Strategic Approaches to Supply Chain Management

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Circular Supplier Sourcing and Performance of Manufacturing Companies in Kenya

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Abstract

Purpose: This study evaluated the influence of circular supply supplier sourcing on the performance of manufacturing companies in Kenya. The research was guided by the specific objectives: to determine the effect of circular supplier sourcing on performance of manufacturing companies in Kenya and to assess the moderating effect of circular supply chain reconfiguration on the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya. The theoretical framework was underpinned by Systems theory and Strategic choice theory.

Methodology: Employing a cross-sectional survey design, the study targeted 795 manufacturing companies in Kenya, excluding the service sector, as per the 2023 KAM directory. A sample of 266 companies was drawn using Slovin's formula and stratified sampling technique. Data was collected using questionnaires. Quantitative data was analyzed using both descriptive and inferential statistics and with the help of SPSS version 27. Regression analysis was used to show the relationship between the dependent variable and the independent variable and the study employed multiple linear regression analysis to test the hypotheses.

Findings: Key findings revealed that circular supplier sourcing had significant positive effects on company performance and supply chain reconfiguration demonstrated a significant moderating effect on the relationship between circular supplier sourcing and company performance. These findings contribute to understanding circular economy principles in the Kenyan

manufacturing context and provide valuable insights for practitioners and policymakers in implementing circular supply chain management practices.

Unique Contribution to Theory, Policy and Practice: Thus, the study recommends that manufacturing firms should put into consideration circular supplier sourcing practices to improve performance in market share, sales volume and return on investment levels. Future research directions include a longitudinal study to examine the long-term effects of circular supplier sourcing practices on manufacturing performance and a comparative study of circular supplier sourcing practices across different industries in Kenya to identify sector-specific challenges and opportunities.

Keywords: *Circular Supply Chain, Manufacturing*

INTRODUCTION

Sourcing decisions typically concern internal buying processes that relate primarily to relations with direct suppliers (Miemczyk et al., 2012). These relations also termed as buying, purchasing or procurement have in the recent years shifted focus from purchasing as a transactional action to a more strategic one, especially regarding sustainable and circular sourcing that considers social and environmental factors (Giunipero et al., 2019). Sustainable sourcing in the circular economy context, i.e. circular sourcing, is more narrowly defined; while striving for environmentally friendly material, it aims to create new loops of material use across supply chains to minimize waste, for instance by recycling or by purchasing recycled materials (Qazi and Appolloni, 2022). Transition to a circular economy by firms in an industry is majorly influenced by individual firm's circular sourcing strategies as circularity is linked both within individual firms and across industries (Gothár & Schanz, 2024).

Emphasis is put on the manufacturing industry as the sector is regarded as the backbone of the world's social and economic development (Byrne et al., 2020). The manufacturing industry focuses on one business, creating products from raw materials, semi-finished products, and finished products (KNID, 2017). Manufacturing companies usually operate in highly competitive environments as they are at times subjected to global competition in terms of new products, production technologies, new materials, and legislative or organizational or business model developments (Mamasioulas et al., 2020). The most successful companies in the sector are expected to expand their market share and pioneer in innovation as the global consumption for manufacturing goods annually rises (Cobano-Conde, 2018).

According to (WEForum, 2019) China is the world's largest manufacturing economy driven with its ability to deliver low-cost labor and materials, favorable policies and infrastructure, a large consumer base, established supplier network, manufacturing capabilities from low-cost goods to more advanced products. The U.S manufacturing sector also represents over 18.2% of the world's total goods every year with it being one of the greatest contributors to the U.S' employment GDP and overall economic development (Cobano-Conde, 2018). Given the large contributions to the economy for these superpower countries, it is interesting to note the level of combined contributions of manufacturing companies in the entire global economy which has significant effect in the world. Their processes and performance ought to be at the optimum (Simiyu & Maina, 2018).

When applied as an industrialization strategy, the circular supply chain management has the potential to decouple resource use from economic development to help address key African challenges like climate change, food security, water scarcity and natural resource management, which all affect management in our industries. Circularity can also promote greater resilience to exogenous shocks through the creation of regional value chains for self-sufficiency hence it is particularly relevant to tackle pandemic-induced economic fragility (WEForum, 2021).

According to (Laurin & Fantazy, 2017) in the process of balancing cost reduction with social responsibilities, there are many events involving environmental degradation, global warming and corporate pressures that lead to adoption of circular initiatives. These activities are currently stressing organizations to incorporate and implement circular practices into their manufacturing operations and seek effective strategies to measure the performance of their sustainability efforts while still meeting their performance goals (Laurin & Fantazy, 2017). This paper aims to define a set of aspects that are currently being used by manufacturers in circular supplier sourcing practices and how they assist in meeting their performance goals.

Statement of the Problem

According to the (Circle Economy, 2021) about 100 billion tons of raw materials enter the production channel per year but only 8.6% of all these are recycled implying that demand for raw materials will outstrip its supply thus affecting manufacturing performance. Furthermore, the increasing commodity prices and resource scarcity poses a great threat to global supply chains, whose impact is felt significantly on the GDP of developing economies (UNEP, 2019). In the local context and specifically in Kenya, policies have been created by the Vision 2030 Manufacturing Sector agenda to ensure that the manufacturing and industry space is developing to generate employment and positively contribute to GDP using assets present in Kenya (Were, 2016). Despite all this the performance of manufacturing companies in the Kenyan context has not been growing as expected (Were, 2016).

Manufacturing plays a pivotal role in Kenya's economic development due to its significant contribution to industrial output, employment and export growth. Manufacturing GDP contribution can give indications whether a country is making strides in industrialization. Notwithstanding, the sector's performance over the last 10 years has faced significant challenges, which has seen its contribution to GDP drop significantly from 11.08% recorded in 2011

to 7.8% in 2022. Kenya hopes to reverse this trend through the Manufacturing 20BY30 Vision that seeks to increase the sector's contribution to GDP to 20% by 2030. However, it is good to note that in the recent years the world real GDP growth has slowed down to 2.4% in 2024 from 2.6% in 2023, 3.0% in 2022 and a high of 6.2% in 2021 while the Kenyan real GDP has experienced volatility with a high of 7.8% in 2021, dropping to 4.8% in 2022, staggering to 5.1% in 2023 and 5.3% in 2024 as per (KAM, 2024) and (KNBS, 2024). All this is affected by various circumstances such as Kenyan institutions struggling with SCM issues where malpractices cases have been reported because of existing supply chain operations not being based on sustainable goals according to World Bank (2017). It is also notable that in the Kenyan context more focus has been on green sustainable practices and their effects on manufacturing performance and the few studies on circular economy approach are based only on waste management for instance (Abong et al., 2021) studies on green consumerism in Kenya and (Musau, 2021) who studied the effects of green manufacturing in Kenya. The impact of circular supplier sourcing practices on performance of manufacturing companies are yet to be fully explored in the Kenyan perspective hence this study.

The lack of well-established circular supplier sourcing practices and the inefficiencies in supply chain coordination adversely affects the overall performance of manufacturing companies hence hindering the companies' ability to meet sustainability goals, optimize costs and remain competitive in a global market that increasingly demands sustainable practices. There is hence a need to understand how circular supplier sourcing practice can be integrated into the supply chain and its impact on the overall performance of manufacturing companies in Kenya (Giudice et al., 2021). Apart from the sparse information, it is not adequate to only consider the technical and engineering performance of manufacturing systems as per the current available information. This study hence entails measuring the ability of manufacturing companies in Kenya to satisfy their present performance needs through circular supplier sourcing practices of restoration and regeneration by onboarding reliable suppliers with circular and sustainable contracts with an emphasis on adoption of current circular innovations in their company operations and additionally, identifying the variables that have the highest influence or role (Geissdoerfer et al., 2017).

Specific Objectives

i. To determine the effect of circular supplier sourcing on performance of manufacturing companies in Kenya.
ii. To assess the moderating effect of circular supply chain reconfiguration on the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya.

Study Hypothesis

H_{01}: Circular supplier sourcing has no significant effect on the performance of manufacturing companies in Kenya.

H_{02}: Circular supply chain reconfiguration has no significant moderating effect on the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya.

Theoretical Review

The Systems Theory

A systems theory is a theoretical perspective that analyses a phenomenon seen as a whole. It is an interdisciplinary study of systems as they relate to one another within a larger, more complex system. Basically, the whole is greater than the sum of its parts (Hedayat & Lapraz, 2019). The focus is on the systems, subsystems, interrelatedness, interconnectivity and on the relationships between parts in order to understand an entity's organization, functioning and outcomes and eventually developing an appropriate design for the same.

Systems can be found in nature, in science, in society, in an economic context, and within information systems. System theory can also be related to the effects of external systems on the decisions and behaviour of an organization; where external systems include regulations, the law, professional standards, interest organizations and social belief. The ultimate success of a supply chain depends upon various factors among which are customer's expectations, globalization, information technology, government regulations, competition, and the environment (Singh et al., 2015).

Circular supplier sourcing is well elaborated through systems theory as a worldview of holism. It involves shared attributes with suppliers concerning circular practices of everything and methodology of holistic thinking with the aim of developing a circular supply chain system having common goals and values. Creative co-operation of the different suppliers in a supply chain from

mutually different professions with similar goals and values enables creating means of sustainable products and features sustaining their systems and operations. It involves a transition from reductionism to perspectivism allowing for many perspectives in the supply chain to co-exist. This is enabled through education of the different operations processes of the partners in the supply chain and the development of interdisciplinary principles which when applied through circular supplier sourcing, will contribute to efficient overall organisational performance (Ngoto, 2016).

Strategic Choice Theory

Strategic choice is a systemic theory of strategy. According to (Zhu, 2012) the theory is built on an interaction mode where organisations adapt to their environment in a conducive manner that will enable achievement of their goals. It was developed by John Child (1972) and continues to provide a significant influence on the study of organisations and management (Harney, 2016). The variance of environmental conditions, whether the environment was dynamic or static, and organisational contingencies were seen to automatically produce a specific type of organisational response. This contingency approach served the objective of offering insights into what management should do (Harney, 2016). Strategic choice brings about managerial agency and decision making more directly into the equation. For (Child, 1972), strategic choice was defined as the process whereby power holders in an organisation decide upon courses of strategic action. Managerial discretion is important in making strategic choices and it ought to be informed by underlying values and beliefs (Harney, 2016).

Strategic choice being a systematic theory of strategy in this study is built on a notion of interaction between partners in a supply chain which enhances organisations adapt to their environment in a self- regulating manner to achieve their goals and the dynamics over time become stable hence bring about circular economy aspects in the social, economic and environmental aspects of the supply chain partners. The strategic choice decisions determine the future strategy of the firm, hence the strengths, weaknesses, threats and opportunities that can be exploited. This in turn determines the performance of the entity. It is therefore a paramount theory in consideration of circular reconfiguration practices which will affect the performance of any organisation while taking into consideration return on investment. This is because the Strategic Choice Theory details the importance of taking the right action in a contradicting situation so as to achieve efficiency as a result of the choices picked.

Conceptual Framework

A conceptual framework is a set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentation. Mugenda and Mugenda (2016) define a conceptual framework as hypothesized model identifying the model under study and the relationship between study variables variables. Figure 1 presents the hypothesized relationship between the independent variables, the moderating variable and the dependent variable for testing in this study:

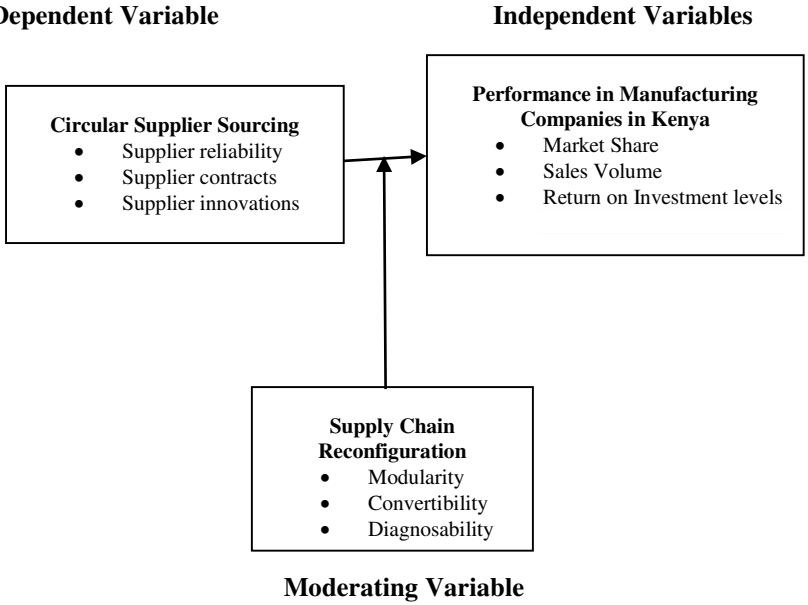

Figure 1: Conceptual Framework

Circular Supplier Sourcing

Circular supplier sourcing or circular procurement is when people or organizations buy products and services that involves sourcing sustainable circular products, materials and services thus strengthening the foundations upon which circular dolphin choirs are built and minimizing environmental impacts over their life cycle of manufacturing, transportation, use and recycling or disposal. It refers to the procurement of products and services that have a reduced effect on human health and the environment when compared

with competing products or services that serve the same purpose (Cruz, 2019). Research in this area has consistently shown that professional purchasers who adopt criteria which is environmentally preferable can reduce or even eliminate waste and environmental impacts as well as reduce costs.

According to University of Louisville, (2018), environmental performance is improved while addressing ethics, social regeneration, and economic concerns. Circular supplier sourcing can enable an organization to offset financial and environmental risk rather than inheriting it from their suppliers. It encourages an organisation to involve the suppliers at the design stage or develop a network to prequalify suppliers that have responsible environmental management. It can also bring important benefits for its practitioners: risk management, eco-efficiency, stronger supplier relationships and improvements in environmental performance, according to University of Louisville (2018).

Additionally, rapid developments in technology, globalisation and competition have heightened the interest and opportunities for inter-organisational relationships as firms seek productive efficiencies in sourcing, production, distribution, retail and other supply chain functions. These, together with changing consumer demand, give rise to uncertainties in firms when maintaining inter-organisational relationships between all the stakeholders in the organisational environment (Soosay & Hyland, 2015).

To grasp the sustainability impacts of your supply chain it is important for a business to have a detailed analysis of the product journey starting with inviting Tier 1 suppliers to join the process and who in turn will pass the invite to Tier 2s and so on right down through the tiers. Thereafter it is important to evaluate their supplier contracts and environmental requirements in the supply chain and whether they meet the sustainability thresholds. The circular innovation methods used by the suppliers are also analysed and linked to each other in the chain. The key to success is to ensure that each person can link what they sell to whom and the details of what they buy link to the next party in the supply chain (Agyabeng-Mensah et al., 2020).

Supply Chain Reconfiguration

Reconfigurability is used to measure quantitatively the capability of supply chain to easily change their structure and functions. Given the COVID 19 pandemic, fluctuating demand, market uncertainty and the emergence of new technologies, a more flexible and agile supply chain in response to the market trends is needed. Ensuring supply chain flexibility, agility, resilience, and

viability requires the development of a reconfigurable supply chain that can cope with various market changes in the supply chain levels with the minimum resources time and cost (Zidi et al., 2022).

To stay responsive to evolving customer demands and to meet the need for greater product customizations, there is need for organizations to quickly reconfigure their manufacturing systems and supply chain. Supply chain reconfiguration is hence applied as a moderating variable as reconfiguration can alter the association between the independent and dependent variables by either strengthening or diminishing the association according to operational circumstances of the organization (Tian & Guo, 2019).

Modularity based manufacturing practices are the application of unit standardisation or substitution principles to create modular components and processes that can be configured into a wide range of end products to meet specific customer needs (Tu et al., 2004). These practices enable firms to achieve modularity in product design, production process design and organizational design which can be achieved when their components can be disaggregated and recombined into new configurations with little loss of functionality. Dividing a complex system into smaller modules and examining each piece separately can ease management in a business and increase benefits such as economies of scale, increased feasibility of product/components change, increased product variety and reduced lead time, ease of product upgrade, maintenance, repair and disposal among others thus implementing a reconfigurable manufacturing system (Omai et al., 2018).

To support these processes, convertibility is incorporated which involves having flexible and changeable dynamics in the manufacturing process which can easily be applied at the equipment, production system and assembly levels to dynamically and efficiently change the capabilities of the system, resources, and new configurations to adopt to the rapidly changing manufacturing environment hence increase and maintain efficient performance in the companies (Zidi et al., 2022). To detect and correct failures quickly, the reconfigurable supply chain system must have a high degree of diagnosability which can be measured through parameters like detectability, predictability, and distinguishability. Detectability determines the time before detecting the failure, predictability which measures the time before the failure re-occurrence and distinguishability which measures the time necessary to identify the replaceable unit of a system that causes a failure. Bottom line, supply chain reconfiguration aspect of diagnosability is measured by considering two

quantitative factors: supply chain visibility and detection time (Zidi et al., 2022).

The Concept of Performance

Performance is defined as the operational excellence to deliver leading customer experience (Trong, 2016). According to (Byrne et al., 2020) performance is to be interpreted in relation to technical efficiencies and capabilities, agility, resilience and robustness of manufacturing companies. For a long time in history, the goals of organizations' existence was making of profits or return on investments but during the more recent years marketplace characteristics have changed as customers are demanding goods and services at a more quicker delivery, higher quality, better price and greater service excellence (Nia et al., 2016) which also leads to increased awareness of the ecological dimension and the social dimensions such as people's fear of losing their jobs due to emerging technologies (Birkel & Müllerb, 2021).

Also, apart from economic performance, other stakeholders such as policy makers and non-governmental organizations (NGO)s are also showing interest in the social and environmental performance of companies (Schoggl et al., 2016). To thus achieve synergies in performance, the three interdependent dimensions of triple bottom line (TBL) concept are considered. They include economic, environmental and social aspects of performance (Birkel & Müllerb, 2021).

Sustainable performance of an organization refers to its ability to meet the needs and expectations of customers and other stakeholders on long-term, balanced by an effective management organization by organizing staff awareness by learning and applying appropriate improvements and innovation which in turn leads to an increase in market share and return on investments of the companies as a consequence of the social and economic aspects and effects of an organization (Stanciu, Constandache, & Condrea, 2014).

METHODOLOGY

Research Design

The study applied a cross-sectional research design in analysis. The design was applied as it enabled the researcher to generalize the findings to a larger population and focus on the relationship between independent variables and the dependent variables. The research design helped to describe the existing scenario in the circular supplier sourcing practices and performance of

manufacturing companies and expounded on the relationship between the variables Shikokoti, Okoth & Abungana, (2024).

Target Population and Sample Size

In this study, the target population was manufacturing companies in Kenya. This was to reach the entire Kenyan manufacturing segment to provide up to date information on circular supply chain operations as a country because different regions and sectors contain different information which will be important to capture thus making the results more conclusive in comparison to focus on one region and sector. The 2023 KAM directory has a listing of members by sectors, which contains a register of 14 sectors of those in manufacturing firms spread all over Kenya. The directory categorizes members per sector, which is defined by the services they produce, the type of raw materials they import or the products they manufacture. The population of all the registered members for the 14 sectors, as per the directory, was 1,048. The two service sectors of fresh produce and service and consultancy were eliminated to remain with the 12 manufacturing sectors because their focus is on the provision of services and not the actual manufacture of goods and products.

The 12 manufacturing sectors have a total population of 795 companies, which comprise the unit of analysis while the unit of observation was the organizational management officers conversant with the supply chain process and their assistants. Additionally, the sample size derived from the target population using the Slovin formula for this study was 266 respondents and is shown in Table 1 below:

Table 1: Classification of the Sample Size

Types of Sectors	Manufacturing Companies in the Sector	Sample Size
Building, Mining & Construction	49	16
Chemical & Allied	81	29
Energy, Electrical & Electronics	50	17
Food & Beverages	193	64
Leather & Footwear	17	6
Metal & Allied	87	29
Automotive	56	18
Paper & Board	58	19
Pharmaceutical & Medical Equipment	29	10
Plastics & Rubber	83	27
Textiles & Apparel	62	21
Timber, Wood & Furniture	30	10
Total	**795**	**266**

Note. This table was created by the author of this article.

The stratified sampling method was used to put the population into distinct, independent strata that enable the researcher to draw inferences about specific subgroups that may be lost in a more generalized random sample, thus leading to more efficient statistical estimates (Creswell & Guetterman, 2018).

Data Collection Instrument

Data collection is how information is obtained from the selected subject of an investigation (Mugenda & Mugenda, 2016). The researcher collected primary data during the research. Primary data was collected using a questionnaire covering circular supplier sourcing practices and the performance of manufacturing companies in Kenya. The questionnaire contained closed-ended questions that limited the respondents to variables in which the researcher was interested.

Data Analysis

The objectives of the study were analyzed using descriptive statistics techniques and multiple regression models were fitted to the data to determine how the predictor/independent variables affect the response/dependent variable. The equation for circular supplier sourcing and the performance of manufacturing companies in Kenya is expressed in the following equation:

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \varepsilon}$$

This study used multiple regressions analysis (hierarchical moderated method) to establish the moderating effect of Supply Chain Reconfiguration (Z) on the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya. The regression model for the moderating effect was as follows.

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 (X_1 Z) + e}$$

Where:

Y = Performance of manufacturing companies

β_0= Intercept coefficient or value of dependent variable when the independent variable is zero

β_1= Coefficient for circular supplier sourcing

X_1 = Circular supplier sourcing

β_2= Coefficients for interaction terms between supply chain reconfiguration and circular supplier sourcing

Z = Circular supply chain reconfiguration

e = Error term

FINDINGS

Out of the 266 questionnaires administered among the respondents, 221 questionnaires were returned filled, representing a response rate of 83.1%.

Descriptive Statistics

In this section, the study presents the finding on the specific objectives of the study. On the likert scale questions, the scale was 5 with 1 Strongly Disagree, 2 Disagree, 3 Moderate, 4 Agree and 5 Strongly agree. Means and standard deviations were used to interpret the results with a mean of 0-1.4 implied that the respondents strongly disagreed, a mean of 1.4-2.4 implied they disagreed, 2.5-3.4 suggest that they were neutral, a mean of 3.5-4.4 suggest they agreed, and a mean of 4.5-5 implies the respondents strongly agreed (Trochim, 2016).

Circular Supplier Sourcing

The 12-item scale assessed circular souring practices across several areas, including organisational policies and standards, supplier selection, adherence to existing regulations, and circular metrics. The overall mean response score was 4.27, with a standard deviation of 0.591. This score falls within the interval

range, indicating that respondents agreed that circular supplier sourcing has an impact on the performance of manufacturing companies in Kenya. The results were as shown in Table 2 below:

Table 2: Circular Supplier Sourcing

Circular Supplier Sourcing	1	2	3	4	5	N	Mean	Std D
Our organisation has a circular sourcing policy in place	0	6	0	154	60	220	4.22	0.579
Our suppliers are selected based on compliance to circular standards and practices	0	10	8	129	74	221	4.21	0.715
Our suppliers are reliable in terms of quality	0	3	1	135	82	221	4.34	0.562
Our organisation shares feedback with our suppliers on areas of improvement	0	0	5	120	96	221	4.41	0.537
There is an evaluation and selection process for suppliers	0	0	2	129	89	220	4.40	0.508
Our suppliers have circular values and metrics	1	12	12	163	32	220	3.97	0.678
Our suppliers have environmental certifications	0	0	7	130	84	221	4.35	0.540
Our suppliers adhere tour contracts	0	1	3	121	96	221	4.41	0.546
Our suppliers have total product knowledge, functional systems, research and development of circular practices	6	2	17	158	37	220	3.99	0.728
Our Suppliers have internal competence in product and process development	1	0	3	150	67	221	4.28	0.532
Our suppliers adopt technology that reduces energy consumption	1	1	6	120	92	220	4.37	0.609
Our suppliers use environmentally friendly processes	0	1	9	138	73	221	4.28	0.558
Circular Supplier Sourcing							**4.27**	**0.591**

Key: 1 = strongly disagree, 2 = disagree, 3 = Neither agree nor disagree, 4 = agree, 5 = strongly agree

Note. This table was created by the author of this article.

Supply Chain Reconfiguration

The second specific objective of the study was to assess the moderating effect of circular supply chain reconfiguration on the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya. The supply chain reconfiguration construct measured SC flexibility or the degree

to which manufacturing companies can easily modify their SC structure to meet changing needs (Zidi et al., 2022). A 12-item scale was used for this construct. Areas of focus included modular design, circular inputs and sub-products, circular and efficient conversion, and emergency response. The responses to the SCR items are in Table 3.

Table 3: Supply Chain Reconfiguration Variables

Supply Chain Reconfiguration	**1**	**2**	**3**	**4**	**5**	**N**	**Mean**	**S D**
Our organisation uses the modular design of creating an item out of smaller, interchangeable parts or modules.	1	34	8	150	28	221	3.77	0.877
Our sub products and input in production leads to specialization	0	31	9	149	32	221	3.82	0.848
Circular sub-products and input in production enhances operations	1	29	13	151	26	220	3.78	0.837
Circular sub-products and input are easy to source	0	69	20	111	21	221	3.38	1.027
Our organisation manages conversion of circular material i.e., biodegradable material without use of toxic chemicals, to finished products	1	44	9	130	37	221	3.71	0.984
Our organisation has invested in machinery and systems that are used in conversion of input to finish products	1	23	11	137	49	221	3.95	0.854
Our organisation employs professionals who are knowledgeable of the company's production process	1	26	5	124	65	221	4.02	0.912
The conversion of raw material to finished goods in our organisation is effective	1	25	7	141	47	221	3.94	0.859
Our organisation has a laid down structure for adoption in operation	0	26	6	130	59	221	4.00	0.876
Our organisation can quickly diagnose issues within its supply chain	1	25	7	128	60	221	4.00	0.894
There are monitoring teams tasked with ensuring smooth operation of the company	0	26	6	128	61	221	4.01	0.882
Our organisation is quick in responding to emergency situations	1	24	6	133	57	221	4.00	0.874
Supply Chain Reconfiguration							**3.87**	**0.894**

Key: 1= strongly disagree, 2= disagree, 3 = neither agree nor disagree, 4= agree, 5= strongly agree

Note. This table was created by the author of this article.

Manufacturing Performance

The study assessed participants' views of the performances of their organizations using a 12-item instrument. The questionnaire covered various performance aspects, including customer relations, product/service delivery/quality, technology integration, and financial performance. The questionnaire prompted participants to indicate their agreement with each item. Their responses are shown in Table 4. All the 12 items were assessed using positively worded statements. Mean scores were then computed for the items following the procedure outlined previously. The overall mean in the 12 items was 3.82 (SD = 0.911), an equivalent of 76.3%. In other words, on average, participants assigned a rating of 76.3% (high) to their organizations' manufacturing performance.

Table 4: Manufacturing Performance Variable

Manufacturing Performance	**1**	**2**	**3**	**4**	**5**	**N**	**Mn**	**Std D**
Our business has improved because of the trust with customers and suppliers	0	26	7	130	58	221	4.00	0.876
Our organization delivers services to its customers at a reduced cost	1	35	8	141	36	221	3.80	0.914
The integration of technology, people, business, and processes has enhanced our organization's competitive edge in the current digital age	1	21	7	147	45	221	3.97	0.811
Our organisation can provide better products to our customers	1	25	6	146	43	221	3.93	0.844
Our organisation has an Enterprise Resource management system that tracks sales volumes and stock turnover levels which enable the company to reorder with greater accuracy.	1	25	6	149	40	221	3.91	0.835
Our sales and inventory turnover levels are reported and forecasted effectively.	1	2	10	142	40	219	3.89	0.857
Our management of inventory turnover levels helps in managing production schedules	1	24	6	126	64	221	4.03	0.891
Proper management of inventory turnover levels promotes relationships	1	24	7	151	38	221	3.91	0.821
Our company has significant financial reserve to cover all potential needs	3	32	18	140	28	221	3.71	0.912
Our company's profits have increased for the last 3 years.	3	37	17	137	27	221	3.67	0.941
Our overhead costs have reduced for the last 3 years	4	73	14	107	23	221	3.33	1.097
Our company's procurement costs have reduced for the last 3 years	0	39	20	143	19	221	3.64	0.871
Manufacturing Performance							**3.82**	**0.885**

Key: 1= strongly disagree, 2= disagree, 3 = neither agree nor disagree, 4= agree, 5= strongly agree

Note. This table was created by the author of this article.

Hypothesis Testing

Test for Hypothesis One

The first objective of the study was to determine the effect of circular supplier sourcing on performance of manufacturing companies in Kenya. The corresponding hypothesis was:

Ho_1: Circular supplier sourcing has no significant effect on the performance of manufacturing companies in Kenya.

A univariate analysis was therefore conducted to test the null hypothesis. From the model summary findings in Table 5, the r-squared for the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya was 0.437; this is an indication that at 95% confidence interval, 43.7% variation in performance of manufacturing companies in Kenya can be attributed to changes in circular supplier sourcing. However, the remaining 56.3% variation in supply chain performance suggests that there are other factors other than circular supplier sourcing that explain performance of manufacturing companies in Kenya.

Table 5: Model Summary for Circular Supplier Sourcing

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.661[a]	.437	.434	.65924

a. Predictors: (Constant), Circular supplier sourcing

b. Dependent Variable: Performance of manufacturing companies

The ANOVA results for this hypothesis displayed in table 7 showed that the model was statistically significant ($F = 169.855$, $p < 0.001$). This indicates that circular supplier sourcing significantly influences the performance of manufacturing companies in Kenya. The significant F-statistic confirms that the predictor variable, circular supplier sourcing, contributes meaningfully to the model, explaining a portion of the variance in performance. Since the F value is large at 169.855, it indicates that the model explains a significant portion of the variation in the performance of manufacturing companies in Kenya. These findings suggested that as manufacturing companies in Kenya increased their focus on circular supplier sourcing, their overall performance tended to improve. Additionally, the null hypothesis was rejected and the alternative hypothesis was upheld as the p value was below the significant value of 0.05 at 0.000, meaning that means that there is enough evidence to

conclude that Circular supplier sourcing does have a significant impact on performance.

Table 6: ANOVA for Circular Supplier Sourcing

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	73.818	1	73.818	169.855	.000[b]
	Residual	95.177	219	.435		
	Total	**168.995**	**220**			

a. Dependent Variable: Performance of manufacturing companies

b. Predictors: (Constant), Circular supplier sourcing

From the results in Table 7, the following regression model was fitted.

Y (Performance of manufacturing companies)=1.506+0.66X_1 (Circular supplier sourcing)+e

The coefficient results showed that the constant had a coefficient of 1.506 suggesting that if circular supplier sourcing was held constant at zero, performance of manufacturing companies in Kenya would be at 1.505 units. In addition, results showed that circular supplier sourcing coefficient was 0.66 indicating that a unit increase in circular supplier sourcing would result in a 0.660 increase in supply chain performance. It was also noted that the P-value for circular supplier sourcing coefficient was 0.000 which is less than the set 0.05 significance level indicating that circular supplier sourcing was significant. Based on these results, the study rejected the null hypothesis and accepted the alternative that Circular supplier sourcing has a significant effect on the performance of manufacturing companies in Kenya

Table 7: Beta Coefficients for Circular Supplier Sourcing

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.506	.196		7.680	.000
	Circular supplier sourcing	.660	.051	.661	13.033	.000

a. Dependent Variable: Performance of manufacturing companies

Test for Hypothesis Two

The second objective of the study was to assess the moderating effect of circular supply chain reconfiguration on the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya. Moderation happens when the relationship between the dependent variable and

the independent variables is dependent on a third variable (moderating variable). The effect that this variable has is termed as interaction as it affects the direction or strength of the relationship between the dependent and independent variable. To achieve this research objective, the study computed moderating effect regression analysis. Supply chain reconfiguration was introduced as the moderating variable.

Ho_2: Circular supply chain reconfiguration has no significant moderating effect on the relationship between circular supplier sourcing and performance of manufacturing companies in Kenya.

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 (X_1 Z) + e}$$

Where:

Y = Performance of manufacturing companies

β_0= Intercept coefficient or value of dependent variable when the independent variable is zero

β_1= Coefficient for circular supplier sourcing

X_1 = Circular supplier sourcing

β_2= Coefficients for interaction terms between supply chain reconfiguration and circular supplier sourcing

Z = Circular supply chain reconfiguration

e = Error term

Table 8: Model Summary between Circular Supply Sourcing and Manufacturing Performance with the Moderating Variable of Supply Chain Reconfiguration

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.661[a]	.437	.434	.65924	.437	169.855	1	219	.000
2	.684[b]	.468	.463	.64242	.031	12.618	1	218	.000

a. Predictors: (Constant), Circular supplier sourcing

b. Predictors: (Constant), Circular supplier sourcing, Supply chain reconfiguration

Table 8 shows the model summary which has a positive relationship; R= 0.437, between the circular supply sourcing and Manufacturing performance. The combined linear effects of the variables explained 43.7 percent variance in the

management. This implied that management was lowly predictable by the determinant. Additionally, there is the model summary 2 which has a positive relationship; R= 0.031, between the circular supply sourcing and Manufacturing performance with the moderating variable of supply reconfiguration. The combined linear effects of the variables explained 3.1 percent variance in the manufacturing performance. This implied that manufacturing performance was lowly predictable by the determinant with effect from supply chain reconfiguration.

Table 9: ANOVA Table

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	73.818	1	73.818	169.855	.000[b]
	Residual	95.177	219	.435		
	Total	**168.995**	**220**			
2	Regression	79.026	2	39.513	95.742	.000[c]
	Residual	89.969	218	.413		
	Total	**168.995**	**220**			

a. Dependent Variable: Manufacturing Performance
b. Predictors: (Constant), Circular Supply Sourcing
c. Predictors: (Constant), Circular Supply Sourcing, Supply Chain Reconfiguration

Table 9 shows the test of significance of the model using ANOVA between Circular supplier sourcing and Manufacturing performance. There are a total of 220(N-1) degrees of freedom. With 1 predictor variable, the regression effect has 1 degrees of freedom. The regression effect was statistically significant; F (1,219) =169.855, p=.000). The test of significance of the model using ANOVA between Circular Supply Sourcing and Manufacturing performance with the moderating variable of Supply Chain Reconfiguration. There are a total of 220(N-1) degrees of freedom. With 2 predictor variables, the regression effect has 2 degrees of freedom. The regression effect was statistically significant; F (2,218) =95.742, p=.000).

Table 10: Regression Analysis between Circular Supplier Sourcing and Manufacturing Performance with the Moderating Variable of Supply Chain Reconfiguration

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.506	.196		7.680	.000
	Circular Supplier Sourcing	.660	.051	.661	13.033	.000
2	(Constant)	1.751	.203		8.620	.000
	Circular Supplier Sourcing,	.716	.052	.717	13.822	.000
	Supply Chain reconfiguration	.142	.040	.184	3.552	.000

a. Dependent Variable: Manufacturing Performance

Table 11 shows that out of the 1 predictor that displayed significant relationships, Circular supplier sourcing (β=.660, p<.05) had a higher influence on the criterion variable. This implies that a change in one unit (going up) of a predictor, Manufacturing performance, is predicted to go up by the standardized β-value shown in Table 10. For instance, if Circular Supplier Sourcing, which had a higher influence, goes up by 1-unit Manufacturing performance goes up by .660. Further, by substituting the beta values as well as the constant term from the coefficient's findings for the first step regression modelling, the following regression model will be fitted:

$Y = 1.506 + 0.660\ \mathbf{X_1}$

Where $\mathbf{X_1}$ is Circular Supplier Sourcing

The second model in Table 10 shows that out of the 1 predictor that displayed significant relationships, Circular Supply Sourcing (β=.716, p<.05) had a higher influence on the criterion variable with Supply Chain reconfiguration (β=.142, p<.05) having a positive influence on the criterion variable as a moderating variable. This implies that a change in one unit (going up) of a moderating variable, the predictor goes up, Manufacturing performance is predicted to go up by the standardized β-value shown in Table 4.8. For instance, if supply chain configuration influences positively the Circular Supply Sourcing goes up by one unit influencing Manufacturing performance by going up by .716.

By substituting the beta values as well as the constant term from model 2 emanating from the second step in regression modeling the following regression model was fitted:

$$\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 (X_1 Z) + e}$$

$$\mathbf{Y = 1.751 + 0.716\ X_1 + 1.42(X_1 Z)}$$

Where:

Y = Performance of manufacturing companies

β_0= Intercept coefficient or value of dependent variable when the independent variable is zero

β_1= Coefficient for circular supplier sourcing

X_1 = Circular supplier sourcing

β_2= Coefficients for interaction terms between supply chain reconfiguration and circular supplier sourcing

Z = Circular supply chain reconfiguration

e = Error term

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The study sought to establish the effect of circular supplier sourcing on the performance of manufacturing companies in Kenya. The study found a strong positive relationship between circular supplier sourcing and performance of manufacturing companies in Kenya. Further, the relationship between circular supplier sourcing and the performance of manufacturing companies was found to be significant. This suggests that their overall performance improved as companies increased their focus on circular supplier sourcing. The study revealed that moderate companies have a sourcing policy in place and that their supplier selection is based on compliance with their standards and policies. The suppliers selected are reliable in terms of conforming to the quality of materials and products required and any feedback on areas of improvement is usually shared with the suppliers and when necessary, they educate them on the requirements needed. Additionally, moderate suppliers have circular model values and metrics together with environmental certifications, but most of the suppliers adhere to the contracts with the companies involved.

Conclusion

The study concludes that circular supplier sourcing has a positive and significant effect on performance of manufacturing companies in Kenya. Based on the findings it was revealed that supplier reliability, supplier contracts and supplier innovation influences performance of manufacturing companies in Kenya. This implies that a unit improvement in circular supplier sourcing would lead to improvement in performance of manufacturing companies in Kenya.

Recommendations

Manufacturing companies in Kenya should emphasize implementing circular supplier sourcing practices as a critical strategy to enhance performance. By integrating these practices, firms can reduce waste, improve resource efficiency, and meet growing consumer and regulatory demands for sustainability. Additionally, these practices can enhance supplier relationships and create competitive advantages by aligning with global trends in circular and sustainable manufacturing. Further, when reconfiguring supply chains to support circular supplier sourcing, companies should carefully evaluate the scope and potential effects of these changes. In this case, companies must assess the financial and operational impact of these changes while ensuring they do not compromise supply chain effectiveness and trust between the companies involved. Besides, conducting pilot programs, collaborating with stakeholders, and leveraging digital tools for data-driven decision-making will help the companies achieve the desired balance.

To build upon the findings of this study, the following further research areas are suggested: The study was limited to the variables: circular supplier sourcing practices with supply chain reconfiguration as a moderating variable. The study recommends that similar studies be conducted with the inclusion of other circular supply chain management practices variable and with a different moderating variable. Future research should also focus on a longitudinal study to assess the long-term effects of circular supplier sourcing practices on the performance of manufacturing companies in Kenya.

Additionally, to enhance the quality and impact of the paper, it is suggested that future research incorporate a mixed-methods approach, combining quantitative data with qualitative insights from industry practitioners. This could provide a richer understanding of the barriers to implementing circular supplier sourcing practices and the contextual factors influencing performance. It is also good to note that the study focused on the entire manufacturing

industry. Although the industry was selected as it is one of the largest sectors in the country, a comparative study of circular supply chain management practices across various industries in Kenya could help identify sector-specific challenges and best practices in circular economy implementation. Furthermore, other comparative studies touching the different sectors of the manufacturing industry in Kenya can be conducted to add on more knowledge of the industry.

Emerging Issues and Controversies

Integration of Circular Economy Principles into Supply Chains: Integrating circular economy (CE) principles into traditional supply chains remains a significant challenge for many manufacturing companies. While circular sourcing offers clear sustainability benefits, such as waste reduction and resource efficiency, many organizations continue to operate under linear models of production and consumption. Transitioning to a circular model requires substantial investments in redesigning products, altering supply chain infrastructure, and establishing new supplier relationships. However, the lack of reliable circular suppliers, adequate recycling technologies, and supporting infrastructure presents a major hurdle. As companies strive to adopt circular sourcing practices, they often face resistance to change from stakeholders who are entrenched in traditional, linear supply chain operations, thus hindering the shift to a more sustainable approach.

Cost and Economic Viability: A major point of controversy surrounding circular supplier sourcing is the economic feasibility of adopting circular practices. Critics argue that the transition to circular supply chains often incurs higher upfront costs due to the need for new technologies, redesigning products for recyclability, and sourcing from specialized suppliers who can meet circular economy standards. These costs can include investments in recycling infrastructure, collection systems, and research and development to develop new circular processes. While the long-term benefits of circular supply chains, such as resource efficiency and lower waste management costs, may outweigh these initial expenses, the financial pressure to generate immediate returns often forces companies to prioritize short-term profits over sustainability. Therefore, achieving an economically viable circular model remains a contentious issue.

Supplier Reliability and Performance: The reliability and performance of circular suppliers present a significant challenge in the implementation of circular supply chains. Many traditional suppliers are not yet equipped to meet the stringent requirements of circularity, such as ensuring that products can be easily recycled or repurposed. This raises concerns over the quality and consistency of materials sourced from circular suppliers. For instance, recycled materials may not always meet the same performance standards as virgin materials, and suppliers may struggle to meet the demand for high-quality, circular inputs. Manufacturers must therefore carefully evaluate the performance of circular suppliers, which may involve establishing new quality

control measures and supplier selection criteria that consider both sustainability and reliability, thus complicating the sourcing process.

Consumer Demand and Market Acceptance: Although there is a growing awareness of sustainability issues among consumers, the demand for products created through circular supply chains is still uncertain. One of the major controversies is whether consumers are truly willing to pay a premium for products made with recycled or repurposed materials. While some studies suggest that consumer preferences are shifting toward more sustainable products, price sensitivity remains a key factor. Many consumers still prioritize cost over sustainability, especially in emerging markets where price competition is intense. Furthermore, the lack of consumer education on the benefits of circular products adds to the challenge, as many people may not fully understand or appreciate the environmental advantages of purchasing circular goods. As such, manufacturers must carefully navigate market readiness while trying to align circular sourcing with consumer expectations.

Regulatory and Policy Frameworks: The lack of uniform regulations governing circular sourcing is a major point of controversy. Regulatory frameworks for circular economies vary significantly across different regions, which creates inconsistency in how circular supply chains are developed and operated. In some countries, regulations may incentivize recycling and the use of renewable materials, while others may lack clear guidelines on circular practices. This regulatory fragmentation makes it difficult for companies to implement circular supply chains at a global scale, as they must navigate a patchwork of local regulations and compliance standards. The absence of consistent, international standards also complicates supply chain coordination and increases the risk of non-compliance, further deterring companies from adopting circular sourcing practices.

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The Impact of Geopolitical Factors on Global Oil Prices and Supply Chain Sustainability

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Abstract

Purpose: This paper assessed the effects of political stability and trade sanctions on SCSC; with references to the Russo-Ukraine war ordeal, Iranian SCSC under sanctions, and SCSC under the oil embargo. Trade restrictions, environmental policies and other regulatory factors have an impact on energy trade by increasing the volatility of the global energy market and the inefficiency of supply chains.

Methodology: In this study, secondary source of data collection was employed by extracting information from government documents, journals specializing in oil industry and academic database to evaluate the economic and policy effects of changes in the oil market.

Findings: It is found out that supply influences oil price fluctuations resulting from geopolitical crisis such as wars, trade policies and regulation initiatives, economic sanctions, piracy and terrorism, and political instability. Nonetheless, restrictions like embargoes significantly impact oil trade, hence adversely affecting supply chain operations and associated costs. Furthermore, environmental policies are altering the nature of supply chain resilience through carbon regulations, fluctuations in energy availability, and the imposition of emission capacity limitations that are disadvantageous for oil-dependent nations.

Unique Contribution to Theory, Policy and Practice: It was suggested that both the governments and the economies which rely heavily on oil put more relaxed measures in place in an attempt to counter the challenges of the oil supply chain fundamental to the environmental as well as the trade policies. That is why future research should investigate the problems of real-time monitoring of geopolitical risks and the impact of digitalization of the oil market on a more distant outlook.

Keywords: *Geopolitical Risk, Oil Price, Energy Supply, Trade Sanctions, Energy Security*

INTRODUCTION

The global oil market is a vital component in sustaining wealth, supporting industry, and enhancing international commerce. Nonetheless, the supply and demand of oil and stamina might be seen as pressing issues now, primarily due to uncertain geopolitical conditions. This research consequently examines several elements, including supply-demand dynamics, production policies, speculation, and political upheavals. Conversely, supply chain sustainability in the oil sector pertains to the stability and ongoing nature of the logistics that facilitate the procurement, transportation, and distribution of energy, particularly when disruptions arise from geopolitical factors (Carnazza and Cappelli, 2025). Given the efficiency and interconnectedness of energy markets, geopolitical conditions have emerged as a primary factor influencing oil prices and supply chain vulnerabilities.

The subsequent factors that affect the dynamics or condition of the oil market are as follows: Primarily, crude oil is the most vital commodity in the energy sector; hence, variations in crude oil prices influence the stability of global economies in both producing and consuming nations (Niknami, 2024). This is due to OPEC+ controlling supply via production targets and quotas, hence possessing the ability to influence pricing. External shocks, such as trade barriers, sanctions, embargoes, and geopolitical issues, have intermittently impacted energy markets, thereby influencing oil prices in economies that are entirely reliant on them (Struk and Hurnyak, 2024).

Another element of the oil market component is the transition to alternative energy sources and sustainable energy policies. Various nations have enacted policies such as carbon taxes, subsidies for renewable energy, and regulatory frameworks to diminish the reliance on fossil fuels. They present enduring hazards to oil-exporting countries due to alterations in consumer behavior patterns within global marketplaces (Yılmaz and Bozdemir, 2024). Nevertheless, crude oil remains a crucial energy source, and its logistical reserves are subject to political influences.

This study eludes that energy security is contingent upon geopolitics, including trade connections, organizational affiliations, and resource availability. Social uncertainties, political hazards, and the organization of armed forces are critical factors in the production, transportation, and marketing of oil, as noted by Madubuko (2024). Countries dependent on imported energy are expected to be substantially affected by concerns such as power conflicts, trade restrictions, or economic penalties (Wen, 2024).

Energy security refers to the assurance of a sufficient and consistent supply of oil, particularly in times of potential disruption. Currently, oil-exporting nations use their resources as geopolitical instruments, manipulating output and policies to influence market dynamics more significantly than the market itself (Nassar and Azzi, 2024). The oil-importing nation aims to diversify its oil supply sources, invest in energy infrastructure, and engage in diplomacy to mitigate risks associated with instabilities.

Given the global pursuit of more energy supplies, it is implausible to assert that geopolitical factors will exert no influence on the supply and pricing of oil. Variations in worldwide political status, along with alterations in oil production regulations and initiatives for energy resource diversification, will dictate the future trajectory of the oil market.

Problem Statement

The international oil sector encounters elements such as political risks and instabilities, trade policies, and energy regulations that influence oil prices and the entire supply chain of the oil business (Niknami, 2024). Geopolitical risk constitutes a component of market risk; hence, there are no stability considerations for either exporting or importing nations. Although various opinions exist regarding the factors influencing oil prices and the impact of geopolitics on these prices, the effects of unforeseen variables on the stability of oil prices and the configuration of the liquefied supply chain have not been addressed in previous literature (Madubuko, 2024). The current literature places considerable emphasis on short-term fluctuations due to prevalent conflicts and trading restrictions, yet there is limited attention to the ability to establish sustainable global oil supply sources amid enduring geopolitical risks (Carnazza and Cappelli, 2025).

Although numerous studies examine volatility in oil markets and its dynamics, none concentrate primarily on economic and market aspects while disregarding geopolitical influences on energy markets (Struk and Hurnyak, 2024). The literature review on political instability and wars elucidates the immediate implications of these factors on the oil market; thus, insufficient attention has been devoted to their long-term impact on supply chain sustainability (Bozdemir, 2024). Thus, trading practices, diplomatic ties, and settings have been analyzed independently as factors contributing to the volatility in oil prices and energy supply chains (Ogugbuaja and Willies, 2024).

The unpredictability in global oil markets precipitates significant fluctuations in the economic and strategic importance of countries that either export or import oil. Consequently, political instability, conflict, and trade restrictions affect fluctuations in oil output, inflation, and energy insecurity (Wen, 2024). Conditions such as the OPEC+ agreements and sanctions govern the oil supply in the worldwide market, establishing a dependency among countries, as noted by Nassar and Azzi (2024). Energy policies and environmental restrictions introduce additional risks to the supply chain, prompting governments to consider critical considerations regarding economic benefits, climate change objectives, and various connections (Struk and Hurnyak, 2024). To formulate energy policy, prepare for energy stability, assure oil price stability, and secure supply, all relationships must be comprehended.

Objectives

i. To analyze the impact of political instability and global oil prices and supply chain sustainability
ii. To evaluate how trade policies, sanctions, and international relations influence global oil prices and supply chain sustainability
iii. To examine the effects of energy policies and environmental regulations global oil prices and supply chain sustainability

LITERATURE REVIEW

Theoretical Review

Resource Dependence Theory (RDT)

Resource Dependence Theory, formulated by Pfeffer and Salancik (1978), posits that all organizations, whether industrial entities, sector-specific organizations, or nations, necessitate external resources to operate efficiently. The theory posits that entities are unable to evade power dynamics, negotiate international trade, or mitigate risks associated with external resource-related shocks. RDT has been applied in supply chain management to assess how organizations prepare for issues that may cause disruptions in the political environment. It has also been utilized in the energy sector to assess how nations position themselves regarding energy policies in an effort to diminish their dependence on unpredictable oil-exporting countries. RDT effectively elucidates trade relationships, the establishment of economic partnerships, and policy-induced changes; yet, it fails to account for shocks that alter the spatial dynamics of oil markets. This study utilized RDT to ascertain the methods and frequency by which trade policies, market sanctions, and supply chains

influenced the oil market, aimed at analyzing political stability, global oil prices, and energy transition policies.

Geopolitical Risk Theory (GRT) - Caldara and Iacoviello (2018)

The Global Risk Theory (GRT) was initially presented by Caldara and Iacoviello (2018) as an indicator of the global market's volatility stemming from political instability, violence, trade restrictions, and diplomatic difficulties. The idea is employed to compare the impacts of warfare, diplomacy, and international politics on commodities markets within the social, economic, and energy sectors. It has also been utilized in the examination of fluctuations in oil prices, where it is acknowledged that market credit, trading, and supply chain disruptions escalate with heightened geopolitical concerns. The efficacy of GRT lies on its capacity to measure geopolitical risk and allocate the resultant detrimental effects on trading and investment strategies. Nonetheless, it must be acknowledged that the theory does not invest much effort in demonstrating that market issues and crises can be resolved in the long term. In this context, GRT was employed to ascertain the correlation with the study's objectives concerning trade sanctions, energy sustainability, and economic stability in relation to political instability and trade restrictions within oil supply chains, significant oil price volatility, and the influence of the subject on the development of energy policies.

Empirical Review

Political Instability, Global Oil Prices and the Sustainability of Supply Chains

In their study, Daghighiasli et. al., (2024) elucidated how government stability, socio-economic conditions, and geopolitical risk affected short-term crude oil prices and the supply chain of oil-exporting nations in the Middle East and North Africa, using a quantitative research design, with secondary data collected from international energy organizations, relevant websites, economic considerations, and OPEC production records, upon which regression models were applied. The result suggested that stable nations enjoyed a consistent oil supply, but unstable ones saw fluctuations and disruptions in oil prices. The report advocated for the diversification of the economies of oil-exporting nations, enhancement of energy diplomacy, and the formulation of contingency strategies regarding energy and insecurity.

Khalilnezhad and Eslamloueyan (2024) examined strategies and efforts about the stability of oil prices following geopolitical problems and the onset of

COVID-19, applying Keynesian Economic Theory to analyze how government interventions influence stability in oil-dependent developing countries within the Middle East and North African (MENA) area, and qualitative assessment of change through applied research utilizing statistical methods and expert interviews to government policymakers, economists, and corporate people within the energy sector. The result turned out that nations with prudent fiscal management saw more rapid and significant recovery from declining oil prices compared to those that deteriorated financially. It is advisable for governments to disclose their accounts, increase financial reserves for emergencies, promote cross-border energy commerce, and formulate sound economic policies to address market concerns in the oil sector.

Zhao et. al., (2024) In their study article titled, 'Does Political Instability Affect Energy Policies and Oil Prices?' aimed to analyze the relationship among political stability, energy policies, and oil prices concerning major producers, specifically the US, China, and the EU, as well as consumers, applied cross-sectional study design to investigate political instability and regulatory changes in the oil industry from 2015 to 2024; focusing on energy regulators, oil trading firms, and policymakers. They used integrated theoretical and expert data on oil prices and found out that political discord and trade restrictions contribute to the fluctuation of oil prices by elevating supply chain risks. The report additionally advised that governments should formulate effective energy policies, strengthen trade relations, and invest adequately in stable energy sources.

Trade Policies, Sanctions, Global Oil Prices and Supply Chain Sustainability

Niknami (2024) tested the effects of EU sanctions on Russia's petroleum sector, pinpointing trade processes, pricing, and supply chain commotions from 2022 to 2024. In light of international trade theory, the study applied quantitative methods to device the economic effects of reactive actions by means of secondary data sources such as EU trade reports, government reports, and OPEC statistics. Studies specify that sanctions have reduced Russian oil exports, scaled up European energy prices, and routed Russian supplies into Asian marketplaces. The study suggested that European policymakers diversify energy sources, enhance trade partnerships, and de-politicize politically sensitive oil suppliers to achieve supply chain efficiency and market stability. These findings highlight the critical intersection of sanctions, trade policy, and global energy security.

Also, Zhilina et al. (2024) appraised the role of sanctions and energy disparity on the oil market of Europe and Eurasia, with interest on political and economic intricacies in resource supply. They described supply chain disruption, e.g., US-Iran embargo, through qualitative study of nationwide energy adaptation to trade embargos by use of Energy Market Equilibrium Theory. Focus was on policymakers, trade regulators, and energy-reliant industries by using skilled decision to get the views of experts, and the mined data comprised trade treaties, global energy policy, and case studies of sanctioning regions. It is found out that sanctions made oil-importing nations shift to alternative energy sources, increasing the cost of imports and changing international trade balances. Desired action are flexible trade policies, diversified energy mixes, and increased cooperation for energy security.

Meanwhile Talus (2024) scrutinized the influence of international energy regulations and sanctions on the petroleum business, value chains, and market context and conditions, with geographic focus areas in the United States, Europe, and the Middle East. Based on institutional and legal theory, the study inspected policy design in energy commodity markets and reflected on role of trade policy in influencing energy security as a doctrinal method. Pointing to policymakers, trade regulators, and industry planners, evidence was collected from sanction-related laws, trade policies, and legal documents. The result is that sanctions puts legal hurdles on oil-exporting states, which recommends new regulatory actions and preparations of law. Thus, international energy trade conventions to match new political and economic settings so as to realize market strength and energy security that is sustainable is advised.

Energy Policies, Global Oil Pricing and Supply Chain Sustainability

Sarkodie et al. (2025) explored the effect of biofuel policy on oil price strength and supply chain management in Ghana via Energy Policy Transition Theory to study the change from fossil fuels to renewables. The study, which was based on six years of economic data, investigated how energy policy influences oil markets in developing economies, mainly government agencies, energy sectors, and renewable investors through purposive sampling. Policy steps, reports, and macroeconomic indicators' figures were surveyed in regression models besides content analysis. Results indicate that biofuel policy can alleviate oil prices locally as well, rally investment to fuels spawned with renewability. Thus, regional support, global promotion of biofuels, and green energy regime-building to strengthen chain markets and strengthen energy security is required.

However, Ahani and Dadashpoor (2025) studied performance of energy policy in Tehran under oil demand, price fluctuations, and supply management, using the Spatial Energy Economics Theory and Grounded Theory technique, they hypothesis-tested the level to which policy by government, infrastructure, and urban planning impacts oil use. Urban planners, energy experts, and regulators were the target of sampling, upon which reliance on government reports, municipal energy policy plans, and expert interviews depended. Results showed that eco-friendly urban energy policies improve general supply chain long-term efficacy but unreliable policy realization causes short-run commotions. In their approval, the authors endorse promoting energy conservancy, presenting severe regulations to metropolitan cities, and upholding green energy sources as a means to enhance stable provision and long-term sustainability in urban energy.

Consequently, Li (2024) studied China's oil price and supply chain steadiness with emphasis on energy policy, subsidies, and policy variation based on Macroeconomic Energy Market Theory. Applying quantitative approach, the study explored the government's intrusion in oil pricing and its influence on market stability. With energy policymakers, economists, and corporate planners constituting target audience, the data were mined built on a systematic sample approach and analyzed through time series econometric models. Studies pointed that while subsidies alleviate domestic oil prices, they dislocate supply chains and sway global market volatility. The study recommended developing multidimensional policy and directed investment in green energy to safeguard a bearable transition, shaping long-term stability in the Chinese energy industry and decreasing dependence on instable oil price apparatuses.

Evaluation of Current Literature

Scholars and researchers have conducted studies to understand the impact of geopolitical threats on global oil markets; nonetheless, several gaps have been observed. There is a deficiency of conceptual studies, as the majority of research focus on short-term issues, such as conflicts and sanctions, which affect oil price fluctuations and supply chain risks, neglecting long-term consequences (Niknami, 2024). Additionally, there are apprehensions about the association between certain energy security measures and minor regional conflicts, which may contribute to the volatility of oil prices.

Fundamentalist methodologies are employed for oil price forecasting; nevertheless, while they estimate prices based on supply-demand theories, they

are frequently influenced by political issues in numerous instances (Li et al., 2024). Some models indicate that price direction is influenced by adjusted OPEC production, while others contend that price swings are driven by speculation. This volatility adversely affects the policies governing the development processes of oil-importing nations, as indicated by the findings of Sarkodie et al. (2025).

Nonetheless, supply chain sustainability frameworks are not without issues, as several studies focusing on these frameworks predominantly prioritize logistics and infrastructure over policy intervention (Ahani and Dadashpoor, 2025). The impact of trade sanctions, energy transition policies, and carbon taxes on the long-term supply prospects of oil has been insufficiently examined in study. Future study may focus on the advanced development of geopolitical, comparative, economic, and trade policy frameworks to investigate the sustainability potential within the oil market.

Contextual Discrepancy, Methodological Discrepancy and Theoretical Discrepancy

Prevailing research on oil markets emphases on gigantic Middle Eastern, Russian, and North American manufacturers at the cost of the economic bearing on African, Latin American, and Asian oil-importing realms (Niknami, 2024). Moreover, studies have a propensity to relate econometric regression models to estimate oil prices without respect to unending geopolitical proceedings and policy changes (Li, 2024). Major studies are alarmed with supply and demand factors while disregarding the role of political instability, environmental policies, and energy security mechanisms (Sarkodie et al., 2025; Ahani and Dadashpoor, 2025). Thus, to address these deficiencies, this research syndicates Geopolitical Risk Theory, Resource Dependence Theory, and environmental policy paradigms to offer a more comprehensive opinion of the sustainability of the world oil market and the dynamic trade system.

METHODOLOGY

Research Design

This research employed secondary analysis, evaluating literature, reports, studies, and data concerning geopolitical threats, global oil prices, and supply chain sustainability. Desk research was suitable as it included compiling several studies, policies, and reports previously conducted by other researchers, governments, and industries, along with doing a review. The selected methodology allowed the research to leverage historical oil price

trends as a benchmark for identifying price patterns and to incorporate real-time analytical insights regarding specific geopolitical events and the energy policy environment, which would have been more suitable compared to alternative methodologies (Baig et al., 2022).

Methods of Data Collection

This research employed solely a secondary research method, utilizing data from numerous academic databases, research reports, government publications, etc., to assess the influence of geopolitical threats on oil prices and the supply chain. Consequently, the subsequent datasets pertaining to access to professional articles, dissertations, and conference papers were utilized in relation to energy regulations, trade restrictions, and supply chain disruptions.

Additionally, secondary sources like the IEA's annual report, OPEC annual report, EIA, and World Bank were utilized to assess petroleum output, market fluctuations, policies, and pricing (Islam et al., 2024). Papers published prior to 2022 were excluded for failing to meet the criterion concerning the geopolitical influences on energy markets. Furthermore, papers that contained hypotheses, biased data, or limitations in methodological rigor were disregarded. This facilitated the examination of the work against the most recent data and policy-oriented literature in the specific domain.

This study employed thematic and comparative analyses to examine qualitative findings regarding geopolitical threats, fluctuations in oil prices, and supply chain vulnerabilities. Furthermore, the comparison was conducted to analyze the geopolitical impact on diverse regions, their economies, and the energy industry. This approach offered further context on the variations and disturbances in pre- or post-crisis oil pricing and supply chain logistics, grounded in policies (Su et al., 2021).

Constraints of the Research

This research was based on secondary data and so its validity depended on the original writers, and while supportive in market and historical context, is not accurately illustrative of existing geopolitical transferals in oil supply. To add on, political unrest, evolving energy policies, and technology augment fluctuating long-term effects, which demands ceaseless revision and dynamic estimates in follow-up studies.

FINDINGS

Influence of Political Instability on Oil Prices

Conflicts, Sanctions, and Price Fluctuations (Case Studies: Russia-Ukraine, Iran Sanctions)

War, economic sanctions, and other factors that disrupt the supply and demand equilibrium of oil are classified as political risks. The initial two rises were ascribed to the Russia–Ukraine conflict that commenced in 2022, resulting from supply chain disruptions, rapid sanctions on Russian oil exports, and energy volatility in Europe (Nassar and Azzi, 2024). In this dispute, Western nations restricted Russia's access to sell its oil through preferred channels, including China and India, resulting in a market shift in Europe (Van de Graaf, 2023). The numerous consequences of European and American sanctions on Iran's oil industry are evident in elevated oil prices and trade restrictions, which have compelled Iran to become an oil dealer, particularly with allies such as China. Their actions have impacted the limited supplies, the speculations, and the market instability that was apparent during the previous lockdown of the most prominent oil-exporting nations (Olisah et. al., 2024).

Additionally, market expectations and risk differentials typically result in an increase in oil prices during instances of political instability. Following the invasion of Ukraine by Russia, Brent crude oil prices surged above $120 per barrel, marking a period of significant volatility (Volynets, 2024). This was attributable to an unpredictable future energy landscape constraining Russian production capacity, alongside anticipated volatile global oil prices. Additionally, OPEC+'s policy initiatives concerning output led to price volatility, as the cartel sought to regulate global supply in response to varying demand influenced by geopolitical and other factors (Maghdid et. al., 2023).

Effects of Coups and Political Turmoil on Supply Chain Logistics

Political coups and local market uncertainty in OIP (Overall Increase and Production) nations undeniably impact the supply chain, pricing, and investment outflows. Disruptions in oil delivery across African nations, including Sudan and Libya, have been impeded by various factors associated with military intervention and transportation risks (Engebretsen, 2022). For example, concerns regarding the security of energy infrastructure have emerged following the 2023 coup in Niger, as it is integral to the West African oil pipeline systems (Yılmaz, 2023).

Similar to the aforementioned situation in Venezuela, this nation is undergoing political turbulence that has resulted in significant mismanagement, diminished investment, and reduced oil output due to sanctions and civil unrest. The issues are defined by the nationalization of oil businesses and politically unstable relations with Western nations, which have impeded infrastructure investment, so constraining supply chains and limiting export potential for expansion. Moreover, political instabilities in regions such as Iraq and Syria have adversely affected transportation links to other places, hence increasing operational costs for refiners and traders (Sielker and Dannenberg, 2025).

A critical element of a turbulent supply chain is the threat to the security of trade routes, together with the limitations arising from instability inside specific countries. Particular risks linked to supply routes encompass piracy and terrorism, notably in the Straits of Hormuz, Red Sea, and Gulf of Guinea, which have historically endangered transit through these regions, thereby increasing transportation and insurance costs for oil supply. These interruptions impact the reliability of nations that consistently deliver oil, a feature that intensifies market price volatility.

Politics is a significant element influencing international oil pricing and the reliability of the supply system. Political dynamics, economic conditions, warfare, economic sanctions, and the recent political coup influence supply chains, thus heightening the price volatility of commodities. Currently, Russia's invasion of Ukraine, sanctions on Iran, and coups in Africa exemplify how political instabilities affect oil supply inventories, recalibrate energy market prices, and reshape investments in energy security. Addressing these geopolitical concerns necessitates the implementation of more adaptable energy strategies, diverse supply sources, and enhanced buffer policies, as the repercussions of political disruptions on the oil market could be catastrophic.

Trade Regulations and Oil Supply Chain

Impact of OPEC+ Agreements on Price Stability

The OPEC and its allies, commonly known as OPEC+, play a crucial role in regulating and stabilizing oil supply in the global market. OPEC+ agreements also emphasize supply allocations to ensure oil price stability amid demand fluctuations and geopolitical factors (Taghizadeh-Hesary et. al., 2023). Proposed OPEC+ limits for this year and the next are certain to elevate prices, so confirming the mechanical impact of supply-side measures on global market stability (Vandyck et al., 2023).

OPEC+ moderates the extent of production adjustments to enhance demand and supply stability, so addressing both declining and surging oil prices (Hajiyev et. al., 2023). However, their geopolitics leads to members not rigorously adhering to market quotas, resulting in increased risk. In early 2023, Russia provided a partial uncertainty to the OPEC+ perceptions, so doubting the unity of the new cooperative framework and inducing short-term price instability (Roeben, 2024).

The current economic sanctions imposed on several member countries, including Iran and Venezuela inside OPEC+, consistently disrupt market supplies (Ibrahim, 2023). Even fossil fuel organizations like OPEC are affected by the Paris Climate Agreement, which diminishes long-term demand for fossil fuels owing to the transition to sustainable energy. These dynamics illustrate the equilibrium that OPEC+ must attain to establish a sustainable oil price, which is influenced by both demand and geopolitical factors.

Effects of Trade Restrictions and Embargoes on International Oil Commerce

Trade policies, sanctions, and the establishment of embargoes significantly influence global oil markets and the wider economy. Authoritarian governments utilize oil export and import prohibitions and quotas as geopolitical instruments, affecting energy accessibility, availability, and price stability (Zhang et al., 2023). Western nations implemented sanctions following the Russia-Ukraine conflict, which necessitated a reconfiguration of maritime oil trade and concurrently elevated oil prices throughout 2022 (Vandyck et al., 2023).

The United States similarly constrained Iran and Venezuela's capacity to sell its crude oil through normal international market routes, compelling them to associate their oil with secondary and tertiary entities such as China and India (Roeben, 2024). Similarly, the EU's policy to progressively reduce the importation of Russian crude oil and oil products has intensified rivalry in the quest for alternative oils in the global market, hence affecting oil price ranges (Farah and Cima, 2024).

Likewise, the policies of exporting nations, including oil-exporting countries like Saudi Arabia and the UAE, have further constrained the supply chain due to geopolitical challenges and economic limitations. This encompasses transportation expenses and insurance fees for crude oil, along with storage costs, which have further increased the financial burden on global refiners and customers (Ibrahim, 2023).

However, these trade policies possess politico-geo-economics repercussions rather than only addressing 'price volatility concerns' over long-term energy supplies and associated hazards. Oil-importing nations are diversifying their energy sources by augmenting investments in renewable energy, innovative cooperation, and supply chain management (Taghizadeh-Hesary et al., 2023).

OPEC+ and protective measures significantly influence the structure of oil supply and pricing. OPEC+ aims to regulate oil production to stabilize prices; nevertheless, trade relations, policies, and prohibitions counteract this objective. The relationship between oil-exporting nations and their obligatory Western consumers, characterized by the fear of war and sanctions, and the ongoing pursuit of resource and market diversification, underscores the unique nature of the industry. In the future, these policies should aim to ensure energy demand and bolster economic stability, considering the supply of oil and resource availability amid uncertain global politics.

Sustainability Challenges in Energy Supply Chains

Regulatory Obstacles Impacting Supply Chains

The energy supply chain faces significant regulatory risk stemming from government regulations related to emissions trading and energy generation. The unpredictability in the energy sector and politics has led to goal incongruities, contractual issues, and disruptions in the oil markets (McKinsey and Company, 2025). Carbon taxes, emission reduction regulations, and renewable energy mandates diminish the competitiveness of traditional fossil fuel supply chains in the market (Lavanya, 2024). The EU's carbon border adjustment mechanism (CBAM) levies tariffs on imported commodities with high carbon emissions, hence altering the geography of complex energy supply chains (Kirnats et. al. 2024).

It also raises the subject of the evolving dynamics in the relationship between resource-rich countries and others. Russia and Iran face challenges in exporting, reducing, or regulating pricing, which impact their supply chains and necessitate engagement with markets beyond the Western world (Fathi et al., 2024). The expense of adhering to efficiency standards or clean fuel regulations imposes an additional strain on oil producers, hence impacting trade balance and supply chain flexibility. These concerns underscore the necessity for energy-dependent economies and corporate entities to adapt in relation to market supplies.

Environmental Policies Altering Market Dynamics

Recent economic shifts and energy resource consumption have reaffirmed environmental sustainability as the primary driver of the energy supply chain. Currently, the government and international agencies are actively promoting the transition from fossil fuels to renewable energy in response to climate change (Lavanya, 2024). Policies such as the Paris Agreement, carbon neutrality, and the utilization of renewable energy sources are compelling oil-dependent economies to transition from the conventional oil supply chain business model (Kirnats et al., 2024).

Market behavior may also shift due to investor actions and the rising consumer demand for green energy. Institutional investors and multinational corporations are increasingly moving away from traditional energy sources and prioritizing sustainable supply chain models that are environmentally friendly and compliant with legal standards (Fathi et al., 2024). Consequently, there has been a prolonged pattern of flat or negative investment in new fossil fuel production capabilities, raising several worries over the sustainability of oil supply in international markets. Moreover, contemporary energies are being utilized by energy companies, including Blockchain and intelligent AI-driven supply chain and carbon tracking systems (Agostinho and Zucaro, 2025).

Simultaneously, appropriate regulations can address certain pricing or organizational/instrumental elements in the physical shift to climate-friendly energy systems. The sluggish growth of renewable energy markets has resulted in a limited stock of intermediate suppliers, hence affecting the volatility of energy and oil prices. Concerning the future dynamics of energy security, sustainability is a crucial component, and the unpredictable regulatory changes have resulted in the diversification of the energy industry.

Regulatory variables and policies significantly influence sustainability issues in the energy supply chain. Energy transformation sources arise from climate policies aimed at eliminating carbon emissions, but long-term energy transition processes present several hazards, costs, and disruptions to supply chain management. This paper examines the comprehensive impacts of the transition to green energy, including alterations in the market, investment, management, and global trade. Authorities and industry leaders in supply chain management must implement measures to ensure energy security while also achieving sustainability objectives.

Comparison of Findings with Existing Research

Consistency or Discrepancies with Prior Research

Consequently, the study aligns with prior empirical research indicating that geopolitical concerns significantly affect oil prices and, consequently, the viability of maintaining and sustaining supply chains. Previous studies indicate that wars and sanctions result in price increases and affect the supply of oil in the global market, alongside contributing to political instability (Ngo et. al., 2024). For example, research regarding the implementation of Russia's oil ban and the sanctions imposed on Iran and Venezuela is supported by other studies that assert that supply chain repercussions and price volatility are the outcomes of sanctions (Su and Umar, 2021).

Nonetheless, it is essential to acknowledge certain disparities in the perception of geopolitical concerns that may impact the long-term stability of the oil market. Initially, it was demonstrated that OPEC+'s efforts to sustain or stabilize prices were effective; however, further evidence revealed that self-interested conflicts have undermined oil supply coordination among OPEC+ countries (Ali et al., 2024). This study refutes previous claims by scholars that investment in renewable energy would rapidly reduce fossil fuel consumption, citing constraints such as infrastructural and political barriers that impede energy transition (Trabelsi et al., 2023).

Furthermore, studies conducted on geopolitical hazards do not investigate the cumulative consequences of many dangers occurring concurrently. Previous studies examining the direct effects of geopolitical crises on oil supply and prices typically focus on a singular crisis, such as the oil price decline in 2014 or the Russian invasion of Ukraine in 2022. However, this research suggests that the presence of multiple concurrent crises significantly complicates the prediction of fluctuations in the supply chain and oil prices (Wang et. al., 2024). Political instabilities, potential sanctions, conflicts in oil-producing regions, an unstable global political climate, and volatile oil prices create risks in energy pricing, hindering businesses and governments from accurately forecasting energy costs. Future policy and strategic implications.

Thus, the proposed policy recommendations can be regarded as novel concepts aligned with previous research, wherein Pomerleano emphasized the necessity of reforming governmental interventions essential for bolstering the supply chain and energy market. Contemporary political leaders employ sanctions, temporary trade obstacles, and shuttle diplomacy as instruments of foreign policy to fulfill their nation's short-term foreign policy objectives (Gemechu

and Sonnemann, 2024). Consequently, the study's findings indicate that addressing the deficiencies of conventional analytical methods, typically employed to assess the likelihood of wars, sanctions, and fluctuations in economic stability, necessitates a focus on real-time monitoring of geopolitical risks as a viable solution.

One aspect is the change in perspective regarding the reliability of the Organization of the Petroleum Exporting Countries (OPEC+) in maintaining oil price stability. Future research indicates that OPEC+ ought to adopt a more effective and less constrictive strategy for production limitations, as opposed to the output ceiling, which may not align with prevailing market trends (Helbig and Gemechu, 2024). Countries must also construct infrastructure that supports the creation and utilization of renewable energy while ensuring a reliable supply of fossil fuels for the foreseeable future (Qin et. al., 2023).

Consequently, political oversight of the energy trade must be diminished to enhance long-term sustainability. This is due to the fact that policymakers utilize a mechanism referred to as economic sanctions to govern global trade, a policy that influences energy supply and market prices, as noted by Lee et al. (2021). They should also enhance collaboration and coordination regarding trade policies to mitigate the detrimental effects of economic sanctions and escalating political tensions.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study established that supply influences oil price fluctuations resulting from catastrophe such as war, trade sanctions, and political instability; by considering Russia-Ukraine conflict, Iranian sanctions, and OPEC+ to demonstrate how economic and political interventions upsets oil market variations. Even so, limitations like embargoes considerably impact oil trade, hence poorly affecting supply chain processes and associated costs. Besides, environmental policies are shifting the nature of supply chain pliability over carbon regulations, fluctuations in energy disposal, and the imposition of emission capacity limits that are disadvantageous for oil-dependent countries.

Recommendations for Policy and Industry

Governments have to work out appropriate energy security strategies to battle geopolitical risks in contradiction of oil prices, meanwhile oil companies should improve logistics and broaden their supply networks horizons, beside

with universal efforts in renewable power practice, infrastructure investment, and open rules to withstand market stability.

There is a necessity for a greater volume of research centered on real-time geopolitical risk analysis to enhance current methodologies for projecting oil market stability. Further research is necessary in the domain of digital transformation in oil trading, specifically regarding the applicability of intelligent technologies such as Artificial Intelligence, Blockchain, and Big Data Analytics in managing supply chain risks. Future research may investigate the impact of geopolitical conflicts on the development of environmental policies concerning a nation's energy security and economic stability. These insights might be advantageous for both the government and business professionals to enhance their understanding of the evolving energy industry landscape.

Emerging Issues and Controversies

Instability in Oil-Producing Regions: Geopolitical instability in oil-producing regions such as the Middle East, Russia, and Venezuela has been a long-standing driver of volatility in global oil prices. Conflicts, civil wars, sanctions, and regime changes can disrupt oil production and supply chains, leading to sharp fluctuations in prices. The controversy arises over how much influence these regions truly have over the global oil market, with critics pointing out that speculation and market manipulation often exacerbate price swings. Geopolitical events can lead to sudden disruptions, making it difficult for companies to predict oil prices and secure stable supplies. The resulting volatility forces companies dependent on oil for manufacturing and transportation to adjust their strategies, often by diversifying supply sources or investing in alternative energy, to mitigate risk and ensure operational continuity.

Sanctions and Trade Wars: Economic sanctions, particularly those imposed on oil-exporting nations such as Iran and Russia, are a contentious aspect of geopolitical influences on oil prices. While sanctions are often implemented to exert political pressure, they can lead to significant disruptions in oil supply chains, affecting global oil prices. Critics argue that these sanctions can result in higher prices for consumers and cause inefficiencies in global oil markets, as countries that rely on sanctioned oil may face difficulties securing alternative sources. On the other hand, proponents of sanctions contend that they are a necessary tool for achieving political objectives, such as influencing a country's behavior regarding security or human rights. The increasing use of sanctions, coupled with trade wars, complicates the stability of global oil markets, leading to unpredictable price shifts and making long-term supply chain planning challenging for businesses.

Shift Toward Energy Transition and Diversification: The global push for renewable energy and reducing reliance on fossil fuels has raised debates about the future of oil in global energy markets. Advocates for energy transition argue that decreasing dependence on oil is essential for addressing climate change and creating a sustainable future, while oil-dependent economies, especially in developing countries, fear the economic consequences of this shift. The controversy centers on how quickly this transition should occur and how oil-rich regions can adapt to a future with less demand for their resources. Geopolitically, this shift is complicated by countries that rely heavily on oil exports, and the transition can affect oil prices as demand for fossil fuels

decreases over time. As businesses and governments navigate this transition, supply chain sustainability becomes increasingly important, with firms exploring alternatives like renewable energy sources to mitigate risks associated with future oil price declines.

OPEC and Global Market Influence: The Organization of Petroleum Exporting Countries (OPEC) has long played a significant role in regulating global oil prices through production quotas and supply management. However, the effectiveness and fairness of OPEC's influence have become controversial. Critics argue that OPEC's decisions often lead to artificially high prices and that their attempts to control oil production can destabilize global markets. On the other hand, supporters argue that OPEC's efforts to stabilize the oil market are crucial to preventing extreme price fluctuations. The growing influence of non-OPEC producers, particularly shale oil from the United States, adds complexity to this dynamic, as it shifts the balance of power in the oil market. Geopolitical tensions between OPEC and non-OPEC nations have increased in recent years, complicating efforts to stabilize oil prices and maintain predictable supply chains for industries reliant on oil.

Energy Security and Strategic Reserves: Energy security remains a critical concern for many nations, especially as geopolitical risks to oil supply chains increase. The ability to maintain strategic oil reserves is seen as an essential safeguard against supply disruptions caused by geopolitical factors, such as conflicts or natural disasters. However, using strategic reserves to address short-term supply shortages or political tensions can lead to market distortions and price volatility. Some critics argue that relying on reserves to manage energy security is not a sustainable solution, especially in an era where energy transition is becoming increasingly important. The debate continues over how best to balance energy security with sustainability, with some advocating for diversification into renewable energy sources as a way to reduce dependence on oil and mitigate geopolitical risks in the long run.

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Procurement Risk Management Practices and Service Delivery in Level Five Hospitals in Western Region, Kenya

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Abstract

Purpose: The general objective of this study was to examine the influence of procurement risk management practices on service delivery in Level five hospitals in Western region. Specifically the study assessed the influence of supplier diversification, supplier relationship management, strategic inventory management and procurement automation on service delivery in Level five hospitals in Western region. The study was guided by efficiency theory, resource dependence theory, transaction cost theory and diffusion of innovations theory.

Methodology: The descriptive survey design was employed. This study targeted 116 stores and procurement staff from level five hospitals in Western region. These included Vihiga, Kakamega, Busia, TransNzoia and Bungoma County referral hospitals. Purposive sampling was used to select 86 staffs of the level five hospitals. Structured questionnaire were used to collect data. The study assessed validity through content, and construct validity. Reliability was evaluated using internal consistency of the instrument with the aid of Cronbach's Alpha coefficient. Data analysis involved descriptive statistics, including means and standard deviations. Additionally, inferential statistics, such as Pearson correlation and multiple regression were employed to analyze and test the hypotheses.

Findings: The findings of the study revealed that all the independent variables had a significant positive influence on service delivery of level five hospitals. Specifically, the results showed that supplier relationship management had the greatest contribution to service delivery in the hospitals.

Unique Contribution to Theory, Policy and Practice: The study, therefore, recommends that supplier diversification, relationships, inventory management, and automation be fully embraced to improve procurement performance and service delivery to hospital clients.

Keywords: *Procurement Automation, Service Delivery, Supplier Diversification, Relationship Management, Inventory Management*

INTRODUCTION

Service delivery is a concept that describes the means of getting goods and services to the citizenry in a way that meets their expectations (Li & Shang, 2020). Hospitals play a critical role in providing healthcare services, making the efficiency of their service delivery a matter of public importance. Effective service delivery ensures that patients receive timely, quality care, which contributes to improved health outcomes and patient satisfaction (Erhabor, 2024). However, the healthcare sector globally has faced significant challenges in maintaining high service delivery standards, partly due to procurement inefficiencies and risks (Yu & Guo, 2024). Issues such as delayed delivery of medical supplies, procurement fraud, and poor supplier performance have hindered hospitals' ability to respond to patient needs effectively. For example, delayed delivery of critical medicines and equipment during emergencies has often exacerbated health crises, underscoring the need for robust procurement risk management practices to mitigate these challenges.

Procurement risk management practices are essential for ensuring the smooth operation of healthcare services (Repo, 2023). Effective management of procurement risks such as supplier defaults, price volatility, and quality concerns can directly impact the availability of essential resources in hospitals (Getele, & Ruoliu, 2023). Procurement is central to service delivery, as it ensures timely access to medical supplies, equipment, and services required for patient care. In implementing risk management strategies such as supplier evaluation, contract management, and contingency planning, hospitals can enhance their operational efficiency and reduce disruptions in service delivery. Studies have shown that hospitals with proactive risk management frameworks experience fewer procurement-related delays, leading to better service outcomes and patient satisfaction (Getele & Ruoliu, 2023; Senna, et al., 2024)

In Kenya, hospitals face unique challenges related to procurement risk management, which have been exacerbated by limited resources, regulatory gaps, and inefficiencies in procurement processes (Owich & Odero, 2023). County-level referral hospitals, particularly those classified as Level Five, often struggle with inconsistent supply chains, fraud risks, and lack of transparency in procurement. The absence of lack of empirical evidence on procurement risk management practices that contribute to service delivery. Addressing these issues requires a thorough understanding of the procurement

risks hospitals face and the implementation of tailored risk management practices to enhance service quality and operational reliability.

Procurement risk management is a key aspect of supply chain resilience worldwide. In the US, companies leverage AI-driven risk assessment models and predictive analytics to mitigate risks like supplier defaults and geopolitical uncertainties (Gustavsson, 2023). In Germany, the focus is on sustainability and compliance with EU regulations, with technologies like blockchain used for ethical sourcing (Rhode, 2019). In Asia, China utilizes blockchain for supply chain transparency, while Thailand emphasizes diversifying supply chains to reduce risks (Nguyen et al., 2022).

In Africa, procurement risk management varies by region. South Africa's health sector uses risk assessment frameworks and digital platforms to address political instability and fraud (Omoruyi & Quayson, 2023). East Africa, including Kenya, has adopted digital tools and reforms like e-procurement to enhance transparency (Omondi & Wanyama, 2023). In West Africa, oil-exporting nations face risks from exchange rate volatility and militant activities, with local sourcing and supplier relationship management emphasized (Akintoye et al., 2023).

Locally, studies in Kenya highlight the importance of competitive procurement practices, strategic planning, and supplier appraisal to mitigate procurement risks and improve service delivery, particularly in public hospitals and mega projects in the energy sector (Gituru, 2018; Mwau et al., 2018). Effective procurement risk management is essential for improved performance and service delivery across sectors.

Statement of the Problem

Scholars widely agree that improving public service delivery in the public sector is neither a simple nor a short-term endeavor but a continuous and complex process that requires bureaucratic reinforcement (Agboola, 2015). Public organizations, designed to serve the public, face significant challenges that necessitate thorough investigations into their operations (Anane *et al*., 2019). Despite increased resource allocations, the quality-of-service delivery in the public sector especially in health sector continues to decline in many developing countries (Leni *et al*., 2012). The performance of public hospitals, particularly during global pandemics like COVID-19, has become a critical concern. In Kenya, Level 5 hospitals contribute 22% of healthcare services and significantly impact economic growth (Kenya Association of Private Hospitals, 2023). These hospitals are preferred due to their high-quality

services, advanced equipment, skilled medical personnel, and robust infrastructure. As a result, assessing the performance of Level 5 hospitals and identifying its determinants is crucial for maintaining service quality and achieving organizational objectives (Mohamoud & Mash, 2022).

However, the growth rate of Level 4, 5, and 6 hospitals has declined steadily, dropping to 5.2%, 3.5%, and 2.3% in 2008, 2009, and 2010, respectively (Kenya Association of Private Hospitals, 2023). This decline mirrors a broader deterioration in public hospital performance (Kelvin & Morrisson, 2023). Many Level 5 hospitals face significant procurement challenges, including insufficient suppliers of medicine, supplier defaults, price instability, and quality issues (Kenya Medical Supplies Authority, 2021). Approximately 40% of private hospitals report procurement risks, which adversely affect their performance (Bwire, 2018; Kenya Medical Practitioners and Dentists Council, 2019; Kaguthi, Nduba & Adams, 2020). These risks are often linked to ineffective procurement risk management strategies.

Studies on procurement risk management highlight its critical influence on organizational performance. For example, Mwau et al. (2018) examined procurement risk management in the energy sector, while Gituru (2018) explored competitive procurement practices and service delivery in public hospitals in Nakuru County. Muinde *et al.* (2020) investigated procurement risk management in Kenyan public universities, and Okonjo (2016) connected procurement risk management to performance outcomes. Despite the growing interest in procurement risk management, researchers such as Kalvert and Lember (2011) and Murray (2013) observe limited attention to this subject in the public sector. Although existing studies have emphasized the relationship between procurement risk management and procurement performance, there remains a gap in understanding its direct impact on service delivery especially in health sector. The current study therefore, sought to address this gap and contribute to the growing body of knowledge on procurement risk management within the Level five public hospitals in Western region.

General Objective

The general objective of this study was to examine the influence of risk management practices on service delivery in Level five hospitals in Western region.

Specific Objectives

The study was guided by the following specific objectives:

i. To assess the influence of supplier diversification on service delivery in Level fivehospitals in Western region.

ii. To establish the influence of supplier relationship management on service delivery of Level fivehospitals in Western region.

iii. To establish the influence of strategic inventory management on service delivery in Levelfive hospitals in Western region.

iv. To assess the influence of procurement automation on service delivery in Level five hospitalsin Western region.

LITERATURE REVIEW

Theoretical Review

Efficiency Theory

Richard Efficiency theory was first conceptualized by Richard Posner in the 1970s as part of his work on the economic analysis of law. Posner argued that legal and organizational systems should prioritize efficiency by allocating resources in ways that maximize output while minimizing costs. His work emphasized the importance of rational decision-making processes in achieving economic and operational efficiency. The theory draws heavily from principles in microeconomics, particularly the concept of Pareto efficiency, which occurs when resources cannot be reallocated to make one party better off without making another worse off (Posner, 1973). Over time, efficiency theory has been expanded and applied to various fields, including public administration, supply chain management, and healthcare service delivery.

Scholars have extensively debated and refined efficiency theory to incorporate modern organizational dynamics. Williamson (1981) incorporated it into transaction cost economics, arguing that organizations optimize efficiency by minimizing the costs of transactions within and across firms. Kaplan and Norton (1996) explored efficiency in strategic performance management, emphasizing the balance between financial and operational measures. In supply chain contexts, Chopra and Meindl (2021) highlight how efficiency aligns with cost reductions, streamlined logistics, and enhanced supplier management. Critics of the theory, such as Freeman (1984), argue that efficiency-focused strategies must balance profitability with ethical and social

considerations, particularly in sectors like healthcare, where service quality directly impacts lives.

Efficiency theory is particularly relevant when analyzing the influence of supplier diversification on service delivery in Level 5 hospitals. Supplier diversification, a strategy to mitigate risks associated with dependence on a single supplier, aligns with efficiency principles by ensuring a consistent supply of medical equipment and drugs, thereby minimizing service disruptions. According to Posner's framework, diversified suppliers can enhance resource allocation efficiency, leading to improved patient outcomes through reduced delays and optimized costs. Moreover, the theory supports the need for dynamic supplier relationships in healthcare to address the unpredictable nature of demand for medical supplies and services. In leveraging efficiency theory, hospital administrators can evaluate and implement supplier strategies that balance cost, quality, and reliability, ensuring that service delivery meets the expectations of Kenya's growing healthcare demands.

Resource Dependence Theory

Resource dependence theory, Resource Dependence Theory (RDT) was introduced by Jeffrey Pfeffer and Gerald Salancik in their seminal 1978 work, *The External Control of Organizations: A Resource Dependence Perspective*. The theory emphasizes how organizations depend on external resources to function and succeed, such as suppliers, customers, and funding sources. Pfeffer and Salancik argued that organizations aim to minimize dependency and manage uncertainty by forming strategic alliances, diversifying resource sources, or exerting control over critical resources. RDT highlights the strategic importance of managing relationships and dependencies to reduce vulnerabilities and ensure operational stability, which is particularly significant in sectors like healthcare, where access to reliable supplies is critical.

Subsequent studies have extended RDT to various organizational contexts. Hillman, Withers, and Collins (2009) explored how inter-organizational relationships, such as joint ventures or partnerships, help organizations mitigate resource dependence. Carter and Rogers (2008) examined its application in supply chain management, arguing that strong supplier relationships can reduce operational risks and enhance efficiency. In the healthcare context, scholars like Singh and Power (2020) emphasized the role of supplier management in ensuring the availability of critical resources and

maintaining service quality. Critics, however, argue that excessive reliance on external resources can lead to power imbalances, making organizations susceptible to exploitation by dominant suppliers (Casciaro & Piskorski, 2005).

Resource Dependence Theory is highly relevant to understanding how supplier relationship management influences service delivery in Level 5 hospitals. Effective supplier relationship management allows hospitals to reduce dependency on single suppliers, ensuring consistent availability of essential medical supplies and equipment. RDT suggests that fostering collaborative and mutually beneficial supplier relationships can help mitigate risks associated with resource shortages or price fluctuations. This is crucial for Level 5 hospitals, where delays in acquiring critical resources directly impact patient care. Additionally, the theory underscores the importance of diversifying supply chains and negotiating favorable terms with suppliers to enhance service reliability and efficiency. In applying RDT, hospitals can strategically manage supplier dependencies to achieve better service delivery outcomes and optimize resource utilization.

Transaction Cost Theory (TCT)

Transaction Cost Theory (TCT) was developed by Ronald Coase in 1937 through his groundbreaking article The Nature of the Firm. Coase introduced the concept that firms exist to minimize transaction costs, such as the costs of negotiating, monitoring, and enforcing contracts. Later, Oliver Williamson expanded the theory in the 1970s and 1980s, providing a robust framework for understanding the trade-offs between using markets and hierarchies for economic transactions. Williamson emphasized factors like asset specificity, uncertainty, and frequency as determinants of transaction costs. This theory has since become a cornerstone of organizational economics, widely applied in supply chain and inventory management contexts to evaluate cost-efficiency in transactions.

Scholars like Williamson (1985) have highlighted how TCT applies to inventory management by emphasizing the cost-effectiveness of strategic decisions regarding stock procurement and holding. Hobbs (1996) explored its application in supply chain management, noting that organizations often balance transaction costs against operational efficiency. Recent studies, such as those by Masteika and Čepinskis (2020), argue that TCT is pivotal in reducing operational inefficiencies and ensuring resource availability through proper inventory management. Critiques of TCT include its assumption of

rational decision-making and its neglect of social and relational dimensions in organizational interactions (Ghoshal & Moran, 1996).

Transaction Cost Theory is highly relevant for examining how strategic inventory management influences service delivery in Level 5 hospitals. In healthcare, efficient inventory management minimizes wastage and ensures the timely availability of critical medical supplies, directly impacting patient care quality. TCT suggests that hospitals can lower transaction costs by adopting centralized inventory systems, reducing reliance on intermediaries, and improving procurement processes. For Level 5 hospitals, implementing strategic inventory practices—such as just-in-time inventory and vendor-managed inventory systems—aligns with TCT principles by optimizing costs and ensuring a seamless flow of supplies. In leveraging TCT, hospitals can identify cost-efficient procurement and storage strategies, leading to enhanced service delivery and reduced resource bottlenecks.

Diffusion of Innovations Theory

The Diffusion of Innovations Theory (DOI), first introduced by Everett Rogers in 1962, explains how new ideas, technologies, and practices spread within a social system. Rogers identified five key attributes that influence the adoption of innovations: relative advantage, compatibility, complexity, trialability, and observability. According to DOI, innovations are adopted over time through a process that begins with innovators and early adopters, followed by the majority and laggards. The theory has been widely applied in fields such as healthcare, business, and technology to understand how new practices are accepted and integrated into organizational structures.

Scholars have further developed and applied DOI in various contexts. For example, Greenhalgh et al. (2004) extended the theory by emphasizing the role of contextual factors such as organizational culture and leadership in the diffusion process. In the context of procurement automation, DOI suggests that the adoption of automated systems can be influenced by factors like the perceived benefits of reducing administrative costs, enhancing transparency, and improving procurement efficiency (Kwon & Zmud, 2020). The theory has been particularly relevant in healthcare, where the adoption of technology is often slow due to resistance to change, lack of resources, or perceived complexity (Agarwal et al., 2018).

Diffusion of Innovations Theory offers valuable insights into how procurement automation can influence service delivery in Level 5 hospitals. As healthcare facilities look to improve service delivery, automating

procurement processes is seen as a way to streamline operations, reduce human error, and improve inventory management, ultimately leading to better patient outcomes. DOI suggests that hospitals may adopt procurement automation when they perceive a relative advantage in terms of cost savings, efficiency, and accuracy. For example, automated systems reduce procurement delays, minimize stockouts, and ensure timely availability of medical supplies, which directly impacts service delivery. However, factors such as organizational culture, the complexity of implementation, and the availability of resources can influence the speed and extent of adoption. As hospitals move toward digital systems, understanding the adoption curve of innovation can help policymakers and healthcare leaders effectively manage the transition and improve service delivery outcomes (Vasquez et al., 2021).

Conceptual Framework

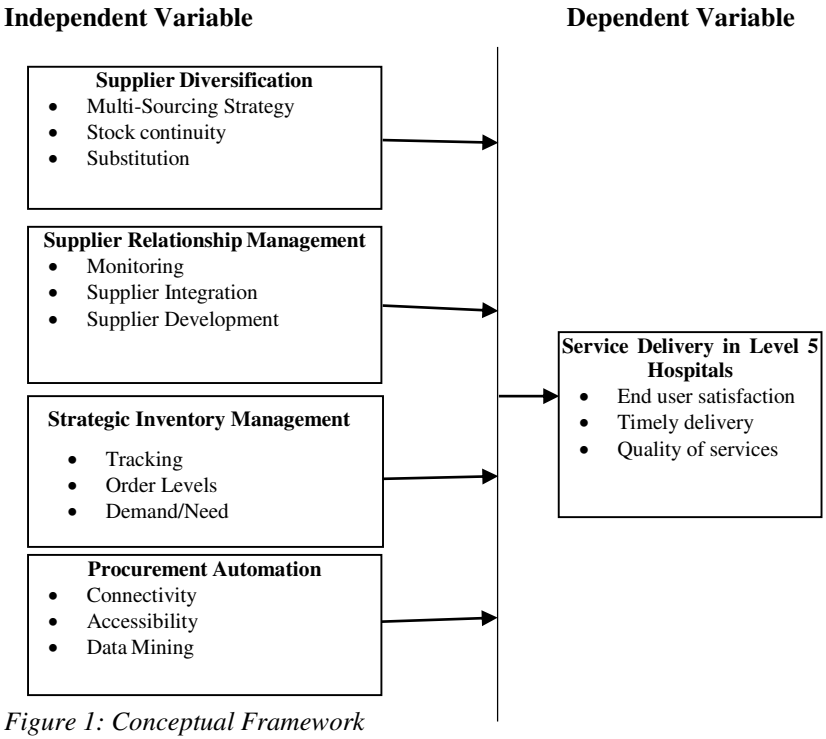

Figure 1: Conceptual Framework

Empirical Review

The review of literature provides valuable insights into procurement risk management practices and their potential to improve service delivery in various sectors, including healthcare. For instance, studies by Kusi and Appiah (2023), Tiwari and Gupta (2023), and Weller and Palmer (2023) highlight the importance of supplier diversification, strategic inventory management, and procurement automation, respectively, in enhancing service delivery. However, most of these studies were conducted in different sectors, such as manufacturing, retail, or the foodservice industry, with limited emphasis on healthcare and hospitals. For example, Oduro and Awuah (2022) focused on supplier diversification in manufacturing, while Lee and Lee (2020) explored retail settings, making their findings less directly applicable to hospitals. Additionally, studies like Yin and Ran (2022) and Alvarado and Krivkovich (2021) emphasize broader operational efficiencies rather than directly linking these practices to service delivery in healthcare facilities.

Furthermore, many studies, such as those by Kang and Park (2021) and Kumar and Singh (2021), examine procurement risk management's impact on firm performance rather than explicitly on service delivery, which is a critical outcome for healthcare institutions. Most existing studies are also geographically skewed, with a predominant focus on developed or industrialized contexts, as observed in the works of Choi and Krause (2022) and Li and Zhang (2020). This limits the applicability of their findings to hospitals in resource-constrained environments. Additionally, many of these studies rely heavily on quantitative results, offering limited qualitative insights into practical implementation challenges and contextual factors.

Research Gaps

Despite the contributions of the existing studies, significant gaps remain. There is limited research directly addressing the combined impact of procurement risk management practices—supplier diversification, supplier relationship management, strategic inventory management, and procurement automation—on service delivery within hospitals, particularly Level Five hospitals. Most studies focus on individual procurement practices in isolation, overlooking how these strategies interact to influence service delivery outcomes. Additionally, many studies prioritize firm performance over service delivery, which is a critical metric in healthcare settings. Furthermore, there is a lack of research focusing on healthcare systems in developing regions such as Kenya, where resource-constrained environments present unique challenges. Existing

studies also provide limited qualitative insights into the practical challenges and contextual factors that influence the implementation of procurement risk management strategies. This study seeks to address these gaps by focusing on the healthcare sector in Kenya, integrating multiple procurement risk management practices, and emphasizing their collective influence on service delivery outcomes in Level Five hospitals.

METHODOLOGY

The descriptive survey design was employed where data was collected one point in time. This study targets 116 stores and procurement staff from Level Five hospitals in the Western region, specifically Vihiga, Kakamega, Busia, Trans Nzoia, and Bungoma County referral hospitals. The target population consists of these five hospitals, which form the unit of analysis as they represent the organizations where procurement risk management practices and service delivery outcomes are being assessed. The unit of observation, however, is procurement and stores employees within these hospitals. For this study, Slovin's formula (2018) also developed by Yamane (1967), will be used to calculate the sample size of 89 . This study sampled the 89 staffs of the level four hospitals. The respondents were selected purposively.

This study adopted the use of primary data collection methods. This study used a semi- structured questionnaires to obtain primary data for analysis. A pilot study was done on 10% of the sample (8 respondents) in Jaramogi Oginga Odinga Teaching and Referral hospital who were then excluded from the main study to avoid response bias. This study applied quantitative approaches to process and analyze the data. Quantitative data processing involved coding the closed-ended data, entry, cleaning, transformation, analysis andinterpretation. Quantitative data was sorted, coded and input into SPSS Version 24 for generation of descriptive statistics and inferential statistics. Descriptive statistics involved frequencies, means and standard deviation while inferential statistics were measured at significance level of 0.05. A multiple linear regression model was used to test the significanceof the influence of the independent variables on the dependent variable.

FINDINGS

Response Rate

In order to conduct the study, eighty nine (89) questionnaires were distributed to sample respondents, out of which eighty six (86) were duly filled and collected, representing 96.6% return rate. This study's response rate of 96.6%

was good enough to proceed with analysis, make conclusions and consequent reporting. The high response rate was realized due to the researcher's personal participation in distributing, following up and picking the completed questionnaires.

Table 1: Response Rate

Response	Frequency	Percentage (%)
Returned	86	96.6
Not returned	3	3.4
Total	**89**	**100**

Descriptive Statistics

The general objective of the study was to examine the influence of risk management practices on service delivery of level five hospitals. The research instrument was based on a five-point Likert scale which had applicable codes to enable rating of responses which were premised on assigned values where 1 denoted strongly disagree, 2 denoted disagree, 3 denoted neither agree nor disagree, 4 denoted agree while 5 denoted strongly agree. Standard deviation values greater than two (>2) indicated that there was marked divergence in responses to the questionnaire items.

Supplier Diversification

Opinion was sought from study respondents regarding statements about supplier diversification and its influence on service delivery in level five hospitals and the obtained results are shown in Table 2;

Table 2: Descriptive Statistics

Statement	N	Mean	Std. Dev
The hospital has multiple suppliers from whom goods or services are sourced	86	3.76	.830
All risks related to suppliers are assessed and handled in good time	86	4.13	.729
The hospital is able to effectively substitute a supplier in case of failure or disruption	86	3.98	.808
The hospital acquires a greater variety of goods since it has several supplier sources	86	3.81	.933
Stock availability has been maintained due to multiple sourcing	86	4.04	.724
The hospital ensures continuity of supplies and any stock outs do not result from supplier delays	86	3.78	.931
Valid N (listwise)	86		

Results in Table 2 show that standard deviation values for all items were less than two (<2) demonstrating that the opinions by respondents were converging. The strongest convergence in opinion was on the statement that

all risks related to suppliers are assessed and handled in good time (M=4.13, SD=.729).

Supplier Relationship Management

Respondents presented their sentiments on the item supplier relationship management and its influence on service delivery in level five hospitals and the derived results are shown;

Table 3: Supplier Relationships

	N	Mean	Std. Dev
The department engages with suppliers to create a warm and conducive work environment	86	3.98	.794
The hospital monitors and evaluates supplier activities at all times to ensure conformity to standards	86	3.88	.729
The department integrates its suppliers into its processes to gain trust	86	3.54	.939
The hospital has supplier development programs which are executed quite frequently	86	3.86	.803
The procurement staff strive for effective communication with suppliers to ensure continuity in improvement of services/relationships.	86	3.73	.957
The hospital suppliers work with us through trust and very transparently	86	3.91	.712
Procurement staff seek solutions to supplier challenges through collaboration	86	3.88	.771
Valid N (listwise)	86		

Results in Table 3 show that all questionnaire items had appropriate mean scores tilting towards confirmatory views on the questions and returned standard deviation values below two (<2) indicating that there was convergence in views and the item that department engages with suppliers to create a warm and conducive work environment (M=3.98, SD=.794).

Strategic Inventory Management

Respondents gave their answers on statements relating to strategic inventory management and obtained the results as presented in Table 4.

Table 4: Strategic Inventory Management

Statement	N	Mean	Std. Dev
The hospital keeps track of inventory levels each time withdrawals or purchases are made	86	3.86	.720
The hospital relies on the same level of orders each time purchases are made	86	3.98	.740
The hospital makes orders depending on user needs only	86	3.75	1.026
The hospital considers both financial and space constraints when making purchases	86	3.93	.811
Perishable items are ordered only when there is surety that they will be consumed by the users	86	3.66	.916
The hospital minimizes orders of items which are larger than their demand	86	3.76	.750
Valid N (listwise)	86		

Results in Table 4 show that all statements had high mean scores and low standard deviation values denoting that there was convergence in opinion by respondents, which was more on the statement that the hospitals rely on the same level of orders each time purchases are made (M=3.98, SD=.740). The result shows that there is need for public hospitals to allow for flexibility in ordering based more on need as opposed to uniform ordering levels.

Procurement Automation

Respondents provided their opinions on questionnaire statements about procurement automation and the findings are shown in Table 5;

Table 5: Procurement Automation

Statement	N	Mean	Std. Dev
Procurement staff are familiar with and use the automated procurement processes	86	3.98	.740
Electronic procurement processes enable streamlined sourcing, ordering, and transactions.	86	3.95	.701
The hospital adopts large-scale data analysis to uncover insights and patterns, enhancing decision- making.	86	3.97	.774
There is a network of interconnected devices collecting and exchanging data for informed actions.	86	3.90	.801
Decentralized and secure digital ledger ensures transparency and trust in transactions.	86	3.57	.992
Simulation of human intelligence in machines, enables data-driven insights and optimized decisions.	86	3.52	.973
Valid N (listwise)	86		

The results in Table 5 indicate that the mean scores were notably high and the standard deviation values for the statements were below two (< 2), demonstrating general convergence of opinions around the mean. The item regarding hospitals adopting large-scale data analysis to uncover insights and

patterns, thereby enhancing decision-making, returned the highest score (M=4.01, SD=761). However, the relationship between these scores and actual purchases may not be clear.

Service Delivery in Level Five Hospitals

Respondents provided their opinions on the statements relating to the dependent variable; service delivery. The results are shown in Table 6 below;

Table 6: Implementation of Service Delivery

	N	Mean	Std. Dev
The hospital participates in engagements that lead to dialogue, information sharing and transparency	86	3.65	.951
We receive positive feedback on satisfactory user experiences	86	3.71	.845
The hospital provides dependable and satisfactory services.	86	3.64	.860
The hospital provides dependable and satisfactory services.	86	4.01	.733
I have knowledge, courtesy and the ability to inspire trust and confidence in customers.	86	3.87	.837
Staffs provide caring, individualized attention to the hospital customers.	86	3.92	.749
The hospital has visible medical facilities, equipment, communication materials and technology that provide enough hints to customers about the quality of service	86	3.79	.820
Valid N (listwise)	86		

Derived statistics had standard deviation values for all the items under implementation of road construction projects being less than two (< 2) validating that there was convergence in opinion and more so on the item about the hospital providing dependable and satisfactory services. (M = 4.01, SD = .733).

Correlation Analysis

Correlational analysis is a statistical procedure that quantifies the strength of a linear relationship between two variables and computes their association. The correlation coefficient, represented by the symbol (r), is a measure of the strength of the linear relationship between the variables. It is expressed as a value without units and falls between -1 and 1. A low correlation suggests a weak relationship between two variables, whereas a high correlation suggests a strong relationship.

Table 7: Correlation Analysis

		Y	X_1	X_2	X_3	X_4
Y	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	86				
X_1	Pearson Correlation	.439*	1			
	Sig. (2-tailed)	.001				
	N	86	96			
X_2	Pearson Correlation	.719**	-.062	1		
	Sig. (2-tailed)	.000	.547			
	N	86	86	86		
X_3	Pearson Correlation	.508**	.008	.034	1	
	Sig. (2-tailed)	.001	.937	.740		
	N	86	86	86	86	
X_4	Pearson Correlation	.603**	.043	.116	.103	1
	Sig. (2-tailed)	.000	.661	.261	.317	
	N	86	86	86	86	86

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Key: Y = Service Delivery in Level 5 Hospitals; X_1 = supplier diversification; X_2 = supplier relationships; X_3 = strategic inventory management; X_4 = Procurement automation

The correlation results in Table 7 indicate that there was a positive and significant linear relationship between the dependent variable and the independent variables namely supplier diversification r = 0.439, p-value =.001; supplier relationship management r = 0.719, p-value .000; strategic inventory management r = .508, p-value = .001 and procurement automation r = .603, p-value = .000. This indicated that the independent variables positively and significantly correlated with the variable on service delivery.

Regression Analysis Results

Regression analysis denotes statistical methods used to estimate the relationships between a dependent variable and one or more independent variables. These techniques can be used to assess the strength of current relationships and model future relationships between variables (Kulaylat *et al.,* 2023). A positive coefficient suggests that the dependent variable's mean tends to increase along with the independent variable's value. A negative coefficient indicates a tendency for the dependent variable to decrease as the independent variable rises.

Model Summary

Table 8: Multiple Regression Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.744[a]	.553	.511	.44458	1.947

a. Predictors: (Constant), Supplier Diversification, Supplier Relationship Management, Strategic Inventory Management and procurement Automation.
b. Dependent Variable: Service Delivery

Table 8 presents results on the correlation coefficient, denoted as R, which was .744, indicating that the relationship between procurement risk management practices and service delivery in level five hospitals had a strong and positive association. The joint independent variables accounted for 55.3% of the variation in service delivery in level five hospitals, as confirmed by an R Square value of .553. With an adjusted R square of .511, it was determined that after controlling for the variables in the model, the joint variables accounted for 51.1% of the variation in service delivery, while the remaining 48.9% of the variation could be explained by other factors not included in the model. The standard error of .44458 indicated the deviation from the line of best fit.

Analysis of Variance (ANOVA)

Table 9 presents results indicating that the adopted model was significant given that the p-value was .000 which was less than the chosen significance level of .05, implying that the model was significant in establishing the relationship between the variables.

Table 9: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.578	4	2.644	28.127	.000[b]
	Residual	8.551	81	.094		
	Total	**19.129**	**85**			

a. Dependent Variable: Service delivery in level five hospitals
b. Predictors: (Constant), Supplier Diversification, Supplier Relationship Management, Strategic Inventory Management and procurement Automation.

The regression model of independent variables and the dependent variable was significant (F (4, 91) = 28.127, p-value = .000). The F-calculated value was 28.127 being greater than the F-critical (F (4, 91 = 2.471), therefore indicating that the joint independent variables were effective predictors in the model thus the regression model perfectly fitted the data.

Regression Coefficients

Table 10: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.754	.708		3.890	.000
	Supplier diversification	.112	.049	.103	2.285	.024
	Supplier relationships	.420	.122	.382	3.442	.000
	Strategic inventory	.166	.073	.168	2.273	.025
	Procurement automation	.296	.119	.290	2.487	.014

a. Dependent Variable: Service delivery in level five hospitals

Results in Table 10 present the beta coefficients of the independent variables operationalizing procurement risk management practices and how they predicted the dependent variable being service delivery. The regression model equation is;

$$\mathbf{Y = 2.754 + .112X_1 + .420X_2 + .166X_3 + .296X_4}$$

Discussion

The descriptive and inferential statistical analyses were undertaken and overall study findings showed that the joint independent variables significantly and positively influenced service delivery in level five hospitals. However, there is discordance in the findings which is normal and happens often due to the varying dynamics under which service delivery is implemented across the facilities. Therefore, this study's overall findings showed that procurement risk management practices indeed influenced service delivery in the public sector in Kenya, which were represented by level five hospitals in Kenya.

Correlation analysis results showed that all the independent variables had a significant relationship with the dependent variable having returned p-values less than 0.05 (p-value <.05). From the results, supplier relationship management had the highest positive and significant correlation with service delivery in level five hospitals (r = .719, p-value = .000), followed by procurement automation with a positive and significant correlation (r = .603, p = 0.000); then strategic inventory management had a positive and significant correlation with implementation of road construction projects (r = 0.508, p = 0.001) and lastly, a moderate positive and significant correlation (r = 0.439, p = 0.001) between supplier diversification and service delivery. The results

showed a general correlation between subsets of procurement risk management practices and service delivery.

The findings concur with Mohammed (2024) who noted that supplier relationship management has emerged as a critical strategy for organizations aiming to enhance collaboration and optimize performance in the increasingly competitive and globalized marketplace. The findings of Kimwaki (2022) also revealed that supplier relationship management significantly and positively influenced the performance of manufacturing firms in Kenya.

Furthermore, the findings were confirmed by Temitope (2025) who asserted that by adopting a proactive, multi-tiered approach to supplier and manufacturing diversification, companies can build agile, flexible, and resilient supply chains that withstand future disruptions, maintain operational continuity, and sustain competitive advantage in an increasingly volatile global market. Agaba and Emenike (2022) also noted that procurement practices have positive and significant influence on public service delivery. A major managerial implication of these findings therefore is that procurement practices is a key driver of service delivery in public institutions.

Manyathi (2022) aimed to ascertain the degree to which public sector procurement processes can be modelled to that of the private sector to improve service delivery. The study established that the current procurement legislation to acquire goods, works and services for the public at large are said to be ineffective and inefficient, hindering the accelerated provision of public services. Anane et l (2019) determined the effect of procurement policy, procurement planning and sustainable procurement on service delivery with their results revealing a strong significant positive correlation between procurement policy and service delivery.

Regression result indicated that the joint independent variables could account for 51.1% of the variation in service delivery, after taking into account every component of the model. This was indicated by the value of adjusted r square which was .511 meaning that the remaining 48.9% represented other variables that influenced implementation of road construction projects but were not taken into account by the model. Based on the findings, there was a strong and positive relationship between the joint independent variables and the dependent variable as indicated by the correlation coefficient (r) of 0.744.

The results concur with Sassaoui *et al* (2023) who observed that if not properly managed, the risks associated with procurement activities can have a severe effect on the performance of the business. As a result, there is an increasing

need for systematic and organized frameworks that help businesses in mitigating procurement risks and achieve profitable outcomes. Asasira and Namuyonga (2024) also confirmed that contract administration through procurement planning, record keeping and contract execution assist the entity in achieving value for money procurement.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study concluded that supplier diversification had significant positive influence on service delivery in level five hospitals. Supplier diversification strategy helps in spreading out sourcing and procurement across multiple suppliers to reduce risk and increase flexibility. The study concludes that supplier diversification is important since it mitigates risks such as supply chain disruptions, quality issues, and price fluctuations.

The study concluded that supplier relationship management had a positive and significant influence on service delivery. The type of relationships that should be formed with suppliers depends on the criticality of the goods or services being purchased and supplied into the organization. The study concludes that the hospitals should have the right levels of contact to ensure that the relationship remains on track for both parties. Supplier relationship management can in turn lead to benefits within the relationship.

Strategic inventory management played a positive and significant role in enhancing the service delivery. The study concludes that finalization of purchase orders in a timeous manner is necessary to maintain inventory levels and ensure that all relevant materials are available when required. Procurement teams need to identify goods and services required in order to have the requisite fit for purpose materials that are deployed. Teams can negotiate contract terms with identified suppliers to ensure that prices settled on are agreeable to all relevant parties.

The study concluded that procurement automation positively and significantly influenced service delivery. The goal of automating procurement processes is to enhance service delivery by reducing manual intervention and improving the speed and accuracy of procurement processes. By automating repetitive tasks, hospital managers can allocate their time and resources toward more strategic activities such as planning, decision-making, and managing stakeholders.

Recommendations

The following are the recommendations of this study;

There is need to embrace supplier diversification as a key driver for service delivery since it reduces vulnerability to disruptions associated with relying on a single supplier. Working with multiple suppliers can provide access to new ideas and technologies. Furthermore, competition among suppliers can lead to better quality products, allowing for more flexibility in sourcing and may aid in negotiating better terms, prices, and service levels.

Supplier relationship management should be maintained as they lead to working collaboratively and sharing forward forecasts which can open a discussion to remove cost from the procurement process, or any other areas of the supply chain. Highly regarded customers are often offered priority in key processes.

This study has shown that strategic inventory management influences service delivery in hospitals. With solid inventory management, the procurement department would know what is available in stock and order only the amount of inventory needed to meet demand. Better planning and management helps can help hospitals minimize the number of days that an item would be out of stock and avoid carrying too much inventory. This would result in saving time that could be spent on other organizational activities.

Based on the findings of this study regarding procurement automation, the study recommends that automation should be embraced as it significantly reduces the need for more manual labour that leads to cost savings. This also provides real time visibility into procurement processes that may allow tracking of activities and monitoring of supplier performance. Automated processes ensure adherence to regulations and internal policies.

Emerging Issues and Controversies

Inadequate Procurement Processes and Supply Chain Disruptions: Procurement processes in level five hospitals are often marked by inefficiencies, such as delays in procurement approval, lack of transparency, and inconsistencies in supplier evaluations. These inefficiencies lead to disruptions in the timely delivery of critical medical supplies, pharmaceuticals, and equipment. As a result, patients face delayed or inadequate treatment, and the overall service delivery is compromised. Furthermore, many hospitals continue to operate under outdated procurement systems, and procurement decisions can sometimes be influenced by corruption or political interference, which further exacerbates inefficiencies. This issue remains contentious as hospitals seek to adopt more streamlined and transparent procurement practices, but the financial and infrastructural challenges they face complicate the implementation of such improvements.

Corruption and Lack of Accountability in Procurement: Corruption is a persistent problem in the procurement processes of level five hospitals, where issues like bribery, kickbacks, and favoritism often dictate supplier selection and contract awarding. These corrupt practices lead to the misallocation of public funds, procurement of substandard goods, and delayed deliveries, all of which negatively affect the quality of healthcare services provided. The lack of accountability and oversight in many procurement departments further fuels this issue, as it becomes difficult to track and address misconduct. This controversy has prompted calls for stronger regulatory frameworks, increased transparency, and more stringent auditing processes, yet concerns persist about the practical implementation of such measures, especially in environments where corruption is deeply entrenched.

Lack of Skilled Procurement Personnel: A significant challenge in procurement risk management at level five hospitals is the shortage of skilled procurement professionals who can effectively manage the complexities of healthcare supply chains. Procurement in the healthcare sector requires specialized knowledge not only of standard procurement practices but also an understanding of the specific needs of medical supplies, pharmaceuticals, and equipment. Unfortunately, many hospitals lack personnel with the necessary expertise, leading to suboptimal decision-making and delayed procurement. The shortage of trained professionals is exacerbated by limited opportunities for staff development and training, creating a gap in the skills required to navigate the intricate procurement processes in healthcare. The controversy

lies in whether hospitals can afford to invest in training and professional development for their procurement teams, given the financial constraints in the healthcare sector.

Supplier Reliability and Quality of Goods: Supplier reliability and the quality of procured goods are crucial in ensuring that hospitals can deliver high-quality care to patients. However, many level five hospitals face challenges with unreliable suppliers who fail to meet deadlines or deliver goods of the expected quality. This issue is particularly problematic for critical medical supplies, such as medications, surgical instruments, and diagnostic equipment, where delays or substandard products can lead to adverse patient outcomes. The controversy arises from the complexity of managing supplier relationships and ensuring that they meet the high standards required in healthcare. Many hospitals struggle with selecting reliable suppliers, especially in the context of emergency procurement or where there is limited competition. This has led to calls for more rigorous supplier evaluations and stronger contracts, but implementing these solutions remains challenging in environments with weak regulatory frameworks.

Inventory Management and Stockouts: Stockouts of essential medical supplies, including pharmaceuticals, surgical instruments, and personal protective equipment (PPE), are a recurring issue in level five hospitals. Poor inventory management, lack of forecasting, and delayed procurement are often the root causes of these stockouts, which severely disrupt service delivery. Patients may experience delays in treatment, and the hospital's ability to respond to emergencies can be compromised. In some cases, hospitals may resort to substituting inferior products or purchasing from unapproved suppliers, further compromising care quality. The challenge of managing inventory efficiently is compounded by the financial limitations of public healthcare systems, which struggle to maintain the necessary stock levels. There is ongoing debate over whether more advanced inventory management technologies, such as automated systems or just-in-time procurement models, can solve these problems, especially given the resources required to implement such systems.

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Electronic Procurement and Performance of the Hospitality Industry in Homabay Town, Kenya

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Abstract

Purpose: This study sought to examine the effect of e-procurement on the performance of the hospitality industry in Kenya, focusing specifically on hotels in Homa Bay town. The study investigated key components of e-procurement, including e-tendering, e-awarding, e-ordering and e-invoicing, and how they influence operational efficiency, cost reduction, service delivery, and overall organizational performance.

Methodology: The research adopted a descriptive research design and targeted procurement officers, hotel managers, and finance staff as key respondents. Data was collected using structured questionnaires and analyzed using both descriptive and inferential statistics.

Findings: The findings revealed that all four e-procurement practices positively impact hotel performance. E-tendering worsens the transparency of procurement processes and reduces cycle times, contributing to cost savings. E-awarding enhances fairness, accountability, and efficiency in the supplier selection process. E-ordering has the most significant impact, streamlining the ordering process, reducing errors, and ensuring timely deliveries. E-invoicing, while having a smaller impact compared to other practices, improves the accuracy of billing, reduces paperwork, and speeds up payment processing. E-procurement practices lead to enhanced operational efficiency, cost reductions, and improved supplier relationships, all of which contribute to better hotel performance.

Unique Contribution to Theory, Policy and Practice: This study advances procurement theory by integrating electronic procurement's role in service sector efficiency, specifically within hospitality. It informs policy by providing empirical evidence for digital procurement adoption to enhance transparency and cost-effectiveness in Homabay's hospitality industry. Practically, the research offers actionable insights for managers to optimize procurement processes, improve supplier relationships, and boost operational performance,

fostering competitiveness and sustainable growth in the local hospitality sector.

Keywords: *E-Awarding, E-Invoicing, E-Ordering, E-Procurement, E-Tendering, Hospitality Industry, Performance of Hotels*

INTRODUCTION

Globally, the adoption of e-procurement systems has significantly transformed operations within the hospitality industry. E-procurement refers to the use of digital tools and internet-based technologies to manage purchasing processes such as requisitioning, tendering, ordering, invoicing, and payments. Its impact on organizational performance has been widely recognized across various regions (Abdel-Aziz & Fathy, 2023).

One of the most notable benefits of e-procurement is its ability to reduce operational costs and enhance efficiency. According to a recent report by HospitalityNet (2023), hospitality businesses that have embraced e-procurement platforms have experienced notable cost savings, with compliance rates improving by over 80%, productivity gains ranging from 10% to 20%, and significant reductions in approval times from several days to just minutes. These efficiency gains are largely attributed to the automation of repetitive tasks and improved procurement transparency.

In Egypt, a study focusing on the hospitality sector revealed that the use of e-procurement systems had a positive influence on supply chain management, cost and time reduction, and overall service quality. The study indicated that many hotels were able to achieve a return on investment in their e-procurement systems within one to two years of implementation (Abdel-Aziz & Fathy, 2023). These findings underscore the potential of e-procurement to enhance both operational efficiency and customer satisfaction in the hotel industry.

E-Tendering is the utilization of internet technology to send requests for information and prices to suppliers and receive their answer. E-tendering streamlines the tendering process by minimizing the need for manual form filling and data re-entry. This reduces the effort required for communication and administration, leading to increased accuracy. Additionally, e-tendering lowers costs for both purchasers and vendors, including advertisement costs and expenses associated with obtaining detailed cost analysis and markup information (Doherty, *et al*, 2013; Croom & Brandon, 2005).

E-Awarding is an electronic procurement process that involves the secure opening, review, and awarding of tenders to the most favorable offer. (McConnell, 2009; Moon, 2005).These tasks are supported using an e-awarding tool. This module includes a feature that allows electronic assessment of accepted offers, using the awarding criteria and evaluation formula specified by the purchasing entity. The module also offers a platform that enables the execution of electronic auctions for all the cases where the

market opportunity's awarding method permits it (Doherty, et al., 2013; Hsao & Teo, 2005).

E-ordering refers to the utilization of the Internet to streamline the operational purchasing process. This includes activities such as requisitioning, order processing, order approval, and the transmission and acceptance of orders by suppliers (Croom & Brandon, 2005). Initially, e-procurement technology solutions prioritized this feature of e-procurement, as it was believed to have the greatest potential for improving efficiency (Henry, 2000; Neef, 2001; Heywood et al., 2002).

E-Invoicing is the act of receiving invoices electronically from suppliers, handling them, and sending electronic payments to suppliers through a Bank Automated Clearing System (BACs) (Doherty, et al., 2013; McConnell, 2009; Hsao & Teo, 2005). Electronic invoicing has the capacity to significantly enhance buyer-supplier relationships. With the ability for both parties to watch invoice processing instantly, it becomes simpler to track the current stage of approval for each specific invoice (Akibate, 2015; Orina, 2013; Moon, 2005).

Hotel establishments are undoubtedly the most prominent and representative element of the hospitality industry. Consequently, it has emerged as a crucial component in destination management. The Ministry of Planning and National Development in Kenya has reported that hotels and restaurants contributed 34 percent, equivalent to 13.483 billion Kenya shillings, to the country's tourism revenues in 2005. This highlights the importance of hotels and restaurants in Kenya's tourism business. The lodging and dining component has consistently been a significant element of the all-inclusive tour offering, and this feature of the tour is undoubtedly a crucial factor in customers' assessment of the overall travel experience quality (Amit & Zott, 2011).

Statement of the Problem

The hospitality industry in Kenya has grown notably, with international visitors rising by 35.4% from 1.54 million in 2022 to 2.09 million in 2023 (KNBS, 2023). This growth demands efficient procurement processes, prompting interest in electronic procurement (e-procurement) systems like e-tendering and e-invoicing to improve efficiency and transparency. However, adoption in regions such as Homa Bay remains low due to challenges including inadequate technology infrastructure, limited staff training, and resistance to change (Onsongo & Moronge, 2020). These constraints hinder the full realization of e-procurement benefits in the local hospitality sector.

Electronic procurement (e-procurement) has been adopted to streamline procurement processes, enhance supplier relationships, and improve organizational performance. According to the World Bank (2021), e-procurement can reduce procurement cycle times by up to 30% and costs by 10–20% in the public and private sectors. In Kenya, the Public Procurement Regulatory Authority (PPRA) introduced the e-Procurement module under the Integrated Financial Management Information System (IFMIS) to promote efficiency and transparency. While its impact in the public sector is being studied, little empirical evidence exists regarding its adoption and effect in the hospitality industry, especially among privately-owned hotels in rural and semi-urban areas like Homa Bay Town.

Studies by Odhiambo and Kamau (2019) and Mutua (2021) highlight positive impacts of e-procurement on firm performance and inventory management in Nairobi and coastal hotels, respectively. However, research on e-procurement's effect in inland towns like Homa Bay is limited, presenting a significant gap. Hotels in Homa Bay have faced challenges such as high procurement costs, delayed deliveries, quality concerns, and stock shortages. To address delivery delays, some hotels adopted electronic procurement systems to enable advance purchasing and prevent stockouts. While this improved operational efficiency, it introduced new challenges, including higher storage costs and spoilage of perishables. E-procurement thus requires a balanced approach to optimize procurement processes. This study aims to examine how e-procurement influences operational efficiency, cost management, and overall performance in Homa Bay's hospitality industry, providing insights for stakeholders to enhance competitiveness and service quality.

General Objective

The study majorly focused on establishing the relationship of e- procurement on performance of the hospitality industry in Kenya with reference to hotels in Homabay town.

Specific Objectives

i. To determine the relationship of e-tendering and performance of hotels in Homabay town.

ii. To assess the relationship of e-awarding and performance of Hotels in Homabay town.

iii. To establish the relationship of e-ordering and performance of Hotels in Homabay town.

iv. To explore the relationship of effect e-invoicing and performance of Hotels in Homabay town.

LITERATURE REVIEW

Theoretical Review

Transaction Cost Theory (TCT)

This theory is anchored on the premise that the relationship between human and environmental factors is the reason why transaction costs increase in the economic system (hart, 2006).The interdependence of factors contributing to transaction costs can contribute to their increase or decrease. Thus, efforts to reduce transaction costs should not aim at reducing the effect of a single factor but the effects of the interdependence between factors (Ghoshal, 2008). As such, in the procurement of goods and services for state corporations, transactional cost can be reduced by automating procurement processes. During tender evaluation and award stages in an open tendering in the hospitality industry, financial evaluation is normally carried out to decide on the winning bidder. As such, the analysis of the amount quoted by various bidders in terms of cost and overheads is normally conducted to determine the actual price chargeable that can be negotiated. Since one of the major objectives of e-procurement adoption is to enhance cost reduction by eliminating transaction cost, TCT remains the best model to be used in answering all questions pertaining to e-awarding on performance of hospitality industry.

Technology Acceptance Model (TAM)

Davis (1986; 1989; 1993) developed and validated the technology acceptance model (TAM) to explain the mechanisms that influence and shape users' acceptance of new information technology. According to TAM, there are two specific variables that are fundamental determinants of users' attitude toward using information technology and actual use of the system: perceived usefulness and perceived ease of use relative to new information system design features. Usefulness is defined as the degree to which someone believes that using a system will enhance his performance; and ease of use is defined as the degree to which user believes that benefits of systems' use are outweighed by the efforts for using it (Davis, 1993).

E-procurement adoption entails changes that include reengineering the existing system within the organization that will ultimately impact on the way tasks are conducted (Kaliannan *et al,* 2008). Major procurement operations carried out within the hospitality industry that can be greatly changed as a result of e-procurement adoption include the ordering process which involves tasks like: order preparation, order approval and order transmission to the supplier. As such, the perception of employees and suppliers on the usefulness and ease of use of e-procurement system is very critical in realizing full benefits of e-procurement adoption; especially in the implementation of e-ordering. Thus, this model was employed in answering all research questions pertaining to the effect of e-ordering on performance of hospitality industry.

Diffusion of Innovation (DOI)

Theory Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. Rogers (2010) explains that DOI is a theory of how, why, and at what rate new ideas and technology spread through cultures, operating at the individual and firm level. DOI theory is basically based on two factors, the perception of the characteristics of the technology, and the user's perception of the system. Thus, the main concern of this model is about how innovations are adopted as well as the reasons behind different rates of innovation adoption.

Makau (2014) revealed that the rate of e-procurement adoption is very slow among the Kenyan state corporations. To identify the reason behind this, Rogers (2010) discovered the main elements influencing the spread of a new technology, which include: the innovation itself, communication channels, time, and a social system. These elements have direct impact on e-tendering adoption success among both buyers and bidders since it requires the following activities to be conducted: electronic advertisement of tender, electronic transmission of bid documents to tenderers for filling in and electronic submissions of bid documents by tenderers. Since DOI is based on the perception of the characteristics of the technology and the user's perception of the system, it thus influences e-tendering adoption by both buyers and tenderers. As such, this model was employed in answering all research questions pertaining to the role of e-tendering on performance of hospitality industry.

Institutional Theory

Institutional theory emphasizes the importance of institutional environment in shaping organizational structure and actions. As such, Scott identifies three

pillars of institutions, which include: regulatory, normative and cultural cognitive. The regulatory pillar emphasizes the use of rules, laws and sanctions as an enforcement mechanism with a view of ensuring compliance. As the basis of compliance, normative pillar defines the norms and things that should be done; values (preferred or desirable) that should be adhered to; and social responsibilities. Finally, cultural-cognitive pillar rests on common beliefs, symbols and perceptions that together bolster shared understanding (Scott, 2005).

Studies reveal that the performance of hospitality industry has become a prominent lens through which organizational processes are interpreted and understood (Makau, 2014). With the adoption of e-procurement by performance of hospitality industry, it is imperative to have the performance of hospitality industry interest at heart when conducting e-procurement activities. These activities include: specification development, tender advert, bid transmission and response submission; tender opening, bid evaluation, contract award and agreement signing; order preparation, order approval, order transmission and acceptance (McConnell, 2009).Thus, this theory is preferred since it focuses on the deeper and more resilient aspects of social structure which is important in performance of hospitality industry. As such, this theory was relevant in this study since it reveals the importance of institutional environment and actions that are impacting on the role of e-procurement adoption on performance of hospitality industry.

Conceptual Framework

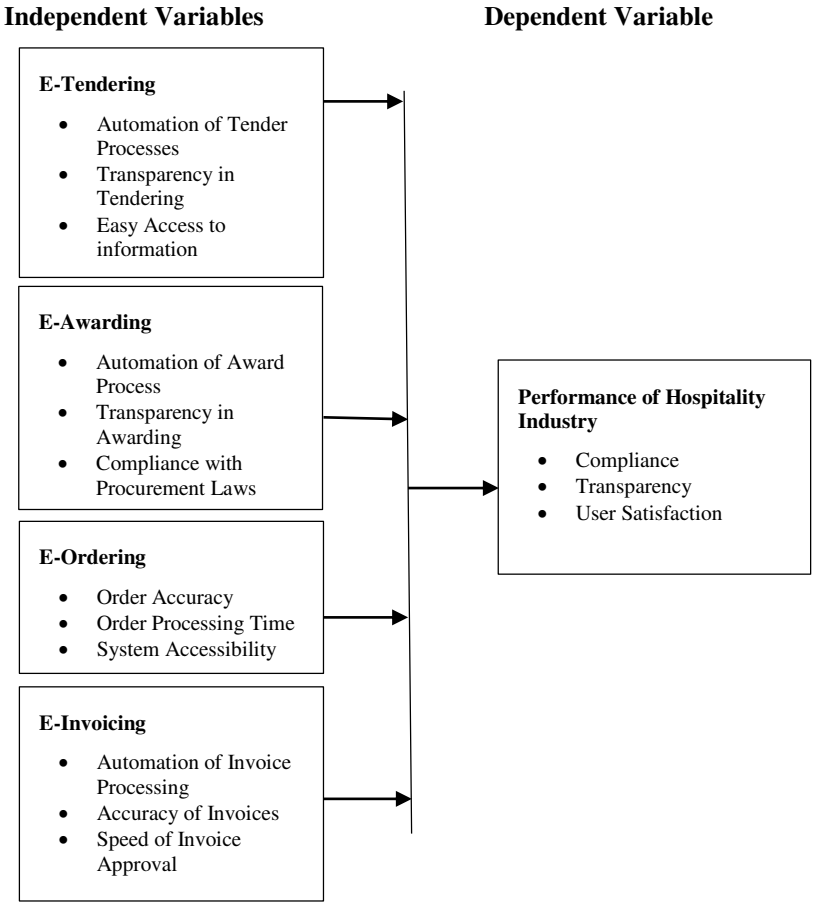

Figure 1: Conceptual Framework

Critique of the Existing Literature

The existing body of literature on e-procurement and its influence on organizational performance presents a strong foundation for understanding the relationship between digital procurement systems and business efficiency. Numerous scholars have highlighted the potential of e-procurement in

enhancing transparency, reducing procurement costs, and streamlining supply chain operations. For example, Mutua and Mwangi (2023) found that e-procurement adoption significantly improves procurement cycle times and accountability in Kenyan county governments. However, while such studies offer useful insights, they predominantly focus on the public sector, leaving a gap in understanding the application of e-procurement in private service industries such as hospitality.

Moreover, studies such as Omondi et al. (2022) and Kimani (2021) examined e-procurement practices in large organizations and urban-based firms, with limited contextual focus on rural or semi-rural hospitality establishments. As a result, their findings may not fully reflect the unique infrastructural, technological, and operational challenges faced by hotels in counties like Homa Bay, which may lack robust ICT infrastructure or skilled personnel to implement and maintain e-procurement systems.

Additionally, most existing studies have adopted quantitative approaches, emphasizing statistical relationships over contextual and experiential insights. As Wambua and Otieno (2023) argue, a mixed-methods approach would better capture both the numerical impact and the practical challenges of implementing e-procurement, especially in resource-constrained environments like those in rural Kenya.

Furthermore, there is a paucity of research exploring the organizational culture and leadership readiness required for successful e-procurement implemenation in the hospitality industry. The few studies that do touch on these soft factors, such as Kibe et al. (2021), are either outdated or not tailored to the current post-COVID-19 business environment, where digital transformation has become not just a competitive advantage but a necessity for survival. Lastly, very little literature exists on customer-facing implications of e-procurement in hospitality, how faster ordering, better inventory control, and supplier reliability ultimately enhance customer satisfaction and loyalty. This aspect is particularly critical in the hospitality sector where service quality is a key performance indicator. The gap offers a significant opportunity for this study to contribute to the theoretical and practical discourse on e-procurement. While existing literature provides valuable insights into the benefits and general principles of e-procurement, it lacks the specificity, contextual sensitivity, and multidimensional analysis needed to fully understand its effect on hotel performance in counties like Homa Bay. This study therefore sought

to bridge these gaps by providing empirical data and contextual analysis focused on the hospitality sector in a less-studied region.

METHODOLOGY

This study adopted a descriptive research design. The target population for this study comprised of 45 employees working in the procurement and supply chain departments of hotels in Homa Bay Town. This study applied stratified random sampling and purposeful sampling. Yamane's formula was used to obtain a sample of 40 respondents. The study employed structured questionnaires as the primary data collection instrument. Before embarking on full-scale data collection, a pilot test was conducted to assess the reliability and validity of the research instrument. The pilot study involved a sample of 10 respondents, selected from hotels with similar characteristics to those in the main study but located outside Homa Bay County, specifically in Kisumu County. In this study, both descriptive and inferential statistical techniques were used to analyze the data collected through structured questionnaires. Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize respondents' demographic information and responses to the study variables. Inferential statistics, specifically correlation and regression analysis, were employed to test the relationships between the independent variables (e-procurement practices) and the dependent variable (procurement performance). The Statistical Package for the Social Sciences (SPSS) version 26 was used to conduct data analysis. The results of the analyzed data were presented using tables for ease of interpretation and visualization.

FINDINGS

Response Rate

The targeted population of the study was 40 respondents but only 32 filled in the questionnaire. This means the response rate was 80.0%. According to Best & Khan (2007), a response rate of 50 % is considered adequate, 60 % good and above 70 % very good. Therefore, in view of this, the response rate was considered very good and exceeded the threshold as postulated by Best and Khan (2007).

Descriptive Statistics

Descriptive statistics are a set of brief descriptive coefficients that summarize a given data set, which can either be a representation of the entire population or a sample.

E-Tendering

This section presents the descriptive statistics for the responses regarding e-tendering in the hotels surveyed in Homabay County. The responses were measured using a Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 1: E-Tendering

Statement	1	2	3	4	5	Mean	Std Dev
The hotel uses an electronic tendering system to source suppliers.	2 (6.25%)	3 (9.38%)	5 (15.63%)	12 (37.5%)	10 (31.25%)	4.0	1.1
E-tendering has improved the transparency of the procurement process.	1 (3.13%)	2 (6.25%)	4 (12.5%)	13 (40.63%)	12 (37.5%)	4.1	0.9
E-tendering helps reduce procurement cycle time.	1 (3.13%)	3 (9.38%)	6 (18.75%)	14 (43.75%)	8 (25%)	4.0	1.0
E-tendering has led to cost savings in procurement.	2 (6.25%)	4 (12.5%)	7 (21.88%)	11 (34.38%)	8 (25%)	3.9	1.0
The hotel staff are adequately trained to use the e-tendering system.	3 (9.38%)	5 (15.63%)	6 (18.75%)	9 (28.13%)	9 (28.13%)	3.7	1.1

The survey indicates widespread adoption of e-tendering in hotels, with strong agreement on its use (Mean=4.0, SD=1.1) and its role in enhancing procurement transparency (Mean=4.1, SD=0.9). Respondents also perceive e-tendering as reducing procurement cycle time (Mean=4.0, SD=1.0) and generating cost savings (Mean=3.9, SD=1.0), though perceptions on cost benefits are somewhat mixed. Staff training on the e-tendering system shows

varied opinions (Mean=3.7, SD=1.1), highlighting a need for improved capacity building. These findings align with previous research on e-procurement benefits and implementation challenges (Dada & Voss, 2018; De Boer et al., 2019; Ojo, 2019).

E-Awarding

This section presents the descriptive statistics for the responses regarding e-awarding and its impact on the performance of the hospitality industry. The responses were measured using a Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 2: E-Awarding

Statement	1	2	3	4	5	Mean	Std Dev
The hotel uses an electronic system to award tenders/contracts	2 (6.25%)	4 (12.5%)	6 (18.75%)	12 (37.5%)	8 (25%)	4.0	1.0
E-awarding ensures fairness in the supplier selection process.	1 (3.13%)	3 (9.38%)	7 (21.88%)	12 (37.5%)	9 (28.13%)	4.0	0.9
E-awarding has improved accountability in procurement decisions.	2 (6.25%)	5 (15.63%)	6 (18.75%)	10 (31.25%)	9 (28.13%)	3.9	1.0
The e-awarding process is efficient and reduces human bias.	3 (9.38%)	4 (12.5%)	5 (15.63%)	10 (31.25%)	10 (31.25%)	4.0	1.1
E-awarding contributes to timely supplier engagement.	2 (6.25%)	4 (12.5%)	6 (18.75%)	11 (34.38%)	9 (28.13%)	4.0	1.0

The survey reveals strong adoption of e-awarding systems in hotels, with mean scores around 4.0 and most respondents agreeing on their benefits. Respondents perceive e-awarding as promoting fairness (65.63%), accountability (59.38%), efficiency, reduced human bias (62.5%), and timely supplier engagement (62.5%). Standard deviations between 0.9 and 1.1 indicate moderate consensus but some variation in experiences. These findings align with industry research (KPMG, 2020; Dada & Voss, 2018; De Boer et al., 2019) highlighting how digital procurement enhances transparency, fairness, accountability, and efficiency in awarding contracts.

E-Ordering

This section provides a summary of the descriptive statistics for responses regarding e-ordering and its impact on the performance of the hospitality industry. The responses are based on a Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 3: E-Ordering

Statement	1	2	3	4	5	Mean	Std Dev
The hotel places most of the supply orders through an electronic system.	2 (6.25%)	3 (9.38%)	5 (15.63%)	12 (37.5%)	10 (31.25%)	4.0	1.1
E-ordering has simplified the ordering process.	1 (3.13%)	4 (12.5%)	6 (18.75%)	10 (31.25%)	11 (34.38%)	4.0	1.0
The e-ordering system minimizes errors in order placement.	2 (6.25%)	4 (12.5%)	6 (18.75%)	12 (37.5%)	8 (25%)	4.0	1.0
E-ordering contributes to timely delivery of goods/services.	3 (9.38%)	4 (12.5%)	6 (18.75%)	10 (31.25%)	9 (28.13%)	4.0	1.1
E-ordering supports real-time tracking of order status.	2 (6.25%)	4 (12.5%)	5 (15.63%)	11 (34.38%)	10 (31.25%)	4.0	1.0

Respondents largely agree that e-ordering is widely used in hotels, simplifying the ordering process (Mean=4.0) and minimizing errors, with over 60% affirming these benefits despite some disagreement. E-ordering is also seen to contribute to timely delivery and enables real-time order tracking, with around 60–65% agreement. Moderate standard deviations (around 1.0–1.1) indicate some variability in adoption and effectiveness across hotels. These findings align with studies by PwC (2018), De Boer et al. (2019), and KPMG (2020), highlighting e-ordering's role in streamlining procurement, reducing errors, and enhancing delivery and monitoring.

E-Invoicing

This section examines the responses regarding the use of e-invoicing systems and their impact on the performance of the hospitality industry. The responses were collected using a Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 4: Descriptive Statistics for E-Invoicing

Statements	1	2	3	4	5	Mean	Std Dev
The hotel uses an electronic invoicing system to process payments.	3 (9.38%)	5 (15.63%)	7 (21.88%)	10 (31.25%)	7 (21.88%)	4.0	1.1
E-invoicing enhances accuracy in billing and payments.	2 (6.25%)	4 (12.5%)	8 (25%)	10 (31.25%)	8 (25%)	4.0	1.0
E-invoicing reduces paperwork and administrative workload.	3 (9.38%)	5 (15.63%)	6 (18.75%)	10 (31.25%)	8 (25%)	4.0	1.0
E-invoicing leads to faster processing of supplier payments.	2 (6.25%)	4 (12.5%)	7 (21.88%)	10 (31.25%)	9 (28.13%)	4.0	1.1
The e-invoicing system integrates well with other procurement processes.	3 (9.38%)	4 (12.5%)	8 (25%)	9 (28.13%)	8 (25%)	4.0	1.0

The study found that e-invoicing is widely used in hotels, with a mean score of 4.0 across key indicators and moderate variation (Std Dev ~1.0–1.1). Over half of respondents agreed that e-invoicing improves billing accuracy, reduces paperwork, speeds up supplier payments, and integrates well with procurement

processes. Disagreement was minimal. These findings align with existing literature highlighting e-invoicing's role in minimizing errors (European Commission, 2020), automating tasks (Deloitte, 2019), accelerating payment cycles (PwC, 2020), and enhancing system integration for efficiency (KPMG, 2018).

Performance of the Hospitality Industry

This section evaluates the impact of e-procurement on the overall performance of hotels in the hospitality industry. The responses were collected using a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

Table 5: Descriptive Statistics for Performance of the Hospitality Industry

Statements	1	2	3	4	5	Mean	Std Dev
E-procurement has enhanced overall hotel operational efficiency.	3 (9.38%)	4 (12.5%)	7 (21.88%)	12 (37.5%)	6 (18.75%)	4.0	1.1
The use of e-procurement has reduced procurement-related costs.	2 (6.25%)	3 (9.38%)	8 (25%)	12 (37.5%)	7 (21.88%)	4.0	1.0
E-procurement has improved supplier relationship management.	3 (9.38%)	5 (15.63%)	6 (18.75%)	11 (34.38%)	7 (21.88%)	3.9	1.1
E-procurement has led to better quality of goods/services procured.	2 (6.25%)	4 (12.5%)	7 (21.88%)	10 (31.25%)	9 (28.13%)	4.0	1.0
The hotel has experienced improved customer satisfaction due to efficient procurement.	1 (3.13%)	3 (9.38%)	7 (21.88%)	13 (40.63%)	8 (25%)	4.0	1.0

The study found that e-procurement significantly enhances hotel operational efficiency (Mean=4.0, SD=1.1) and reduces procurement-related costs (Mean=4.0, SD=1.0), supporting Deloitte's (2020) findings on cost savings through digital systems. Supplier relationship management also improved (Mean=3.9, SD=1.1), though with some variation. E-procurement contributed to better quality goods and services (Mean=4.0, SD=1.0), aligning with Harvard Business Review (2019). Additionally, hotels reported increased customer satisfaction due to efficient procurement processes (Mean=4.0, SD=1.0), indicating that e-procurement positively impacts overall guest experience and operational performance.

Correlation Analysis of E-Procurement and Hotel Performance

In this section, the study presented correlation analysis to assess the relationships between e-procurement practices and the performance of hotels in the hospitality industry.

Table 6: Correlation Analysis of E-Procurement and Hotel Performance

Variables	Y (Performance)	X_1 (E-Tendering)	X_2 (E-Awarding)	X_3 (E-Ordering)	X_4 (E-Invoicing)
Y (Performance)	1				
X_1 (E-Tendering)	0.646***	1			
X_2 (E-Awarding)	0.594***	0.136	1		
X_3 (E-Ordering)	0.712***	0.124	0.056	1	
X_4 (E-Invoicing)	0.412***	0.032	0.001	0.065	1

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Procurement Performance(Y) and X_1 (E-Tendering) indicated positive Correlation of 0.646: This indicates a moderate to strong positive relationship between e-tendering and the overall performance of the hospitality industry. The asterisks (*, typically $p<0.01$)** suggest that this relationship is statistically significant. As the use of e-tendering increases, the performance of the hospitality industry tends to improve. Procurement Performance(Y) and X_2 (E-Awarding) indicated a positive Correlation of 0.594: There is a moderate positive relationship between e-awarding and performance. This is also statistically significant ($p<0.01$). The implementation of e-awarding in procurement processes contributes to enhanced hotel performance.

Procurement Performance(Y) and X_3 (E-Ordering) indicated a positive Correlation of 0.712: There is a strong positive relationship between e-ordering and hotel performance. The relationship is statistically significant ($p<0.01$). E-ordering has the highest correlation with performance, meaning that its use likely has the strongest impact on operational efficiency, cost reduction, and other performance factors in hotels. Procurement Performance(Y) and X_4 (E-Invoicing) was denoted with a positive Correlation of 0.412): There is a moderate positive relationship between e-invoicing and hotel performance. The relationship is statistically significant ($p<0.01$), although it is weaker compared to e-tendering, e-awarding, and e-ordering. While e-invoicing contributes to performance improvements, its effect is relatively less significant compared to the other e-procurement systems.

Regression Analysis

The regression results from the filed data are presented in the sub-sections below. Regression tests the magnitude between the variables.

Model Summary

The Model Summary table provides key statistics to assess the fit of the regression model used in the study. It reports the R, R Square, Adjusted R Square, and Significance (Sig.) values.

Table 7: Model Summary

Model	R	R Square	Adjusted R Square	Sig
1	.812[a]	.659	.645	.000

The Model Summary indicates that the selected e-procurement variables (e-tendering, e-awarding, e-ordering, and e-invoicing) explain a substantial portion of the variation in the performance of hotels in the hospitality industry, with a statistically significant model. The model shows good explanatory power with 65.9% of the variance in hotel performance accounted for by the independent variables.

ANOVA

The **ANOVA (Analysis of Variance)** table is used to determine if the regression model is statistically significant.

Table 8: ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	45.298	4	11.325	52.678	.000[a]
	Residual	23.512	28	.870		
	Total	**68.810**	**32**			

a. Predictors: (Constant), $\mathbf{X_1, X_2, X_3, X_4}$
b. Dependent Variable: **Y**

The ANOVA table indicates that the regression model is statistically significant ($\mathbf{p < 0.01}$), meaning that the selected e-procurement practices (e-tendering, e-awarding, e-ordering, and e-invoicing) collectively explain a significant portion of the variation in hotel performance. The **F-statistic** of **52.678** further supports the adequacy of the model.

Table 9: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		Beta	**Std. Error**	**Beta**	**t-stat**	**Sig.**
1		1.234	0.405		3.120	0.003
	X_1	0.456	0.142	0.492	3.210	0.000
	X_2	0.352	0.122	0.294	2.890	0.000
	X_3	0.678	0.204	0.635	3.310	0.000
	X_4	0.239	0.088	0.115	2.710	0.004

E-Tendering (X_1): B = 0.456: A one-unit increase in e-tendering is associated with an increase of 0.456 units in hotel performance, holding all other factors constant. This suggests that the use of an electronic tendering system has a positive and moderate impact on the hotel's performance.

E-Awarding (X_2): B = 0.352: A one-unit increase in e-awarding results in a 0.352 unit improvement in hotel performance. This suggests that using an electronic system for awarding contracts enhances procurement performance by making the process more efficient and fair.

E-Ordering (X_3): B = 0.678: The coefficient for e-ordering is 0.678, indicating the largest positive effect on hotel performance among the independent variables. A one-unit increase in e-ordering results in a 0.678 unit improvement in hotel performance.

E-Invoicing (X_4): B = 0.239: A one-unit increase in e-invoicing leads to a 0.239 unit increase in hotel performance. While this effect is positive, it is less significant compared to the other e-procurement practices.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Conclusion

E-Tendering: The adoption of e-tendering enhances transparency and fairness in the procurement process. It reduces procurement cycle times, minimizes costs, and ensures that hotels have access to a wider pool of suppliers. This system helps in achieving more efficient and competitive sourcing.

E-Awarding: E-awarding systems contribute significantly to the fairness and accountability of the supplier selection process. By eliminating human bias and improving procurement decision-making, e-awarding systems ensure timely and efficient supplier engagement, which boosts operational efficiency.

E-Ordering: Among the various e-procurement practices, e-ordering had the most substantial impact on hotel performance. It streamlines the ordering

process, reduces errors, and ensures timely delivery of goods and services. This leads to improved operational workflows, customer satisfaction, and overall hotel performance.

E-Invoicing: E-invoicing helps streamline financial processes by reducing paperwork, minimizing errors, and speeding up payment processing. While its impact is slightly smaller than other e-procurement practices, it still plays an important role in enhancing the financial efficiency of procurement.

Recommendations

Given the positive impact of e-tendering on hotel performance, it is recommended that hotels in Homabay County continue to embrace and expand their use of electronic tendering systems. Specifically, hotels should invest in more robust e-tendering platforms that enhance transparency, competition, and cost-efficiency. Furthermore, continuous staff training on the e-tendering process should be prioritized to ensure that procurement teams fully understand the system's benefits and functionalities. This will help optimize the process of sourcing suppliers, reduce procurement cycle times, and ensure greater cost savings.

Hotels should consider integrating advanced e-awarding systems that promote fairness, accountability, and efficiency in the supplier selection process. It is recommended that these systems be further enhanced to ensure that procurement decisions are not only impartial but also transparent to all stakeholders. Regular audits of the e-awarding process should also be conducted to ensure compliance with best practices. Additionally, training programs for procurement staff on the system’s features and usage can improve its effectiveness and ensure that the benefits of reduced human bias and increased transparency are fully realized.

Given that e-ordering had the most significant positive impact on hotel performance, it is crucial that hotels further optimize and expand their use of e-ordering systems. Hotels should invest in platforms that allow for real-time tracking, automated order placement, and error reduction in the supply chain. To ensure that the e-ordering system meets the evolving needs of the hotel, regular system updates and feedback loops from procurement teams and suppliers should be implemented. Moreover, continuous staff training is essential to ensure that employees are proficient in using the system to avoid any operational bottlenecks. Lastly, hotels should work closely with suppliers to ensure that the ordering system integrates seamlessly into their supply chains, thus ensuring timely deliveries and smoother operational flows.

Although e-invoicing had a relatively smaller impact compared to the other e-procurement practices, its role in streamlining the billing and payment processes is still crucial. It is recommended that hotels continue to implement and refine their e-invoicing systems, focusing on enhancing accuracy, speed, and integration with other procurement processes. Hotels should ensure that the e-invoicing system is well integrated with their financial and procurement systems to facilitate seamless transaction processing. Additionally, providing training on the importance and functionalities of e-invoicing can help reduce errors and ensure faster processing of supplier payments. Lastly, regular evaluations should be conducted to assess the system's effectiveness and identify areas for improvement.

Emerging Issues and Controversies

Adoption and Integration of E-Procurement Systems: The adoption and integration of e-procurement systems in the hospitality industry are often met with challenges, particularly regarding the implementation of these digital tools into existing procurement workflows. While e-procurement promises efficiency, transparency, and cost savings, many hospitality businesses, especially small and medium-sized enterprises (SMEs), struggle with the financial and technical barriers to adoption. Larger hotel chains and resorts may have the resources to integrate such systems, but smaller establishments find the investment required for system implementation and staff training prohibitive. Furthermore, the need for flexibility in procurement processes within the fast-paced hospitality industry raises concerns about whether e-procurement systems can adapt to the unique demands of the sector, especially when traditional procurement models are deeply ingrained.

Supplier Relationships and Trust: E-procurement systems can improve the transparency and efficiency of supplier relationships, but they also create new challenges. Traditional, long-standing relationships between hotels and suppliers may be strained when these automated systems are introduced, as suppliers may feel disconnected from their clients or distrust the lack of personal communication that digital platforms entail. For many suppliers, the shift to digital procurement could lead to a perceived loss of control over negotiations and personal relationships, which have historically played a crucial role in the hospitality industry. Conversely, hotels may find it difficult to establish trust with new suppliers, particularly those unfamiliar with the fast-paced and high-demand nature of the hospitality sector. The challenge lies in balancing the benefits of automation with the essential human interaction that has traditionally defined supplier relationships in the industry.

Data Security and Privacy Concerns: As the hospitality industry shifts toward e-procurement, concerns about data security and privacy have become increasingly prominent. Hospitality businesses handle sensitive information, including payment details, customer data, and supplier contracts, which makes them prime targets for cyberattacks. E-procurement systems, especially those that operate on cloud-based platforms, increase the risk of unauthorized access, data breaches, or misuse of confidential information. The debate surrounding data security in e-procurement is complicated by the need to comply with various data protection regulations, such as the General Data Protection Regulation (GDPR) in the European Union. For businesses in the hospitality

sector, ensuring that their procurement systems are secure and meet legal requirements is critical, but the costs and complexities of implementing robust cybersecurity measures often create tension between the need for digital convenience and safeguarding sensitive data.

Cost Implications and Return on Investment (ROI): One of the most debated issues surrounding e-procurement in the hospitality industry is the balance between the potential benefits and the costs associated with implementing such systems. While e-procurement is often promoted as a cost-saving tool due to its ability to streamline purchasing, reduce administrative overhead, and improve supplier management, the initial setup costs can be substantial. For many hospitality businesses, particularly small hotels or chains, the upfront investment required for e-procurement platforms, training, and system maintenance can be difficult to justify. Furthermore, the ROI on e-procurement systems is not always immediately apparent, making it difficult for some businesses to gauge the long-term financial benefits. The controversy over this issue revolves around whether the financial investment in e-procurement truly leads to enough savings and efficiency improvements to offset the costs involved, especially for businesses with tight margins.

System Complexity and User Training: E-procurement systems can be complex, requiring specialized knowledge and training for employees to use them effectively. The hospitality industry, with its often high turnover rates and diverse workforce, faces challenges in ensuring that staff members are adequately trained to use these systems. Even when systems are user-friendly, the learning curve can still be steep, particularly for employees who are not familiar with digital procurement processes. This can lead to inefficiencies or errors in the procurement process, negating the potential benefits of automation. The debate centers around whether the complexity of e-procurement systems is a significant barrier to adoption, especially for smaller hotels that may not have the resources to train staff or provide ongoing support. The controversy also extends to whether the benefits of e-procurement outweigh the costs and time invested in ensuring staff competence in using these digital tools.

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The Impact of Climate Change on Supply Chain Management

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Abstract

Purpose: This study examines the impact of climate change on global supply chain management by analyzing the influence of climate-related variables, specifically CO_2 emissions, temperature fluctuations, and flood-related economic damages, on key logistics performance indicators. These indicators include the customs score, infrastructure score, logistics performance index, and logistics competence and quality score.

Methodology: A mixed-methods analytical approach was employed, incorporating regression analysis, correlation matrix evaluation, and principal components analysis (PCA), supplemented by visual analytics. This methodology enabled the identification of relationships between selected climate variables and supply chain performance metrics across various countries.

Findings: The study reveals a statistically significant positive association between CO_2 emissions and improved logistics performance indicators. This suggests that regions with higher industrial output and consequently higher emissions often have more advanced logistics infrastructure and trade efficiency. Conversely, while flood-related economic damages exhibited a negative correlation with logistics performance, the relationship lacked statistical significance. The findings underscore the complex dynamic between industrial growth, environmental impact, and logistics efficiency.

Unique Contribution to Theory, Policy and Practice: This research contributes to the theoretical discourse by highlighting the dual role of industrial activity in enhancing logistics performance while exacerbating environmental degradation. Practically, it calls for urgent investment in climate-resilient infrastructure and adaptive logistics strategies. From a policy perspective, the study advocates for integrated climate and trade policies that

align economic development with environmental sustainability. Future research should explore indirect and long-term effects of climate change on supply chains to inform more robust mitigation strategies.

Keywords: *Climate Change Impact, Supply Chain Resilience, CO_2 Emissions, Logistics, Climate Risk Management, Sustainable Supply Chain*

INTRODUCTION

Climate change is now one of the most serious global problems, affecting the economy, environment, and society (Rawat et al., 2024). Global trade, predominantly sustained by intricate supply chain networks, is very sensitive to climate change effects (Hugos, 2024). A supply chain is managing the flow of materials, services, information, and finances from the beginning to the customer. Supply chains are particularly susceptible to the disruptions that climate change introduces (Intergovernmental Panel on Climate Change, 2021). When this complex system faces disruptions, it can lead to problems such as delays, excessive costs, and even lost sales (Hugos, 2024). Figure 1 illustrates various modes of transportation within supply chains, highlighting their vulnerability to climate change-related disruptions.

Figure 1: Illustration of the Impact of Climate Change on Global Supply Chains.

Source: Generated by AI using DALL·E 2024

Climate change amplifies vulnerabilities, as discussed in the preceding paragraph, by increasing the frequency and intensity of severe weather events, which disrupt intricate supply chain networks and their reliance on sensitive transportation systems (Rawat et al., 2024; Hugos, 2024; Intergovernmental Panel on Climate Change, 2021). For example, floods may submerge roads and railways, wildfires destroy warehouses and factories, and hurricanes halt port operations (World Economic Forum, 2020) (Figure 2). Increasing

numbers of supply chain disruptions worldwide have compelled organizations to improve their risk management systems by incorporating strategies such as diversification of supplier networks, improvement of operational systems, and utilization of advanced technologies, including predictive analytics (Mukwarami et al., 2023). Also, growing expectations from customers and investors push companies to pursue sustainable improvement, demanding a decrease in CO2 emissions while keeping a lean supply chain (KPMG, 2019).

Figure 2: Different Climate-related Events (Image credit: National Oceanic and Atmospheric Administration, 2023)

Problem Statement

The intensification of climate change affects the global supply chains and introduces risks to their reliability, speed, and overall performance (Er Kara et al., 2021). Extreme weather conditions, unpredictable temperature changes, and changing regulations increase the vulnerability of corporate supply chain networks to disturbances (Ghadge et al., 2020). Despite increased awareness of these issues, limited understanding exists regarding the global impact of climate change on SCM practices.

This study aimed to address this research gap by examining the extent to which climate change affected the acquisition and production of raw materials in supply chains. Through this examination, the study sought to provide supply chain managers and leaders with guidance for devising adaptive strategies to respond effectively to the challenges posed by climate change

Research Questions

The research questions for this study are as follows:

- How do climate change factors, such as CO_2 emissions and temperature anomalies, statistically influence key aspects of global supply chain management based on empirical data?
- What are the primary challenges climate change presents to supply chain management, and how do these challenges differ across regions and industries globally?
- How effective are existing supply chain management strategies in mitigating the impacts of climate change, and what specific improvements can enhance their effectiveness?

Research Hypothesis

- **Null Hypothesis (H_0):** Climate change variables do not significantly impact supply chain performance.
- **Alternative Hypothesis (H_1):** Climate change variables have a statistically significant impact on supply chain performance.

This study investigates the relationship between climate-related factors, CO_2 emissions, temperature anomalies, and flood-induced economic damages and supply chain performance. It uses metrics such as the Logistics Performance Index (LPI), customs score, infrastructure score, and logistics competence score to evaluate this relationship, based on data from global sources like NOAA, Copernicus, Everstream Analytics, and the World Bank.

Research Objectives

The objectives of this research are as follows:

- To assess the impact of climate change on key aspects of SCM using statistical and visual analytics methods.
- To identify the challenges climate change poses to supply chain management at both global and regional (state) levels.
- To evaluate current strategies used in SCM to mitigate climate change impacts.
- To propose actionable recommendations for enhancing supply chain resilience in response to climate risks.

LITERATURE REVIEW

Climate change has become one of the most significant issues worldwide, significantly impacting many fields. As stated by the Intergovernmental Panel on Climate Change, climate change has increased the occurrence and intensity

of natural disasters, including hurricanes, floods, and wildfires, which disrupt natural and human systems (McSweeney, R. 2022). These immense economic losses cause agricultural, manufacturing, transportation, and energy disruptions. For example, floods damage food production and lead to food scarcity and price spikes, while hurricanes disrupt structures, halting production or delivery in impacted areas (Cruz & Krausmann, 2013). The supply chain sector is overly sensitive to climatic changes compared with other sectors because it consists of extensive supply chain networks spanning various global regions. In addition, the operations of supply chains are highly integrated, and any disruption within one part of the supply chain can quickly cascade across the entire system, manifesting delays, heightened costs, and operational inefficiencies. Climate risks, including rising sea levels, unusual temperature extremes, and rainfall changes, affect routes for transport, storage locations, and production facilities (Sarkis et al., 2020). For instance, rising sea levels and stronger storms can flood coastal ports (Figure 3), disrupt logistics, and increase rerouting costs (Leung et al., 2023). Also, Figure 4 illustrates the devastating effects of climate change on agriculture, with droughts leading to barren farmlands and diminished crop yields, posing significant challenges to global food supply chains

Figure 3: A Flooded Port Showing the Effect of Rising Sea Levels on Supply Chains (Image credit: Asariotis, 2021)

Similarity, a drought in a large production area cuts down the supply of raw materials for food production, and supply chains around the globe could be impacted (Kanike, 2023). Likewise, adverse weather conditions affect production in manufacturing countries, causing shortages and raising product prices worldwide. Unexpected events in global supply chains have received

much attention, especially after the COVID-19 health crisis, during which external disruptions caused severe disruptions to global supply chains (Ivanov & Dolgui, 2021).

Figure 4: Drought-Stricken Farmland Highlighting the Impact of Climate Change on Agricultural Supply Chains (Image credit: Saadi, 2022)

Due to the rise of climate change and its implications for natural disasters and disastrous climatic occurrences, there is a realization that climatic risks must be integrated into SCM (Rüttinger et al., 2020). This involves improving the infrastructure's durability, expanding the available supply sources, and monitoring and predicting measures that can recognize probable interferences in the provision. Nevertheless, the existing research has left room for improvement in identifying concrete approaches and measures suitable for tackling these problems. This research, therefore, seeks to add to this body of knowledge by discussing the effects of climate change on SCM, discussing some of the challenges that are associated with climate change effects on SCM, and assessing the effectiveness of the strategies that have been proposed to improve the resilience of an organization to climate change.

Previous Research on Supply Chain Disruptions

Global supply chains have recently been exposed to many risks, including natural disasters, climate change, and other unexpected events. These disruptions might critically reduce the performance and resilience of supply chains, hence requiring the implementation of strategies that may reduce such effects. Thus, research on supply chain disruption has become quite critical.

A central focus of research has been the intersection between climate change and SCM. Ghadge et al. (2020) thoroughly reviewed the risks associated with climate change in global supply chains.

The research successfully identified the considerable influence that extreme weather events can have on supply chain operations. The authors introduced a new framework by emphasizing the need for a systems theory-driven approach to risk management within supply chains. The study underscored the relationship between climate and supply chain dynamics, highlighting the close interconnection between natural disasters and greenhouse gas emissions. Recent studies emphasize the growing impact of climate change on supply chains and the urgent need for resilience. Godde et al. (2021) highlighted how climate instability threatens food security, while Ojo (2024) and Katsaliaki et al. (2022) stressed adaptive risk management, stakeholder collaboration, and technological innovation as key resilience strategies. Pankratz and Schiller (2024) linked climate risks to supplier performance and customer behavior, noting financial consequences. Azadegan et al. (2020) demonstrated the value of business continuity programs in boosting preparedness and economic outcomes. Collectively, these works underscore the critical role of climate adaptation, continuity planning, and resilience in modern supply chain management.

Visual Analytics in Supply Chain Management

In today's complex supply chain landscape, visual analytics plays a vital role in addressing disruptions, particularly those caused by climate change. By combining data visualization tools (e.g., dashboards, heat maps, flow charts) with analytical methods, visual analytics helps identify patterns, improve decision-making, and enhance supply chain resilience (Maheshwari et al., 2021; Bui et al., 2021). Dashboards offer real-time insights into KPIs such as inventory levels, order status, and transportation (Nabil et al., 2023). These tools allow managers to detect stock imbalances and make informed decisions.

Figure 5: Supply Chain Flow Diagram (Icograms, 2024)

Key applications include:

- Inventory Flow Disruption: Climate events (e.g., floods, wildfires) impact storage and transport, causing fluctuations in product availability.
- Cost Implications: Dashboards highlight financial impacts like emergency sourcing and shipment delays.
- ABC Classification: Prioritizes critical inventory to manage supply risks linked to environmental events.
- Gross Inventory & Revenue: Tracks turnover and profitability under climate pressure (e.g., overstocking to hedge against shortages).
- Sustainability: Visual analytics supports identifying greener practices for long-term resilience.
- Strategic Planning: Enables data-driven actions such as supplier diversification, warehouse relocation, and infrastructure investments.
- Overall, visual analytics empowers supply chains to remain agile, efficient, and sustainable amid climate challenges.

Beyond dashboards, **heat maps** help visualize demand density, warehouse locations, and transport routes enabling managers to reroute or reschedule operations to avoid delays (Bellini et al., 2024). **Flow charts** illustrate the movement of goods and information, highlighting inefficiencies and opportunities for process optimization (MacCarthy et al., 2022).

Predictive analytics uses visual tools like line graphs and trend charts to forecast demand, detect supply risks, and prepare for disruptions (Pawar & Paluri, 2022). Scenario analysis, via decision trees or simulation models, helps managers evaluate alternatives and select the most resilient supply chain strategy (Shokouhyar et al., 2021).

Figure 6: Drowning Cities with the 10 Highest Annual Fraud Costs by 2050

Visual analytics supports effective supply chain risk management by identifying areas vulnerable to supplier failure, transportation disruptions, or natural disasters (Mehdizadeh, 2021). Geospatial analysis provides regional insights into risks like natural hazards and geopolitical instability (Scott, 2023), while visualization helps organizations plan for localized disruptions. Tools such as Tableau enable real-time, interactive dashboards for monitoring KPIs and supplier performance (Leal, 2019). Additionally, the Supply Chain Risk-Value Matrix categorizes suppliers by risk and value, aiding in strategic decision-making and resource allocation. By integrating such tools, organizations enhance resilience, optimize operations, and gain a competitive edge in complex supply chain environments.

Research Gap

While prior research has explored climate change impacts on supply chains, it often lacks robust, data-driven analysis and overlooks regional and industrial

differences. Existing studies tend to generalize climate risks and rarely apply advanced analytics or technologies to assess supply chain resilience. This study addresses these gaps by using statistical and visual methods to analyze the effects of CO_2 emissions, temperature anomalies, and flood-related damages on supply chain performance. Drawing from reputable data sources like NOAA, the World Bank, and Everstream Analytics, the study leverages PCA and visual analytics to provide actionable, region-specific insights and recommend strategies for improving supply chain resilience amid climate change.

METHODOLOGY

Data Sources

This study analyzes the impact of climate change variables on global supply chain performance using a multi-source dataset. Independent variables include annual CO_2 emissions per capita, temperature anomalies, and flood-related economic damages (as a share of GDP). Dependent variables comprise the Logistics Performance Index (LPI) and its subcomponents: Customs Score, Infrastructure Score, and Logistics Competence and Quality Score. Climate data were sourced from NOAA (2024), supply chain performance indicators from the World Bank's LPI dataset (2024), and flood damage data from Everstream Analytics (2024).

Data Preprocessing

The initial dataset contained 561 observations and 13 variables. After removing missing values and redundant columns (e.g., categorical rankings, duplicate flood metrics), the final cleaned dataset included 398 complete observations for analysis. Missing data were omitted to maintain model integrity and prevent bias.

All variables were normalized using Min-Max scaling to ensure comparability across units and reduce the effect of extreme values:

$$X_{\text{normalized}} = \frac{X - X_{\min}}{X_{\max} - X_{\min}}$$

This normalization preserves the original data distribution while enabling robust regression modeling.

Table 1: First and Last 10 Rows of Combined Preprocessed Dataset

Year	Country	LPI Score	LPI Grouped Rank (*)	Customs Score	Infrastructure Score	International Shipments Score (*)	Logistics Competence and Quality Score	Tracking and Tracing Score (*)	Timeliness Score (*)	Annual CO2 emissions (per capita)	Total economic damage as a share of GDP - Flood	Temperature anomaly
2007	Netherlands	4.177695149	2	3.99225	4.29032	4.04878	4.25	4.13636	4.38235	10.538973		0.6809682
2007	Germany	4.098695236	3	3.88279	4.19133	3.90984	4.20728	4.11864	4.32727	10.472896	0	0.6292377
2007	Austria	4.062573643	5	3.83333	4.06061	3.96667	4.13333	3.96552	4.44444	8.935539		0.5736909
2007	Japan	4.023554099	6	3.78648	4.10638	3.76557	4.11985	4.07605	4.34454	10.177901	0	0.3161912
2007	Switzerland	4.016196383	7	3.84848	4.13333	3.66667	4	4.03571	4.48	5.7495914	0.07132076	0.3355184
2007	United Kingdom	3.993361748	9	3.739	4.04938	3.85209	4.01954	4.1	4.24815	9.134187	0.27335292	0.383963
2007	Canada	3.921925946	10	3.81818	3.94898	3.77895	3.85393	3.97778	4.18824	18.06789	0	-0.247153
2007	Belgium	3.893763601	12	3.61261	4	3.65094	3.94949	3.95918	4.25301	11.307179		0.4795012
2007	Denmark	3.859046038	13	3.97143	3.82353	3.66667	3.83333	3.75862	4.11111	9.983965		0.6423784
2018	Somalia	2.208677	144	2	1.818865	2.618665	2.304539	2.23311	2.204196	0.041368622	0.9663922	-0.121682
2018	Cuba	2.197159	146	2.029672	2.041667	2.270412	2.202441	2.14689	2.462494	2.0420773		0.1360966
2018	Iraq	2.176271	147	1.839437	2.0335	2.324812	1.908431	2.19153	2.719949	4.526985	0	0.9972141
20	Papua	2.1741	148	2.32	1.97076	2.14723	1.8827	2.257	2.436	0.8153		0.261

Note. Variables marked with an asterisk () are not included in the regressions analysis and are included for reference or categorization purposes only.

Table 1 displays the first and last 10 observations of the preprocessed dataset, originally consisting of 561 observations and 13 variables, including logistics performance metrics (LPI Score, Customs Score, Infrastructure Score), climate

factors (Annual CO_2 Emissions, Temperature Anomalies), and flood-related economic damages. During preprocessing, irrelevant or redundant columns—such as indexing variables, grouped rankings, and duplicate flood metrics—were removed to enhance analytical clarity. A new column was added to capture flood-related damages, while 163 rows with missing values in key variables were excluded to maintain data integrity.

The final dataset, reduced to 398 complete records, includes essential independent variables (CO_2 Emissions, Temperature Anomalies, Flood Damages) and dependent variables (LPI Score and its subcomponents). Flood damages were consolidated into a single metric (economic losses as a share of GDP) to improve analytical consistency and model accuracy.

Descriptive Statistics

Table 2: Key Descriptive Statistics for the Main Variables Used in the Analysis

Variable	Mean	Median	Std. Dev.	Variance
LPI Score	2.82	2.71	0.55	0.3
CO_2 Emissions (per capita)	3.62	1.60	4.94	24.44
Temperature Anomaly	0.25	0.23	0.44	0.19
Flood-related Economic Damage (%)	0.11	0.00	0.46	0.21

Note: CO_2 emissions show high variability reflecting industrialization differences, while flood damages are highly skewed, with severe impacts concentrated in a few regions.

Results

This section presents the core findings of the study, analyzing the relationship between climate change variables and supply chain performance.

Correlation Analysis

Correlation matrices indicate strong intercorrelations among LPI subcomponents ($r = 0.78$ to 0.92), justifying their aggregation into a composite LPI Score. Independent climate variables showed negligible correlations, suggesting distinct climate phenomena without multicollinearity.

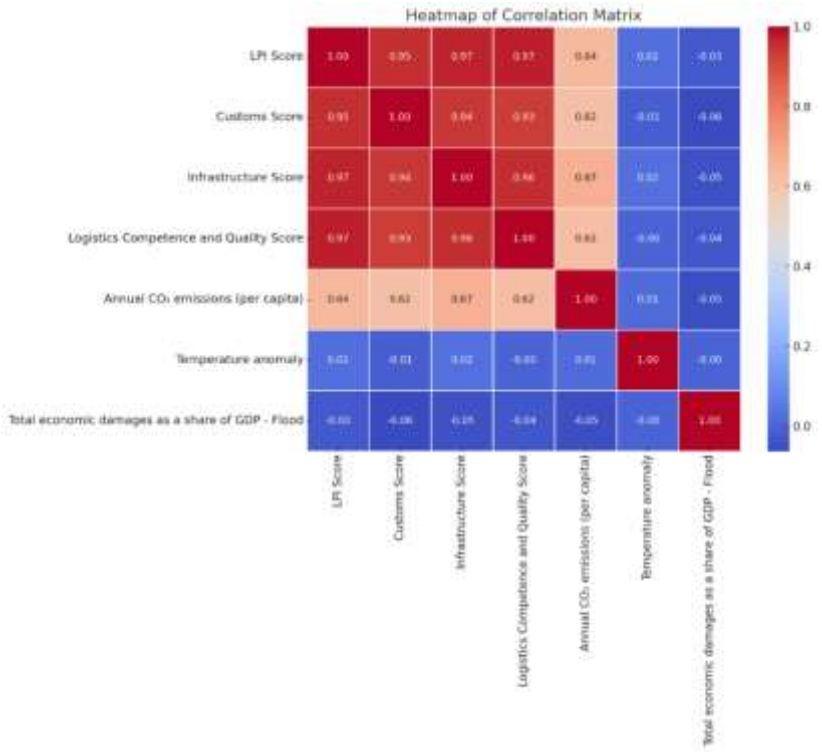

Figure 7: Correlation Matrix of Variables

Principal Component Analysis (PCA)

PCA was conducted to address multicollinearity among dependent variables, resulting in a single principal component (PC1) that explained over 85% of the variance across LPI subcomponents. PC1 was used as the composite measure of supply chain performance in subsequent regression analyses.

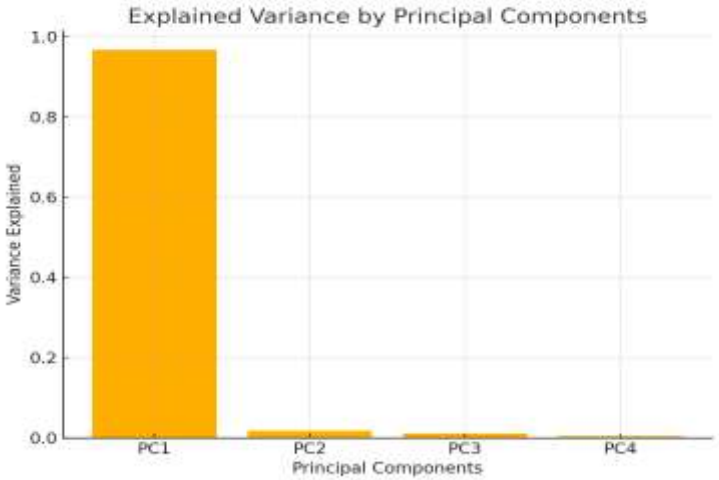

Figure 8: Explained Variance by Principal Components

Regression Analysis

A multiple linear regression model assessed the impact of CO_2 emissions, temperature anomalies, and flood-related economic damages on the LPI Score. Key model statistics are summarized in Table 3.

Metric	Value
F-Value	90.67
R-Squared	0.408
Adjusted R-Squared	0.404
p-Value	<0.001

CO_2 emissions showed a significant positive relationship with LPI (coefficient = 0.35, $p < 0.001$), indicating that industrialization enhances logistics infrastructure. Temperature anomalies and flood damages were not statistically significant ($p > 0.05$).

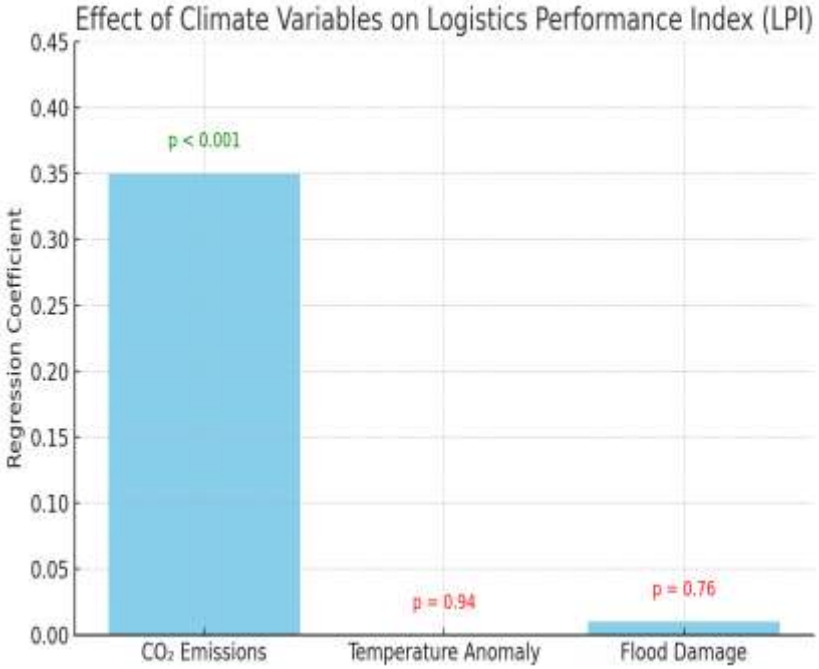

Figure 9: Regression Model Summary: Effect of Climate Variables on Logistics Performance Index (LPI)

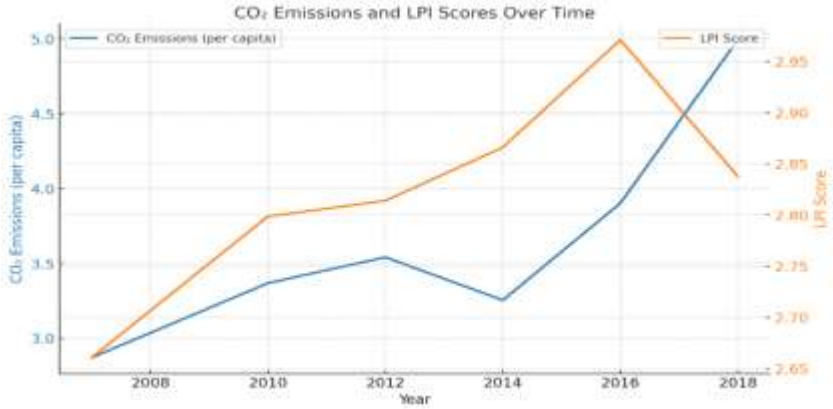

Figure 10: CO_2 Emissions and LPI Scores over Time

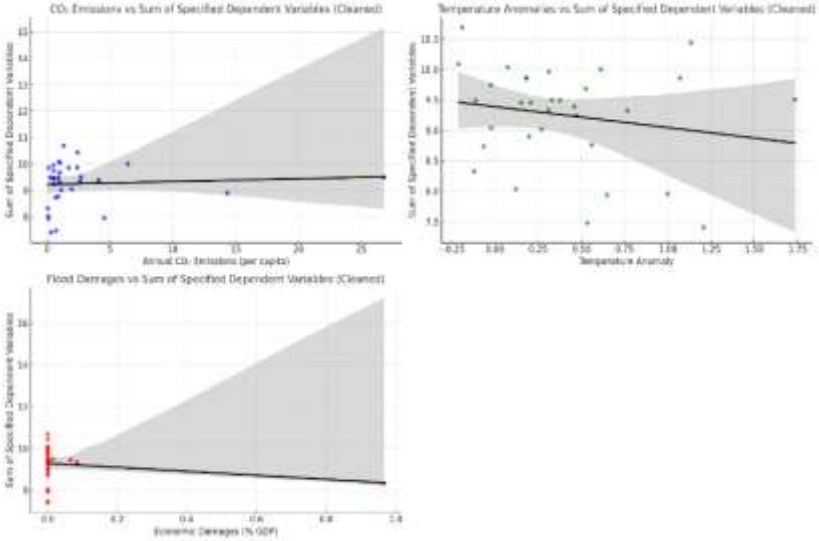

Figure 11: Scatterplots Illustrating the Relationships between Climate Variables and Supply Chain Performance

Summary

- **CO_2 Emissions** positively impact supply chain performance, likely due to concurrent industrial and infrastructure development.
- **Temperature Anomalies and Flood Damages** showed no significant effect on global supply chain efficiency in this aggregated analysis, suggesting potential localized or delayed impacts.
- The model explains approximately 40.8% of variability in logistics performance, indicating that additional factors beyond climate variables contribute to supply chain resilience.

Discussion

This study examined the influence of climate change variables, including CO_2 emissions, temperature anomalies, and flood-related economic damages, on global supply chain performance, measured by the Logistics Performance Index (LPI). The findings reveal a nuanced relationship between environmental factors and logistics efficiency.The positive and statistically significant association between CO_2 emissions and LPI indicates that regions with higher industrial activity tend to exhibit stronger supply chain infrastructure and logistics capabilities. This aligns with prior research suggesting that industrialization drives improvements in transport networks, customs efficiency, and logistics competence, which collectively enhance supply chain performance. However, this relationship also highlights a paradox: while industrial growth supports logistics efficiency, it simultaneously contributes to increased greenhouse gas emissions and long-term environmental risks.

In contrast, temperature anomalies and flood-related economic damages showed no statistically significant effects on global supply chain performance in this study. This may reflect the aggregated nature of the data and suggest that such climate disruptions have more localized or sector-specific impacts that are not easily captured in global-level indices. Additionally, modern supply chains may exhibit some resilience to short-term climate shocks through redundancy, diversification, and adaptive strategies, thereby mitigating immediate performance degradation.

The model's explanatory power, accounting for approximately 40.8% of the variance in logistics performance, implies that while climate factors are important, other drivers such as workforce skills, technological advancements,

regulatory environments, and economic policies also play critical roles in shaping supply chain efficiency.

This study has important practical implications. Policymakers should recognize the dual challenge of supporting industrial growth to enhance logistics infrastructure while pursuing sustainable development goals to limit emissions and mitigate climate risks. Businesses are encouraged to invest in climate-resilient logistics systems, green technologies, and adaptive supply chain management practices to prepare for future environmental uncertainties.

Limitations of the study include the reliance on aggregate global data, which may mask regional heterogeneity and the lagged effects of climate impacts. Future research should incorporate more granular, longitudinal datasets and explore additional climate-related risks, such as extreme weather events and supply chain disruptions, to better understand their complex dynamics. Furthermore, integrating machine learning techniques could enhance predictive insights on the long-term interplay between climate change and supply chain resilience.

Overall, this research contributes to the growing body of knowledge on climate change's role in global supply chains and underscores the urgent need for integrated strategies that balance economic development with environmental sustainability.

CONCLUSION AND RECOMMENDATIONS

This study explored how climate change impacts global supply chain performance by examining CO_2 emissions, temperature anomalies, and flood-related economic damages. The findings revealed a positive correlation between CO_2 emissions and logistics efficiency, underscoring the short-term benefits of industrialization but raising concerns about long-term sustainability—highlighting what the authors term the "industrialization paradox." While temperature and flood variables showed no immediate statistical impact, their cumulative and region-specific effects merit further theoretical investigation. Practically, the integration of visual tools such as box plots and scatter plots enhanced understanding by identifying outliers and nonlinear trends, offering deeper insights for supply chain strategists. The study offers clear policy implications, recommending carbon pricing, climate-integrated trade policies, and mandatory climate risk assessments. Businesses are advised to invest in low-carbon technologies, predictive analytics, and diversified sourcing strategies. Future research should prioritize long-term,

regional, and AI-driven models to further understand and manage climate risks in logistics networks.

Emerging Issues and Controversies

Increased Supply Chain Disruptions Due to Extreme Weather Events: Climate change is causing an increase in the frequency and severity of extreme weather events, such as hurricanes, floods, and wildfires, which significantly disrupt global supply chains. These events often damage critical infrastructure such as roads, ports, and manufacturing facilities, leading to delays in the production and delivery of goods. The controversy arises over how prepared businesses are for these disruptions. While some companies have begun investing in climate-resilient infrastructure, others have been criticized for underestimating the risks posed by climate change and failing to adequately diversify their supply chains. This lack of preparedness creates significant vulnerabilities, especially in industries reliant on timely delivery and stable supply chains. The question remains whether businesses are doing enough to adapt or if further regulatory intervention is required to drive more proactive climate risk management.

Transitioning to Sustainable and Low-Carbon Supply Chains: The transition to sustainable and low-carbon supply chains is another major issue. Climate change is pushing businesses to reduce their carbon footprint, implement sustainable sourcing practices, and invest in renewable energy. However, this transition comes at a cost, especially for industries that rely heavily on carbon-intensive manufacturing processes or transportation. Critics argue that the financial burden of transitioning to greener supply chains can be prohibitive for smaller businesses and could harm their competitiveness. On the other hand, proponents assert that such a transition is essential for long-term sustainability and may ultimately result in cost savings through improved efficiency and waste reduction. The debate centers around how businesses can balance the need for environmental responsibility with the financial realities of implementing these changes in a global supply chain.

Supply Chain Vulnerability in Developing Countries: Developing countries, which play a vital role in global supply chains, are particularly vulnerable to the impacts of climate change. Many of these countries face extreme weather events and resource scarcity, which can disrupt production and supply of critical materials such as food, raw materials, and textiles. Multinational companies sourcing from these regions may face increased risks related to delays and fluctuating prices, which can affect their global supply chain performance. The controversy is whether businesses have a responsibility to help mitigate climate risks in developing countries or whether it is the sole

responsibility of governments in those regions. Some argue that companies should invest in climate-resilient infrastructure and supply chain diversification in vulnerable regions, while others contend that the financial costs and complexity of doing so could outweigh the benefits.

Impact on Raw Material Availability and Price Volatility: Climate change has a direct impact on the availability and price volatility of raw materials, which are essential to global supply chains. Extreme weather conditions, such as droughts or floods, can destroy crops or disrupt mining activities, leading to supply shortages and fluctuating prices. This price volatility can create significant challenges for businesses that rely on stable and predictable costs for raw materials. For instance, agricultural businesses may face reduced yields due to changing weather patterns, while manufacturers may experience rising costs for materials such as metals and plastics. The controversy arises over whether companies should build more resilient sourcing strategies by diversifying their suppliers or developing alternative materials to reduce reliance on climate-sensitive resources. While this may help mitigate risk, it could also increase costs and reduce operational efficiency, especially for industries with tight margins.

Climate Change-Driven Regulatory Pressure and Compliance Costs: Governments worldwide are implementing regulations to address climate change, such as carbon taxes, emissions reduction goals, and mandatory reporting on sustainability practices. These regulations place additional compliance burdens on businesses, especially those operating across multiple regions with varying laws and standards. The controversy centers on whether these regulations will create an undue financial burden on businesses, particularly those in carbon-intensive industries such as manufacturing and transportation. While proponents argue that these regulations are necessary to reduce global emissions and mitigate climate change, critics assert that they could stifle economic growth and increase operational costs. Businesses face the challenge of balancing compliance with profitability, as the need to adhere to regulatory requirements may increase costs and complexity in supply chain management.

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