidence regarding how economic sustainability in supply chains influences firm performance in this critical sector.

Method/methodology: The study employed a descriptive research design targeting 402 mining and extraction firms in Kenya. Using stratified random sampling, a sample of 201 firms was selected. Data collection was done through semi-structured questionnaires administered to supply chain and operations managers. Quantitative data were analyzed using SPSS through correlation and regression techniques to determine relationships between economic sustainability practices and firm performance.

Results of the study: The study found a significant positive relationship between supply chain economic sustainability and firm performance. Practices such as local supplier development, cost-saving technologies, and resource optimization directly enhanced profitability, efficiency, and competitive advantage. Firms that adopted continuous improvement techniques, quality control, and risk management measures performed better overall.

Conclusion and policy recommendation: The study concludes that economic sustainability within supply chains significantly contributes to the improved performance of mining and extraction firms in Kenya. It recommends that firms invest in digital transformation, cost-sharing models, risk management practices, and quality improvement strategies. Policymakers should support these efforts by offering incentives and strengthening regulatory frameworks to promote sustainable economic practices aligned with national development goals.

Keywords: *Supply Chain, Economic Sustainability, Firm Performance, Mining Industry, Kenya, Sustainable Practices*

1. INTRODUCTION

Supply chain economic sustainability has become a crucial driver of firm performance across industries, especially in mining and extraction. It refers to practices ensuring long-term financial viability while minimizing adverse societal and environmental impacts. As part of the triple bottom line framework by Elkington (1998), economic sustainability emphasizes profit alongside environmental and social dimensions. The Brundtland Report (1987) reinforced this perspective by calling for development that meets present needs without compromising future generations.

In mining, the supply chain links activities from exploration to the final product. These operations often result in environmental degradation, water pollution, and community displacement (Igogo et al., 2021). Integrating economic sustainability helps firms mitigate such impacts while boosting competitiveness and corporate reputation. Govindan et al. (2020) note that sustainable supply chains generate long-term value through collaboration and innovation, aligning business outcomes with societal goals.

Globally, sustainable supply chains are seen as key to achieving the United Nations Sustainable Development Goals (SDGs). Although over 70% of firms reference the SDGs in corporate reports, few measure their actual impact (PwC, 2019; Kracauer, 2020). This points to a need for more strategic alignment of economic sustainability in supply chain decisions. Developed countries like Canada, South Korea, and India have adopted robust sustainability policies, particularly in mining (Mungkung et al., 2021; Jagoda & Wojcik, 2019). Emerging markets are also making progress, though at a slower pace (Leal Filho et al., 2023).

In Africa, there is growing awareness of sustainability's importance. South Africa has led with green policies and climate initiatives (Mogano & Mokoele, 2020), while nations like Nigeria and Tanzania are developing sustainable procurement frameworks (Oyewobi & Jimoh, 2022; Kihamba, 2021). Kenya's 2010 Constitution mandates sustainable resource use and environmental protection (Omai, 2019), with Article 69 assigning responsibility for conservation to both government and citizens.

Kenya's mining sector has attracted new investments from firms such as Tata Chemicals Magadi and Base Titanium. It deals in soda ash, fluorspar, diatomite, limestone, and titanium—resources critical to economic development but also linked to environmental and social concerns (Mdasha et al., 2022). As operations grow, adopting sustainable supply chain practices becomes essential for long-term profitability and compliance.

Economic sustainability enhances mining firm performance by lowering costs, improving resource use, and building trust. Bennett et al. (2019) argue these strategies can improve efficiency while addressing social concerns. Still, many Kenyan firms lack empirical data to support investments in sustainable procurement (Wanja & Achuora, 2020). With increasing demands for accountability from stakeholders, embedding economic sustainability in supply chains is vital for competitiveness and alignment with national goals.

Finally, sustainability supports the social license to operate—a concept gaining importance as communities expect ethical, inclusive practices (Suopajärvi et al., 2023). For Kenyan mining firms, adopting economically sustainable models is not just prudent—it is central to future success and green development ambitions.

2. STATEMENT OF THE PROBLEM

For decades, the mining and extraction sector has been a foundational contributor to economic activity across the globe, with both developed and developing nations relying on natural resource extraction to support industrial growth and infrastructure development (Abor, 2023). In Kenya, the sector encompasses the extraction of minerals, oil, and gas, and holds significant potential to drive national development. Despite this potential, the sector's contribution to the country's GDP remains underwhelming—standing at less than 1%—despite estimates suggesting a potential contribution of between 4% and 10% (Mengich et al., 2020). This underperformance is reflective of a broader set of challenges, including regulatory uncertainty, operational inefficiencies, and weak integration of sustainable practices.

In particular, economic sustainability within the supply chain has become a critical area of concern. Supply chain economic sustainability refers to the long-term financial viability of operations, efficient resource use, cost optimization, risk mitigation, and the pursuit of profitability without compromising future capacity. In the context of Kenya's mining sector, many firms continue to operate under cost-intensive and risk-prone models, heavily influenced by outdated technologies, poor infrastructure, and fragmented supply chains. As Fayiah (2020) notes, while natural resource extraction can generate significant economic returns, in many African contexts, these returns are often offset by unsustainable practices and low operational productivity.

The 2016 Mining Act was introduced to revamp Kenya's regulatory framework and attract investment. However, progress has been slow, especially following the 2019 moratorium on license issuance and renewals. The moratorium, which was intended to facilitate geological mapping and curb irregular licensing, has instead created uncertainty and deterred private sector participation. This has compounded the performance challenges that firms already face—ranging from rising operational costs and limited access to capital to unoptimized logistics and weak value chain linkages.

Economic sustainability in the supply chain offers a strategic pathway for addressing these challenges. Practices such as resource-efficient procurement, cost-effective transportation, local supplier development, and long-term financial planning can significantly enhance firm performance. As Alzubi and Akkerman (2022) highlight, supply chain strategies grounded in economic sustainability not only reduce costs but also improve resilience against market volatility. However, there remains a lack of empirical research examining how these practices specifically influence performance in Kenya's mining and extraction firms. Moreover, existing studies tend to focus on the manufacturing sector and green sustainability. For example, Ghaithan et al. (2023) demonstrated a positive relationship between economic sustainability practices and firm performance in manufacturing

industries. Similarly, Mutuku (2018) found that economic efficiency and risk minimization in supply chains contribute to improved organizational outcomes. Nonetheless, these findings may not directly translate to the mining sector, which is shaped by unique regulatory, environmental, and infrastructural dynamics.

This gap in contextual knowledge underscores the need to explore how supply chain economic sustainability affects performance in Kenya's mining and extraction sector. The research contributes to academic literature and informs industry stakeholders and policymakers on strategies for improving economic outcomes while ensuring sustainable exploitation of Kenya's resource wealth.

3. RESEARCH OBJECTIVE

To examine the influence of supply chain economic sustainability on performance of mining and extraction firms in Kenya.

4. NULL HYPOTHESIS

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

5. THEORETICAL FRAMEWORK

This study is informed by Transaction Cost Economic Model. The theory of transaction cost created in 1937 by Coase inspired Transaction Cost Economic (TCE) is often considered to be among the most influential of all organizational theories (Ketokivi & Mahoney, 2020). Organization theory is a central tenet of transaction cost economics, which has led to a wide range of empirical contributions (Cuypers et al., 2021). For instance, transaction cost economics can be used to help with make-or-buy decisions, or to verify the validity of business deals (Ketokivi & Mahoney, 2020). The transaction cost theory suggests that organizations should work to minimize the costs of external resource transfers and internal administrative processes. Therefore, firms must weigh the costs of resource extraction and recycling against the costs of running their operations.

According to the TCE model, markets and institutions are two separate but complementary mechanisms for coordinating economic activities. If the corporation can conduct its activities more cheaply than if they were carried out in the market, it will expand if external transaction costs are greater than internal bureaucratic expenses. Yet if the costs of coordinating the activity's administration exceed the costs of the transactions themselves, the firm will suffer. Indicators of the transaction costs incurred when exchanging resources with the external environment include the presence or absence of environmental uncertainty and risks, the importance of core business assets, the willingness to seize opportunities, and the limits on one's ability to think logically (Hennart, 2019). Several factors may increase an organization's transaction expenses when dealing with the outside world. If companies believe the climate to be excessively unclear, they may opt not to outsource any tasks or engage in any resource exchanges.

The hypothesis provides an explanation for the supply chain economic sustainability of the supply chain the second variable in the current study. Although TCE is a broadly applicable theory of governance, the make-or-buy decision is one of its unique objects of interest. This aligns neatly with a number of critical supply chain management research questions. Increasing the profitability of supply chain operations and fostering sustainability are two of TCE's primary goals. TCE is based on the idea that the participants to a transaction have a common goal of increasing value through the most economically beneficial transaction structure. The premise is that transactions can only be managed effectively through cooperative and coordinated governance (Ominde et al., 2022). Governance [for example, the business firm] is the way an order is accomplished with regards to potential conflict that threatens to undo or upset opportunities, to realize mutual gains (Cuypers et al., 2021). In addition, "identifying, justifying, and mitigating all forms of contractual dangers" is what governance studies focus on (Ketokivi & Mahoney, 2020). Long-term trade relationship risks and uncertainties create contractual hazards in TCE, which might be difficult to adequately represent in a long-term contract.

6. EMPIRICAL REVIEW

Waithira (2021) conducted a study on the impact of procurement cost optimization on the performance of companies in Kenya's manufacturing sector. The study was grounded in the transaction cost analysis theory, the competency theory, and the theory of constraints. A cross-sectional survey design was employed, justified by the need to collect data from various manufacturing companies within a specific timeframe. The target population consisted of supply chain managers overseeing procurement departments in industrial enterprises located in Nairobi County. The study population included 499 supply chain managers from various manufacturing firms, with a sample size of 222 managers randomly selected from the total population. Both primary and secondary data sources were utilized. Secondary data were used to evaluate the performance of the selected manufacturing enterprises from 2012 to 2016, while primary data were collected through questionnaires. The findings demonstrated that the optimization of procurement costs was a significant predictor of operational and financial performance in manufacturing enterprises in Kenya.

Nguyen and Doan (2020) explored the impacts of supply chain quality management on business performance, focusing on a distinct aspect of supply chain economic sustainability. Their study was conducted on 120 manufacturing companies listed on the Vietnamese Stock Exchange. The research identified three key variables—upstream quality management, downstream quality management, and internal quality management—as critical components in assessing and determining supply chain quality management. Supply chain performance was evaluated based on customer satisfaction, which was analyzed through factors such as product quality, cost efficiency, and delivery timeliness. The study employed statistical methodologies, including Cronbach's Alpha and Explanatory Factor Analysis (EFA), to address research concerns. Additionally, the use of the Ordinary Least Squares (OLS) statistical method was referenced in related studies. The findings revealed that supply chain quality management had a significant positive impact on the performance of manufacturing

companies utilizing supply chains and listed on the Vietnamese stock market. These results underscore the importance of quality management practices in enhancing the economic sustainability of supply chains within organizations.

Nyang'au (2017) examined risk management as another critical dimension of economic supply chain sustainability. The study focused on the impact of supply chain risk management methods on the operational performance of selected food and beverage manufacturing companies in Kenya. Using an explanatory survey design, the research highlighted that the adoption of sustainable supply chain management practices enabled UN agencies to improve their economic sustainability. These practices also facilitated access to new market opportunities, enhanced operational and production efficiencies, reduced costs, and improved corporate image. The study emphasized the role of risk management in achieving long-term economic sustainability within supply chains.

7. CONCEPTUAL FRAMEWORK

A conceptual framework is a structure that directs a researcher's study and it stems 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 supply chain economic sustainability as the independent variable. The conceptual framework adopted for the study is presented in the figure below;
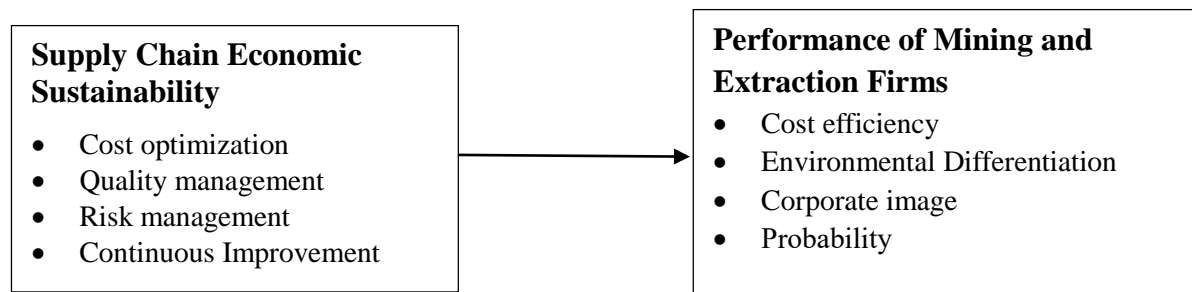
Supply Chain Economic Sustainability	Performance of Mining and Extraction Firms
• Cost optimization • Quality management • Risk management • Continuous Improvement	• Cost efficiency • Environmental Differentiation • Corporate image • Probability

Figure 1: Conceptual Framework

8. RESEARCH METHODOLOGY

A research design refers to plans and procedures for research which involves when and how often to collect the data as well as how much control the researcher have over the research factors Fisher and Bloomfield (2019) posit that it is the overall strategy and procedure that one selects to logically and cogently integrate the various study components ensures that the research problem is successfully handled. This study used a 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).

This 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.

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 of Study

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

Source: (State Department for Mining, 2023)

This study sample frame was derived from the State Department for Mining (2023). It consisted list of licensed mining and extraction firms presented in the Mining Cadastre Portal in Kenya. Kenya's Mining Cadastre Portal classifies licensed firms into three categories: Artisanal/Quarry, involving small-scale, manual extraction of minerals and stones; Exploration**,** focusing on surveying and assessing mineral potential before large-scale mining; and Mining**,** which includes large-scale commercial extraction and processing of minerals.

The study applied a stratified random sampling method. This technique was used because the entire population is divided into three separate, non-overlapping categories. The Mining Cadastre Portal in Kenya categorizes licensed mining and extraction firms into three groups: Artisanal/Quarry, Exploration and Mining. Artisanal and quarry operations involve small-scale, labor-intensive extraction of minerals and building materials, often using rudimentary methods. Exploration firms focus on surveying and assessing mineral deposits to determine their economic viability before full-scale mining begins. Mining companies, on the other hand, engage in large-scale extraction and processing of minerals for commercial use.

This study employed Yamane formula to determine, using Equation 3.1, 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 of study

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)

The research's primary data came from questionnaires. Kuphanga and International (2024) recommended the use of questionnaire because it's cost- effectiveness, ease of accessibility, and able to reach a wider population, allowing efficient gathering of information. Pilot study in research served a very critical role in determination of validity and reliability of instrument before the data can be collected (Rashid et al., 2022). Saunders, Lewis and Thornhill., (2023), recommend a pilot test of between 5% and 10% of the study sample. Twenty supply chain leaders participated in a pilot research, which represent 10% of the sample respondents from the Mining and Extraction firms in Kenya.

The questionnaire's reliability was measured using the Cronbach Alpha. Cronbach Alpha is a dependable coefficient showing the extent of positive relationship among items. Values of 0.70 or higher one on the Cronbach's Alpha scale are considered sufficient (Creswell and Creswell, 2023). Validity on the other hand is used to describe if at all a questionnaire actually measures the variables of interest (Christensen et al., 2020). It is the degree to which explanations of phenomena match up with external realities (Taber, 2018). While it is challenging to establish absolute validity, it is crucial to research to show that a new measure has some degree of validity. Ideally, construct and content validity were both used in the research. Each element of the questionnaire assessed information for a distinct purpose, and the conceptual framework for this study was intimately tied to each section to ensure construct validity. Two independent resource individuals were selected at random from the pilot sample to review the questionnaire in detail to confirm its content validity.

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. It is appropriate for issues of comprehension and representation. To address the research or make a statement on a problem, the aim of the thematic analysis in this study is to discover themes, i.e., patterns in the data that are important or intriguing. Prior to analysis in SPSS version 27, the reliability and consistency of the quantitative data gathered via questionnaires was evaluated.

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. Multiple 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 = {Supply chain economic sustainability}
β_1, represent the coefficients of independent variable.

9. RESULTS AND DISCUSSION

Response rate

The response rate in any research is very key in determining how well the collected data represents the intended sample. The study's target population was the 402 mining and extraction companies operating in Kenya as published in the Mining Cadastre Map of 2023 of the State Department for Mining. The researcher randomly administered 201 questionnaires to the head of supply chain working in the mining and extraction from which 157 were completed and submitted. This was a 78.1% response rate while the unsuccessful response rate was 21.9% as indicated in table 3. This was an acceptable rate and to sufficient extent to which the findings can be generalized to the target population.

Table 3: Response Rate

Category	Frequency	Percentage
Response	157	78.1%
Non response	44	21.9%
Total	**201**	**100**

Descriptive statistics

The goal of the study was to investigate how supply chain economic sustainability affected the performance of mining and extraction firms in Kenya. This goal was evaluated through several assessment metrics: Expense efficiency, Standard control, Threat assessment and Ongoing enhancement in the provided opinion declarations. Participants were requested to specify how much they believed fiscal sustainability affected the operations of excavation and resource extraction companies in Kenya. They responded using a scale ranging from 1-Not at all, 2-Limited degree, 3-Moderate degree, 4-Significant degree, and 5-Extremely significant degree. In this research, ratings of not at all and limited degree were interpreted as disagreement, while significant and extremely significant degree indicated agreement.

The findings were presented as percentages, averages and standard deviations as shown in Table 4.

Table 4: Descriptive results of Supply chain economic sustainability

	NA	SE	ME	LE	VLE	Mean	Standard deviation
The company avoids wastage of raw materials and processes to save on costs	0%	6.4%	8.9%	33.8%	51%	4.29	0.879
The company has digitized its processes to optimize costs	17.2%	27.4%	22.9%	21.7%	10.8%	2.85	0.986
The firm has adopted supply chain costs sharing with various partners of company	0%	0%	5.1%	40.1%	54.8%	4.5	0.595
The organization has adopted Continuous improvement techniques for sustainability	0%	0%	22.9%	27.4%	49.7%	4.27	0.812
The firm manages quality by getting it right the first time	0%	8.3%	19.7%	29.3%	42.7%	4.06	0.978
The firm always undertakes prescreening of supplier's capacity	10.2%	19.7%	27.4%	28.1%	14.6%	3.22	0.915
The firm conducts SWOT analysis is frequently done to identify and manage risks	0%	0%	2.5%	49.7%	47.8%	4.45	0.548
The company has insured its operations	13.4%	28%	28%	21%	9.6%	2.89	0.987
Overall	0%	0%	21.7%	73.8%	4.5%	3.82	0.391

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

Respondents agreed that mining and extraction companies avoid wastage of raw materials and processes to save on costs (Mean=4.29). The companies improve resource efficiency, reduce operational costs and enhance profitability, while also minimizing environmental impact through more responsible resource management. Respondents were indifferent on whether the companies have digitized their processes to optimize costs (Mean=2.85). By fully digitizing their processes, mining and extraction companies could streamline operations and improve decision-making, leading to optimized costs, increased efficiency and better overall performance. The mining firms had adopted supply chain costs sharing with various partners of the companies (Mean=4.5) thus distributing financial risks and expenses more evenly, fostering stronger collaborations, reducing individual cost burdens and improving overall supply chain efficiency and resilience.

The organizations had adopted continuous improvement techniques for sustainability (Mean=4.27) which fosters a culture of ongoing evaluation and refinement, ensuring that processes, products, and practices are consistently enhanced to reduce environmental impact

and to optimize resource use. Further the firms manage quality by getting it right the first time (Mean=4.06), a proactive measure that reduces defects, minimizes rework and enhance efficiency, ultimately leading to cost savings and improved customer satisfaction.

The firms always undertook prescreening of supplier's capacity (Mean=3.22) and conducted SWOT analysis frequently to identify and manage risks (Mean=4.45). Firms proactively identified potential risks, assessed supplier capabilities, and strengthened their supply chain resilience. This strategic approach helps in mitigating risks, ensuring reliable supplier relationships, and enabling informed decision-making to maintain operational efficiency and sustainability.

Respondents were indifferent on whether mining firms had insured their operations (Mean=2.89). Insurance of mining operations would potentially mitigate financial risks associated with accidents, environmental damage or equipment failures, ensuring business continuity and protecting assets. Insurance also provides a safety net for managing unforeseen disruptions, helping the companies maintain stability and comply with regulatory requirements while safeguarding long-term investments.

The results of this investigation support Jovanović et al. (2023) who found out that the mining industry's integration of sustainability principles, such as green innovation, enhances both ecological and economic outcomes, leading to increased efficiency and profitability. Similarly, research by Onyango et al. (2023) on Kenya's mining industry emphasized that adopting sustainable economic practices, such as compliance with environmental regulations, improves operational efficiency and market competitiveness. These findings align with the growing recognition by Roffé et al.(2024), Amoah & Eweje (2022) that sustainable economic practices contribute to long-term success and better performance for mining firms. Govindan et al. (2020b) argue that while supply chain economic sustainability practices, such as cost optimization and risk management, enhance firm performance, their effectiveness largely depends on regulatory enforcement and financial incentives. Their study in the extractive sector suggests that without strong policy support, firms may struggle to fully integrate sustainability into their operations. On the other hand, Govindan et al.(2020) highlight that digitalization and automation significantly enhance cost efficiency and quality management in supply chains, but their adoption remains slow in developing economies due to infrastructure limitations and high capital requirements .Their findings suggest that mining firms in Kenya may benefit from gradual integration of digital tools to improve cost optimization and performance.

Qualitative findings

Two open-ended questions were used to investigate supply chain heads' opinions on supply chain economic sustainability. Finding the different types of wastes and inefficiencies in mining and extraction supply chains was the goal of the first question. The findings from the responses established that mining and extraction supply chains face various forms of waste and inefficiencies. Among them was material waste which included excessive extraction, poor ore grading, and unused by-products. Energy inefficiency arises from

outdated machinery and reliance on non-renewable energy sources. Time inefficiencies occur due to delays in logistics, poor planning, and lengthy approval processes. Water waste results from excessive use in extraction and inadequate recycling systems. Logistics inefficiencies include suboptimal transportation routes and reliance on fuel-intensive modes. Inventory waste arising from overstocking or poor demand forecasting. Lastly, operational inefficiencies, such as equipment downtime and lack of process automation, and further increase waste in these supply chains were identified.

Further, the mechanisms employed by mining and extraction firms were found to reduce waste and maximize supply chain expenses. Lean practices streamlined operations, reducing excess inventory and eliminating non-value-adding activities. Energy-efficient technologies lowered consumption and costs, while recycling programs repurposed materials and minimizing waste. Advanced analytics improved demand forecasting and inventory management to prevent overproduction. Supplier collaboration ensured sustainable sourcing and cost-effective procurement. Process automation enhanced operational efficiency and reduced errors. Route optimization in logistics cut transportation costs and emissions. Additionally, continuous staff training promoted awareness of waste reduction and cost optimization strategies, fostering a culture of sustainability and efficiency.

These qualitative findings are supported by some exiting literature. Jabbour et al. (2020) argue that lean and energy-efficient technologies are essential for waste reduction and cost optimization in industrial supply chains, including mining. Their study found that firms implementing automation and real-time analytics significantly reduce inefficiencies related to inventory management, logistics, and resource utilization. Similarly, Govindan et al. (2021) emphasize that circular economy principles, such as recycling programs and sustainable sourcing, improve both environmental and financial performance in extractive industries. However, they note that mining firms often face high initial investment costs when integrating waste-reduction technologies, which may slow adoption. On the other hand, a study by Liu et al. (2019) challenges the assumption that technology adoption alone ensures efficiency gains. Their research in resource-based industries found that organizational culture, supplier engagement, and employee training play equally critical roles in sustaining cost-saving initiatives. Firms that fail to align workforce behavior with supply chain economic sustainability goals may experience limited success despite technological advancements.

Correlation analysis

The nature and the strength of the relationships between each 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 5.

Table 5: Correlation analysis

	Supply Chain Economic Sustainability	Performance
Pearson Correlation	1	0.582**
Sig. (2-tailed)	-	0.000
N	157	157

According to the findings, there is a strong positive association between Supply chain economic sustainability and performance (r=0.582, p<0.05). This suggests that efforts to improve supply chain economic sustainability lead to improvement in performance of mining and extraction firms also increases. This indicates that companies focusing on financial performance and long-term economic viability are also more likely to invest in social aspects thus contributing to a more socially sustainable supply chain.

Regression results

The dependent variable performance of mining and extraction firms was fitted against supply chain economic sustainability using a simple linear regression. The model summary is given by Table 6.

Table 6: Model Summary of Supply Chain Economic Sustainability

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.582[a]	.339	.334	.3389

a. Predictors: (Constant), Supply chain economic sustainability
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=0.339 which means that about 33.9 percent of the change in the performance of mining and extraction firms in Kenya can be explained by supply chain economic sustainability. Table 6 shows the ANOVA result of the regression performance of mining and extraction firms on supply chain economic sustainability. The result indicates that the significance of the F-statistic is less than 0.05 (F=79.326, p<0.05), an implication that the model was good fit and supply chain economic sustainability has a significant influence on performance of mining and extraction firms.

Table 7: ANOVA of Supply Chain Economic Sustainability

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	9.108	1	9.108	79.326	.000[b]
	Residual	17.797	155	.115		
	Total	26.906	156			

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

Further, Table 7 show the coefficients and t-statistic obtained from the model. The constant term $\beta_0 = 2.001$ is interpreted to mean that if supply chain economic sustainability is held constant, then there will be a positive performance of mining and extraction firms in Kenya by 2.001. The regression coefficient for supply chain economic sustainability was positive and significant ($\beta_1 = 0.618$, p<0.05), with a t-value of 8.907. This implies that a unit increase in supply chain economic Sustainability is predicted to increase the performance of mining and extraction firms by 0.618 units.

Table 8: Regression Coefficient of Supply Chain Economic Sustainability

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	T	Sig.
1 (Constant)	2.001	.266		7.517	.000
Supply chain economic sustainability	.618	.069	.582	8.907	.000

a. Dependent Variable: Performance of mining and extraction firms

The resulting model is given by equation 4.1 as

$$Y = 2.001 + 0.618X_1 \tag{1}$$

Equation 1 shows that for every unit change in supply chain economic sustainability performance increases by 61.8% keeping other factors constant. From the result in Table 5 to 8 above, the decision is to reject the null hypothesis H_{01} that supply chain economic sustainability has no significant influence on the performance of mining and extraction firms in Kenya and conclude that supply chain economic sustainability has significant positive influence on performance of mining and extraction firms in Kenya.

10. CONCLUSIONS

The study examined the influence of supply chain economic sustainability on the performance of mining and extraction firms in Kenya, focusing on cost optimization, quality management, risk management and continuous improvement. Results revealed that firms avoid wastage of raw materials and processes, improving resource efficiency, reducing costs, enhancing profitability, and minimizing environmental impact. However, respondents were indifferent about whether firms had fully digitized their processes. Digitization could optimize costs, streamline operations, and improve decision-making, enhancing efficiency and overall performance.

Mining firms adopted supply chain cost-sharing with partners, distributing financial risks more evenly, fostering collaboration, and improving supply chain efficiency and resilience. Continuous improvement techniques were also employed, fostering a culture of ongoing evaluation and refinement to enhance processes, products, and practices, reducing environmental impact, and optimizing resource use. Quality management practices emphasized "getting it right the first time," minimizing defects, reducing rework, and improving efficiency, leading to cost savings and greater customer satisfaction. Risk management in the mining firms included frequent SWOT analyses and supplier prescreening, enabling firms to identify potential risks, assess supplier capabilities, and enhance supply chain resilience. Respondents were indifferent on whether operations were insured, although insurance could mitigate financial risks from accidents or disruptions, ensuring business continuity, regulatory compliance, and asset protection.

A statistical examination exploring the relationship between Supply chain economic sustainability and the operational success of resource extraction companies revealed a positive linear correlation between these variables. The investigation determined that Supply chain economic sustainability practices significantly impact the performance outcomes of mining and mineral extraction enterprises operating in Kenya. Based on these findings, researchers dismissed the initial null hypothesis which had proposed no meaningful connection between sustainable economic approaches and the business results of Kenyan mining and extraction organizations was thus arrived concluding that Supply chain economic sustainability positively influences the performance of mining and extraction firms in Kenya by optimizing costs, improving resource efficiency and fostering continuous improvement, which enhances profitability and operational resilience. It also strengthens risk management, quality standards, and collaborative supply chain practices, ensuring long-term business stability and competitiveness in the industry.

11. RECOMMENDATIONS

Given the results, it is advised that mining and extraction firms in Kenya focus on further optimizing their resource utilization to reduce waste and improve operational efficiency. Mining companies should prioritize continuous improvement practices to refine their processes and reduce environmental impact while enhancing product quality. Management should implement lean strategies and invest in technologies that minimize wastage of raw materials, improve energy efficiency, and enhance profitability.

It is also crucial for firms to consider digitizing their operations fully. Adopting advanced digital tools can streamline decision-making, improve process efficiency, and enhance overall performance. Digital solutions can also provide real-time data, aiding better risk management and enabling proactive responses to potential challenges. Firms should expand their adoption of supply chain cost-sharing models with partners to evenly distribute financial risks, improve collaboration, and enhance the resilience of their supply chains. Regular SWOT analyses and supplier prescreening should be integrated into risk management practices to better identify risks and assess supplier capabilities.

Additionally, mining companies should consider investing in comprehensive insurance policies to mitigate financial risks from accidents or disruptions. This would help ensure business continuity, regulatory compliance, and asset protection. Finally, firms should continue fostering a culture of quality management, emphasizing defect prevention and efficiency, which will ultimately drive cost savings and boost customer satisfaction.

REFERENCES

Abor, J. (2023). Corporate Governance and Financing Decisions of Listed Firms in Sub-Saharan Africa. *International Journal of Corporate Governance*, *14*(1), 1-21.

Alzubi, H. A., & Akkerman, R. (2022). Unlocking the circular economy in the United Arab Emirates: The role of supply chain management. *Resources, Conservation and Recycling*, *177*, 105979.

Amoah, J., & Eweje, G. (2022). Exploring the dynamics between corporate social responsibility and sustainable development goals in the mining sector. *Business Strategy & Development*, *5*(1), 108-119.

Bennett, N. J., Finkbeiner, E. M., Townsend, H., Whitty, T. S., Allison, E. H., Blythe, E. M., ... & Neuenfeldt, S. (2019). Social equity and justice in marine conservation. *Marine Policy*, *100*, 17-29.

Brundtland Report. (1987). *Our common future: Report of the World Commission on environment and development*. United Nations.

Christensen, L. B., Johnson, R. B., & Turner, L. A. (2020). *Research methods, design, and analysis*. Pearson Education Limited.

Chukwuere, J. E. (2021). Impact of environmental accounting on organizational performance: A study of selected manufacturing companies in Anambra State. *International Journal of Management Sciences and Business Research*, *10*(11), 170-184.

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Cuypers, I. R., Cristea, M., & Martin, O. (2021). The impact of additive manufacturing on supply chain management: An exploratory study. *International Journal of Production Economics*, *233*, 107990.

Dahabreh, I. J., & Hernán, M. A. (2019). Extending directed acyclic graphs to deal with selection bias. *Statistics in medicine*, *38*(22), 4377-4391.

Elkington, J. (1998). *Cannibals with forks: The triple bottom line of 21st century business*. New Society Publishers.

Fayiah, M. (2020). *The role of supply chain management practices in enhancing operational performance of manufacturing firms in Liberia*. [Doctoral dissertation, United States International University-Africa].

Fisher, J., & Bloomfield, J. (2019). Triggering change: How the UN Sustainable Development Goals transform research agendas. *Research Policy*, *48*(9), 103851.

Ghaithan, A. M., Ho, J. A., & Karim, M. R. A. (2023). Supply chain integration and firm performance: The mediating role of supply chain resilience. *Operations Management Research*, *16*(1), 195-214.

Govindan, K., Azevedo, S. G., Carvalho, H., & Cruz-Machado, V. (2020). Impact of supply chain management practices on sustainability. *Journal of Cleaner Production*, *274*, 122908.

Govindan, K., Seuring, S., Zhu, Q., & Azevedo, S. G. (2020b). Accelerating the transition towards sustainable supply chains: Drivers and elements. *International Journal of Production Economics*, *222*, 107493.

Govindan, K., Shankar, K. M., & Kannan, D. (2021). Supplier selection based on corporate social responsibility practices using hybrid multi-criteria decision making methods. *International Journal of Production Economics*, *233*, 107996.

Grape, C., & Salih, M. R. (2022). Environmental management accounting and sustainable development in the Swedish mining industry. *Journal of Cleaner Production*, *330*, 129758.

Hennart, J. F. (2019). The comparative institutional model: Putting institutions at the center of international business research. *Journal of International Business Studies*, *50*, 1475-1490.

Horani, S. (2023). The impact of supply chain integration on supply chain resilience and performance: An empirical study. *International Journal of Logistics Management*, *34*(1), 126-151.

Igogo, E. E., Ngugi, K., & Chege, S. M. (2021). Influence of green supply chain management on the performance of manufacturing firms in Kenya. *International Journal of Supply Chain and Operations Management*, *8*(1), 125-141.

Jabbour, C. J. C., Sarkis, J., de Sousa Jabbour, A. B. L., Govindan, K., & Azevedo, S. G. (2020). Unlocking synergies between industry 4.0 and the circular economy: Applications and a research agenda. *Resources, Conservation and Recycling*, *162*, 105020.

Jagoda, K., & Wójcik, E. (2019). Sustainable supply chain management in the mining sector. *Resources Policy*, *62*, 539-551.

Jovanović, M., Đukić, G., & Erić, A. (2023). Sustainable supply chain management practices and company's performance: The mediating role of supply chain integration. *Sustainability*, *15*(15), 11802.

Karimova, G. F. (2021). Sustainable Development Goals in the Mining Sector: The Case of the Russian Federation. *Resources*, *10*(11), 111.

Ketokivi, M., & Mahoney, J. T. (2020). Of straw men and iron horses: Advancing organizational research by building upon rather than tearing down. *Academy of Management Review*, *45*(1), 221-245.

Kihamba, E. (2021). *Effects of green supply chain management practices on competitive advantage of cement manufacturing firms in Kenya* [Doctoral dissertation, KCA University].

Kracauer, L. (2020). Circular economy in the mining sector: Global opportunities and trends. *Resources Policy*, *68*, 101782.

Kuphanga, E. H., & International, A. (2024). *The extractive industries transparency initiative and revenue management in Malawi*.

Leal Filho, W., Wolf, F., Azeiteiro, U. M., Brandli, L. L., Özuyar, P. G., & Fritzen, B. C. (2023). The role of the mining and quarrying sector in achieving the Sustainable Development Goals. *Resources Policy*, *80*, 103239.

Li, J., & Sarkis, J. (2022). Digitalization and sustainability in global supply chains: Bibliometric analysis and future research directions. *Resources, Conservation and Recycling*, *180*, 106184.

Liu, Y., Luo, X., & Jia, F. (2020). Social media engagement behaviour and purchase decisions: The moderating role of social media platforms. *International Journal of Information Management*, *50*, 175-186.

Liu, Y., Mubarik, M. S., Nazeer, M. I., Khawaja, K. F., & Amin, A. (2019). The interrelationship between green supply chain management practices and environmental performance: The mediating role of green innovation. *Resources, Conservation and Recycling*, *140*, 247-258.

Maxwell, D. (2020). The political economy of urban food security in low-and middle-income countries. *The Journal of Development Studies*, *56*(4), 652-666.

Mbanaso, F. G., Ezenwafor, D. I., & Obi, J. C. (2023). Green supply chain management practices and performance of manufacturing companies in Anambra State, Nigeria. *International Journal of Management Sciences and Business Research*, *12*(1), 29-41.

Mdasha, S. M., Ngugi, K. S., & Machuki, T. O. (2022). Influence of sustainable procurement practices on performance of manufacturing firms in Kenya. *The Strategic Journal of Business & Change Management*, *9*(3), 1168-1188.

Mengich, E. K., Chepkwony, P. K., & Rono, W. K. (2020). Influence of green supply chain management practices on environmental performance of tea processing firms in Kericho County, Kenya. *International Journal of Social Sciences and Information Technology*, *6*(4), 947-961.

Mogano, D. J., & Mokoele, M. A. (2020). The impact of supply chain management on the performance of mining companies in the North West Province. *Journal of contemporary management*, *17*(1), 416-438.

Mohajan, H. K. (2018). Qualitative research methodology in social sciences and related subjects. *Journal of Economic & Development Review, 10*(1), 23-48.

Mungkung, N., Yuniarthe, I. A., & Giantari, I. G. A. K. (2021). Green supply chain management and firm performance: The mediating role of environmental management accounting. *Problems and Perspectives in Management*, *19*(3), 443.

Mutuku, C. M. (2018). *Effect of green supply chain management practices on performance of manufacturing firms in Kenya: A case of Unilever Kenya Limited* [Doctoral dissertation, Jomo Kenyatta University of Agriculture and Technology].

Nguyen, T. T. H., & Doan, D. T. (2020). Green supply chain management factors and performance: Moderating role of the relationship with suppliers. *Management Science Letters*, *10*(16), 3843-3852.

Nyang'au, J. B. (2017). *Effect of green supply chain management practices on environmental performance of manufacturing firms in Kenya: A case of Bamburi Cement Limited* [Doctoral dissertation, Jomo Kenyatta University of Agriculture and Technology].

Oluwabukunmi, O. A., Samuel, E. O., & Tolulope, A. A. (2024). Green Supply Chain Management and Performance of Selected Food and Beverage Companies in Ogun State, Nigeria. *International Journal of Sustainable Development Research*, *6*(1), 10-25.

Omai, G. (2019). *Green supply chain management practices and performance of manufacturing companies in Nairobi County, Kenya* [Doctoral dissertation, University of Nairobi].

Ominde, E., Shukla, J., & Owino, J. (2022). Influence of sustainable procurement practices on the performance of large manufacturing firms in Kenya. *International Journal of Social Sciences and Information Technology*, *8*(1), 154-173.

Onyango, J. O., Odhiambo, R. O., & Awuor, F. M. (2023). Supply Chain Integration and Performance of Sugar Manufacturing Firms in Kenya. *International Journal of Supply Chain Management*, *8*(1), 125-141.

Oyewobi, L. O., & Jimoh, F. A. (2022). Drivers and barriers to sustainable supply chain management practices in the Nigerian construction industry. *Built Environment Project and Asset Management*, *12*(1), 143-160.

Panpatil, V. V., & Kant, R. (2022). A review of barriers to sustainable supply chain management: Trends and future directions. *Sustain Sci*, *17*, 1373-1410.

Park, Y. W., Shin, J. M., & Park, S. M. (2020). The role of top management's environmental awareness in implementing green supply chain management. *Sustainability*, *12*(5), 1888.

Peer, L., Bundsgaard, J., & Brunoe, T. D. (2022). Circular supply chain management: A review of definitions, concepts, and theory. *Resources, Conservation and Recycling*, *182*, 106306.

PwC. (2019). *Mining for a sustainable future*.

Rahman, M. S., Azad, M. A. K., Mamun, A. A., & Alam, A. S. (2022). Impact of green supply chain management practices on the performance of the manufacturing firms in Bangladesh. *Social Sciences & Humanities Open*, *6*(1), 100346.

Rashid, A., Hassan, M. K., Yousuf, M. A., & Almaki, S. S. (2022). Sustainable supply chain management and firm performance: The moderating role of innovation capabilities. *International Journal of Logistics Management*, *33*(4), 986-1008.

Roffé, L., Mirabella, N., & García-Vallés, A. (2024). Sustainable supply chain management in the food industry: Bibliometric analysis and future research directions. *Journal of Cleaner Production*, *436*, 140411.

Rukmana, D. (2023). Green supply chain management and sustainable performance: The role of environmental management accounting. *Cogent Business & Management*, *10*(1), 2174825.

Sammut, P. A., Bathmaker, A. M., & Mann, E. (2021). Using mixed methods research to study vocational education and training: approaches, designs, and methods. *Journal of Vocational Education & Training*, *73*(1), 1-24.

Saunders, M., Lewis, P., & Thornhill, A. (2023). *Research methods for business students*. Pearson education.

Šerić, M., & Ljubica, D. (2018). Sustainable supply chain management in the mining industry. *Rudarsko-geološko-naftni zbornik*, *33*(3), 1-12.

State Department for Mining. (2023). *Mining in Kenya: The journey towards sustainable development*.

Suopajärvi, H., Särkilahti, N., & Haaramo, H. (2023). Circular economy in mining: A systematic literature review. *Resources Policy*, *80*, 103169.

Sürücü, L., & Maslakçi, A. (2020). Validity and reliability in quantitative research. *Business & Management Studies: An International Journal*, *8*(3), 269-294.

Taber, K. S. (2018). The use of Cronbach's alpha when developing research instruments in science education. *Research in science education*, *48*, 1273-1296.

Tamminen, K. A., & Poucher, Z. A. (2020). Considering social sustainability in supply chain management: A value out of supply chains framework. *Journal of Cleaner Production*, *252*, 119906.

Tseng, M. L., Lim, M. K., Wong, W. P., Soosay, C., & Jauhari, F. (2020). Sustainable supply chain management under uncertainty using big data analytics. *Resources, Conservation and Recycling*, *161*, 104962.

Waithira, S. N. (2021). *Influence of green supply chain management practices on organizational performance of manufacturing firms in Kenya: A case of Unilever Kenya limited* [Doctoral dissertation, Jomo Kenyatta University of Agriculture and Technology].

Wanja, D. N., & Achuora, J. O. (2020). Influence of green supply chain management practices on environmental performance of manufacturing firms in Kenya: A case of East African Breweries Limited. *International Journal of Supply Chain and Operations Management*, *7*(1), 102-120.

Yildiz Çankaya, S., & Sezen, B. (2019). Effects of Green Supply Chain Management Practices On Sustainability Performance. *Journal of Manufacturing Technology Management*, *30*(1), 98–121.