LOGISTICS INFRASTRUCTURE AND SUPPLY EFFICIENCY OF PETROLEUM PRODUCTS IN KENYA: A SURVEY OF OIL MARKETING COMPANIES IN KENYA

BY

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A Thesis Report Submitted to the School of Business and Economics, Department of Marketing and Logistics in Partial Fulfillment of the Requirements for the Degree of Master of Science in Logistics & Supplies

Moi University

2023

DECLARATION

Declaration by the Candidate

I declare that this thesis is my original work and has not been presented for a degree in any other University. No part of this thesis proposal may be reproduced without the prior written permission of the author and/or Moi University.

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DEDICATION

This thesis is dedicated to my friends, family, and coworkers. I am especially appreciative of my devoted parents, John and Elizabeth Okitte, whose words of support and insistence on perseverance are still echoing in my head. My brother Gordon, sisters Asenath and Rena have always been by my side and are very special. I dedicate this work to my beloved wife Lilian Anyango, my amazing son John Philip Hawi, and my daughter Elizabeth Chrisencia Amor, who have supported me over the entirety of my master's degree. My greatest supporters have been the three of you.

ACKNOWLEDGEMENTS

I would like to express my gratitude to Drs. Ronald Bonuke and Stanley Kavale, who oversaw my thesis and were extremely patient and kind with their knowledge and valuable time spent reading, thinking, and supporting me. I would like to express my gratitude to a number of Oil Marketing Companies for allowing me to conduct my research there and for their willingness to help out with any requests. I would especially like to thank the staff at Moi University Coast Campus for their unwavering assistance. Mr. Martin Kipyego in particular deserves special recognition for being available for consultations whenever I needed them. Lastly, I would want to express my gratitude to the administration and mentor-lecturers in our campus who helped me with my endeavor. The completion of this research was made fun by their eagerness and openness to offer comments.

ABSTRACT

In Kenya, petroleum products are a major source of commercial energy accounting for about 80% of the country's commercial energy requirements. Petroleum products consumed in Kenya are imported from the Gulf region as refined petroleum products thus this calls for efficient management of downstream petroleum sector. However, the country has been faced with frequent fuel shortages leading to unstable fuel prices which result to high cost of production incurred by manufacturers. The purpose of the study was to establish the effects of Logistics Infrastructure on Supply Efficiency of Petroleum Products in Kenya. The specific objectives were to establish effect of oil Storage Infrastructure, effect of Transport Infrastructure, effect of Handling Infrastructure, and effect of Clearing Infrastructure on Supply Efficiency of Petroleum Products in Kenya. The study adopted the Supply chain operations reference (SCOR) theory, queuing theory, resource-based theory, and network theory. The research design was explanatory research design. The target population was 120 managers of the Oil Marketing companies in Kenya consisting of 60 operations managers and 60 supply managers from the firms. The study used the census method because the target population was small. Data was collected using structured questionnaires. Descriptive statistics was used to analyze the collected data while the relationship between the dependent and the independent variables was tested using regression analysis. The descriptive results showed that Storage Infrastructure (mean=2.49, SD=1.018), Transport Infrastructure (mean=2.36, SD=1.027), Handling Infrastructure (mean=2.23, SD=.838), and Clearing Infrastructure (mean=2.31, SD=.932) all slightly affected Supply Efficiency of Petroleum Products in Kenya. The Correlation results showed that infrastructure variables were all positively and significantly related with supply chain efficiency; with Storage Infrastructure (r=.239, p=.013), Transport Infrastructure (r=.419, p<.001), Handling Infrastructure (r=.436, p<.001), and Clearing Infrastructure (r=.562, p<.001). Regression results indicated that 40.2% (r2=.402) of variance in the supply chain efficiency in Oil Marketing companies is accounted for by Logistics Infrastructure. Further, Storage Infrastructure showed positive but not significant effect on Supply Efficiency (β=.027, p=.657), while Transport Infrastructure (β=.134, p<.001), Handling Infrastructure (β=.183, p<.001) and Clearing Infrastructure (β=.504, p<.001) were found to have positive and significant effect on Supply Efficiency. The study concluded that improvement of Logistics Infrastructure improves Supply Efficiency of petroleum products in the country. The study recommended that the government agencies in partnership with the oil marketing companies should invest in Storage Infrastructure, Transport Infrastructure, Handling Infrastructure and Clearing Infrastructure to improve supply chain efficiency in the oil marketing firms in Kenya.

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ABBREVIATIONS AND ACRONYMS

EPRA – Energy & Petroleum Regulatory Authority

IEA – International Energy Agency

IMF – International Monetary Fund

KIFWA – Kenya International Freight and Warehousing Association

KOSF – Kipevu Oil Storage Facility.

KOT – Kipevu Oil Terminal.

KPC – Kenya Pipeline Company Limited

KPRL – Kenya Petroleum Refinery Limited

KRA – Kenya Revenue Authority

LPG – Liquefied petroleum gas

MOE – Ministry of Energy

OMC – Oil Marketing Companies

PIEA – Petroleum Institute of East Africa

PWC – Price Waterhouse Coopers

SCM – Supply Chain Management

SOT – Shimanzi Oil Terminal.

UNCTAD – United Nations Conference on Trade and Development.

DEFINITION AND OPERATIONALIZATION OF TERMS

Clearing Infrastructure: Is the set of facilities and systems that support cargo Clearing at port (KIFWA, 2018). The current Clearing Infrastructure supporting petroleum cargo clearance at the port include Biller Direct, Simba and ASYCUDA systems for clearing imports and exports of goods by both KRA and KPA.

Demurrage: charge for detaining a ship over and above the time normally given to load/unload (UNCTAD world investment report, 2019). Imported oil products currently take an average 10 to 14 days for a ship to be allocated a berth at the port because of inadequate space forcing shippers to pay between $10,000 and $12,000 per day as demurrage fees.

Handling Infrastructure: Is the mechanical equipment used for the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal (Tompkins, 2020).

Jetty: Is the point of receipt of products from the vessel to the pipeline for transfer to the tanks in the terminals (Business Dictionary.com).

Logistics Infrastructure: Is that physical part of the Supply chain process that implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customer's requirements (Leuschner & Lambert, 2017)

Simba: Is an internet-based Customs IT system used by KRA in cargo clearance at the Port.

Storage Infrastructure: Is an adequate area required for keeping cargo (Hu & Cao, 2016).

Supply chain efficiency: Is the measure of how well the resources in the Supply chain are utilized (Beamon & Balcik, 2019).

Transport Infrastructure: Is the part of logistics that facilitates the development of connections between regions within a country and between countries, and consequently, it supports the formation of mutual economic, social, cultural relations (Skorobogatova & Kuzmina-Merlino, 2017).

Ullage: The space needed in storage tanks for receipt of petroleum products (Soroka, 2019).

Wharfage: charge assessed against cargo for usage of a wharf or pier and its facilities (Shippers Council of Eastern Africa, 2020)

CHAPTER ONE

INTRODUCTION

1.0 Overview

This part covers the background of the study, the research problem, and research objectives. Research hypothesis, the scope of the study and significance of the study is also discussed. Finally, the limitations of the study are discussed.

1.1 Background of the Study

The business world is changing, and companies are always searching for methods to boost their competitiveness and boost productivity and efficacy in order to perform better. An organization's utilization of a set of procedures to provide value to its clients in the form of goods, services, or both is known as supply efficiency (Lysons & Farringtone, 2012). Because it provides products and services like energy, chemicals, heating, petroleum products, lubricants, and transportation, the gas and oil business continues to be one of the biggest in the world. Every nation on the planet uses petroleum products in its economy, and the oil and gas sector is worth billions of dollars (Bacon & Kojima, 2016). Despite their widespread need, petroleum products are only produced in a few, restricted areas of the world. The petroleum industry's management has become increasingly complex and difficult due to the rise in worldwide demand, the ease of conducting business internationally, and the rigidity of the industry's supply chain (Cohen, 2016). World Bank (2018) concurs that growing demand for petroleum products has resulted from market liberalization and easier access to international trade, to the point where the sector's complicated supply chain faces numerous difficulties. The petroleum industry can be broadly classified into three segments: upstream, which involves the discovery, development, and production of natural gas or crude oil; midstream, which involves refining; and downstream, which includes oil tankers, pipelines, retailers, and consumers. When considering the

entire petroleum industry, including production, distribution, refining, and retailing, the total dollar worth of this sector is the highest in the world. When completed petroleum products are efficiently transported from the point of refinery to the final users in gas stations or whole sales, supply chains in the oil business are deemed complete. One of the biggest challenges facing the worldwide industry is getting the product from its point of origin to the end user. Certain forms of transportation are needed for commodities like oil, gas, and petrochemicals, including pipelines, tankers, and trains. In this industry, lead times of a few weeks between the shipping port and the end customer's location are rather typical. An effectively run downstream petroleum sector can help all of the economy's producing sectors. According to Gboney (2009), strengthening supply conditions is necessary since the high costs of petroleum products in the majority of countries are a result of poorly managed supply chains.

Saudi Arabia, Russia, the United States, Iran, Mexico, China, Canada, United Arab Emirates, Venezuela, Norway, Kuwait, Nigeria, Brazil, Kazakhstan, and Iraq are the major producers of oil in the world. Major crude oil is controlled by the Organization of the Petroleum Exporting Countries (OPEC), which establishes output limitations. Because the oil sector involves a wide range of activities, including material handling, technical application, international transportation, and exploration, among others, it has one of the most complicated supply chains in the world. When it comes to applying supply chain management techniques, the oil business offers a highly developed framework. Supply chains must therefore provide the appropriate product at the right location at the right time for the right price in order to satisfy customers of the goods they supply. Despite the significance of supply chain management and its increasing complexity, the petroleum sector globally is still in the early stages of developing effective supply chain management strategies. The oil and petrochemical

industries' understanding of the global supply chain is still in its infancy, according to Briggs et al. (2012). The majority of businesses in North America, Europe, and Asia have realized that increased supply chain efficiency offers significant potential for cost savings, particularly in the logistics sector, which accounts for an estimated 10–20% of total revenue. As a result, they are focusing more on their logistics infrastructure (Cigolini and Rossi, 2017). Although they agree that there is still much space for improvement and cost reduction, particularly in the logistics sector, they have made significant progress in lowering the rigidity and complexity of the petroleum industry's supply chain (British Petroleum, 2015).

In order to capitalize on economies of scale and manage future demand-supply imbalances for petroleum products, nations such as China and India have built up their strategic petroleum reserves (SPRs) (Fernandes et al., 2015). On the other hand, governments in the Arabian Gulf region have started long-term projects aimed at changing the region's oil supply chain environment in order to align it with regional ambitions to rank among the world's leading logistical hubs (World Bank, 2018).

Due to the production capacities of crude oil suppliers, lengthy lead times for transit, and the constraints of available modes of transportation, the petroleum industry's logistics network in Africa is incredibly rigid. Thus, each node in the network poses a significant challenge (World Bank, 2015). Long distances between supply chain partners and sluggish modes of transportation result in high carrying costs for inventory in terms of safety stocks at the ultimate customer location in addition to high transportation costs and in-transit inventory. Due to the large distances between supply chain participants, there is a tremendous deal of uncertainty in the transit timeframes, which can be detrimental to suppliers' service standards and ultimately to final customers' safety stock prices. Few sectors deal with the intricacy of shipping that requires a package to utilize many means of transportation in order to reach the

final customer's location, however it happens frequently. Compared to other industries, this form of business has longer lead times from the shipping point to the ultimate clients' location due to restrictions on transportation modalities (Deloitte, 2018). The World Bank (2015) states that a significant problem facing the African petroleum industry is the degree of rigidity required to satisfy the expanding potential for oil demand and its derivatives while upholding good service standards and efficiency.

Petroleum product markets in Eastern and Southern Africa are seen as modest and fraught with difficulties (PIEA, 2019). In the entire region, only South Africa and Kenya have product pipelines. Power outages have often interrupted pipeline operations in Kenya, and limited pipeline capacity in South Africa is currently driving up petroleum delivery costs (BP, 2018). Although the market-based tariff for road movements is more than 50% greater than that of rail, rail transport is often underutilized; in 2018, just 28% of petroleum products were moved by rail and more than 70% by road (Jones & Murphy, 2012). Poor road conditions, traffic, and perhaps sluggish border clearance when there is cross-border trade all hinder road transportation (PIEA, 2021).

After the collapse of the Kenya Petroleum Refinery Limited (KPRL), which processed crude oil, Kenya's domestic demand for various petroleum fuels estimated to be 2.5 million tons annually are fully imported as refined petroleum products from the Gulf region (PIEA, 2019). Kenya's transportation infrastructure is still insufficient to satisfy the needs of the nation, even though it has developed significantly in recent years. The nation's infrastructure metrics are still below those of middle-income economies in Africa, such as Egypt and Nigeria, although they appear better than those of other low-income nations in the continent (World Bank 2015). Raising Kenya's infrastructure to the level of middle-income nations in the region increased

yearly growth by over three percentage points. In an effort to become more competitive in the global market, Kenya made considerable investments on roads, railroads, seaports, airports, water, and sanitation as part of its development objectives (Deloitte, 2014). Though there are now few road and rail links with its neighbors, Kenya may eventually grow to become a major regional hub for ports, railroads, and air travel. The supply chain for petroleum products in Kenya is still frequently disrupted by a number of issues, including an unstable political climate, strict laws and regulations from the government, heightened competition, and an unclear climate for foreign trade. Products from the Gulf must also be shipped with extended lead periods since local merchants cannot import a full vessel load, which forces boats to combine cargo bound for different ports. Additionally, utilizing a smaller vessel is more expensive per unit. According to the 2012 KPA Stakeholders Report, exporting petroleum products entails significant freight, insurance, wharfage, inspection, and demurrage costs. According to Aderamo (2012), there could be significant demurrage expenses associated with clogged ports, sluggish customs processing, and any other cause that delays fuel discharge.

Petroleum products that are imported are delivered to storage locations near their ultimate markets. Coordination of the purchase and transport logistics is essential for this activity, and factors such as volume requirements, procurement strategies, cost, location, contract terms, and supply reliability must all be taken into account. Petroleum products suffer extra costs after they are landed and transferred to a bulk oil terminal. These costs include storage, transportation, retailing, and profit margins for wholesalers and retailers. Using the marketer's own resources or contracted out road transport services, products are subsequently transported by road tanker to retail service stations and large consumers. Road tankers, rail, and pipelines are among the ways that secondary storage is supplied (IMF, 2018). The Northern Corridor, which

connects Mombasa, Nairobi, Eldoret, Kisumu, Uganda, South Sudan, the Eastern Democratic Republic of the Congo, Burundi, Rwanda, and Northern Tanzania, is the route over which petroleum products from Kenya are transported. According to Consumer Insight (2019), KPC's distribution channel was shown to be ineffective since its product handling methods were out-of-date and consequently unreliable to supply products to the end users in an efficient manner. They list this as a major issue that Kenya's oil sector has been dealing with.

Every stage of the supply chain has storage facilities, which is crucial since inventories can be utilized to lessen the severity of sudden price spikes brought on by actual supply disruptions (Bacon & Kojima, 2016). Building storage facilities is costly, and maintaining supplies at this level entails significant extra financial outlays. Because of this, businesses have backup supplies on hand to prevent stock-outs, but they also employ just-in-time inventory management, just like any other, and work to maximize their capacity with other supply-and-delivery chain links. As a result, huge markets must benefit from economies of scale in their infrastructure supply and procurement, as it is costly to store less goods in a storage tank with a much larger capacity or to have pipeline pumps with frequent stoppages have short run times.

The government owned Kipevu Oil Storage Facility (KOSF) or commercial marketer's storage facilities in Shimanzi accept imported petroleum products. Imported goods are handled by the Shimanzi Oil Terminal (SOT) for both local and transit use. Before being pumped into the mainline, the product imported by KPC is momentarily held at the KOSF depot. According to Mangala & Moronge (2019), the March 2008-commissioned line that connects the Shimanzi and Kipevu depots will improve the flexibility of product movement in distribution and storage. The Ministry of Energy (MOE) released the Petroleum Stock Regulations 2008 in Legal Notice No. 43 to address the issue of the lack of strategic stocks in the nation. The regulations

stated that gasoline, kerosene, diesel, and liquefied petroleum gas were among the strategic national stocks (Senelwa, 2008).

Although significant financial resources have been invested in these initiatives, the government and industry participants have not been able to improve the efficiency of the nation's petroleum product supply. Instead, the country continues to experience recurrent shortages of petroleum products. Petroleum imports and receipts at the Kipevu storage facility, storage depots, truck loading and pump overs, and stock inventories are some of the primary service interactions with clients in this industry. The ability to provide the proper quantities of goods at the right price, at the right time, and in the right location defines the effectiveness of the oil marketers' supply function. With a survey of the 60 operating oil marketing companies in Kenya, this study looked at the impact of Logistics Infrastructure on the efficiency of petroleum product supply in Kenya.

1.2 Statement of the Problem

Most economies in the world have a high need for petroleum products. About 80% of Kenya's needs for commercial energy are met by petroleum products, making them a significant source of energy for the nation. Following the collapse of KPRL, which processed crude oil, all petroleum products used in Kenya are imported as refined petroleum products from the Gulf region (PIEA, 2019). This necessitates effective downstream petroleum industry management. But the nation has had regular fuel shortages, which have led to volatile fuel prices. As a result, manufacturers have had to incur high manufacturing expenses, which they then pass on to customers in the form of higher pricing. It is clear that there are several issues with Kenya's petroleum sector supply chain that require attention (PIEA, 2019). The two oil discharge berths that are now in place are finding it difficult to handle the increased number of vessel arrivals due to a shortage of storage space for petroleum products (KPA's annual

report, 2019). According to PIEA (2021), the current oil terminals, which are built to process one billion liters annually, processed more than 2.5 billion liters in 2017. This increase in oil receipts has put stress on the infrastructure already in place and made the delayed discharge issue worse. Customers and local C&F companies are complaining about Mombasa Port's overworked and overburdened oil handling capabilities (Omolo & Mwabu, 2014; Kenya Shippers report, 2017). There are significant delays in cargo clearance at the Mombasa port. Due to insufficient Logistics Infrastructure, customers' oil product supply is unpredictable, and the government, through its agencies like the Kenya Revenue Authority (KRA) and the Kenya Ports Authority (KPA), suffers significant income losses. Significant losses are also incurred by other private sector participants in the chain, including manufacturers, carriers, and Oil Marketing Companies (OMCs). Due to artificial shortages of petroleum products brought on by this deficient Logistics Infrastructure, the price of oil and other products has increased on the market.

According to a 2018 World Bank study on Kenya's strategy to make liquefied petroleum gas the country's primary cooking fuel, there is not enough bulk storage for imported volumes, and the port of Mombasa is experiencing equipment strain, which leads to the importation of shipments that are not economically viable. This explains why landed supply costs are high and drive up prices for Kenyan consumers (World Bank, 2018). In 2019, UNCTAD carried up a study titled "Kenya's Oil Sector: Situation, Developments, and Prospects," which came to the conclusion that the country's inadequate transportation and Storage Infrastructure was the primary cause of unexpected price increases. Thus, the purpose of this study was to close the aforementioned gaps by determining how Kenya's current Logistics Infrastructure affects the country's ability to supply petroleum products efficiently and by

formulating recommendations for the enhancements that would be required to raise that efficiency.

1.3 Research Objectives

1.3.1 General Objective

The main objective of this study was to establish effects of Logistics Infrastructure on Supply Efficiency of Petroleum Products in Kenya.

1.3.2 Specific Objectives

The specific objectives of the study were:

i) To establish effects of oil Storage Infrastructure on Supply Efficiency of Petroleum Products in Kenya.
ii) To determine effects of Transport Infrastructure on Supply Efficiency of Petroleum Products in Kenya.
iii) To find out effects of Handling Infrastructure on Supply Efficiency of Petroleum Products in Kenya.
iv) To investigate effects of Clearing Infrastructure on Supply Efficiency of Petroleum Products in Kenya.

1.4 Research Hypothesis

The study sought to test the following null hypotheses:

HO_1: Storage Infrastructure has no significant effect on Supply Efficiency of Petroleum Products in Kenya.

HO_2: Transport Infrastructure has no significant effect on Supply Efficiency of Petroleum Products in Kenya.

HO_3: Handling Infrastructure have no significant effect on Supply Efficiency of Petroleum Products in Kenya.

HO_4: Clearing Infrastructure has no significant effect on Supply Efficiency of Petroleum Products in Kenya.

1.5 The Scope of the Study

The study involved administering 120 closed-ended questionnaires to the operations and supply managers of the 60 oil marketing companies in Kenya. The study covered all oil marketing operating in Kenya. The study covered a period of two months between September and October 2022 focusing on factors affecting Supply Efficiency of Petroleum Products in Kenya in relation to Logistics Infrastructure.

1.6 Significance of the Study

The study has provided important recommendations for actions that might be taken to lessen the issues the nation's petroleum supply chain is now experiencing. These suggestions will thus be incorporated into a range of options for resolving the issues that the participants in the oil business are facing. In order to provide the best solutions for resolving the issues with the supply management of petroleum products in Kenya, these findings offer strategic managers and decision makers of the Oil Marketing Companies insightful information on the supply function. In addition, the businesses can use the information to reevaluate their supply chains and assess how resilient and sustainable they are in comparison to the established standards and potential fixes in the event that the desired result is not realized.

The study's recommendations will help customers by increasing the nation's and, consequently, the East African region's supply of petroleum products more efficiently. Improved efficiency of the petroleum products supply chain will lead to stability in the oil supply, which will result in stability in production costs, which will lead to stable prices charged to the final consumer. This will cause the petroleum products

supply chain to become more stable and reduce costs, which will result in reasonable and stable prices.

The results of this study will contribute to the body of information already available on supply chain management, particularly in the oil sector, and be a valuable resource for future research in the same field or for other scholars. The study has also made recommendations for future research directions to improve the nation's petroleum product Supply Efficiency even more. The study's conclusions are thus expected to serve as a springboard for additional research on the supply chain role of Kenya's oil sector as well as future studies and as a source of reference. Additionally, the study's conclusions might help the Energy & Petroleum Regulatory Authority (EPRA), a division of the Ministry of Petroleum and Mining, comprehend the implications of supply function in the management of the country's supply of petroleum products and develop policies that will benefit the industry. Additionally, the report makes recommendations for infrastructure upgrades that are required to increase the nation's petroleum product Supply Efficiency.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter discusses theories relevant to the study and reviewing literature related to the study with the aim of identifying literature gaps. The literature review also guides the relevance of the study findings. This chapter therefore gives a review of the existing literature on the factors affecting petroleum products supply in Kenya. The review is meant to illustrate the key concepts of the area of study, and it provides the foundation of critical review and a clear understanding of the problem. The main sections included therein are the theoretical review of the study, review of empirical data on the four objectives of the study, a conceptual framework showing the interconnectedness between the independent and dependent variables, critique of existing literature relevant to the study, summary, and research gaps.

2.1 The Concept of Supply Chain Efficiency

A supply chain is a network of organizations that are either completely independent or semi-autonomous and are engaged in a variety of commercial operations. These operations ultimately result in the production of physical goods or services for consumers through linkages that are both upstream and downstream. According to Lysons and Farringtone (2012), it is comprised of a number of activities that a company performs in order to offer value to its customers in the form of either goods or services, or both forms of value. The oil and petrochemical sectors both have a global reach through their operations. The result of this is that these commodities and materials are transported between locations that are frequently located on different continents. High carrying costs for inventory are a consequence of long distances between supply chain partners and slow modes of transportation. These factors

contribute to high carrying costs for inventory in terms of safety supplies at the ultimate customer site, in addition to high transportation costs and inventory that is in transit. According to Awojobi and Jenkins (2016), there is a substantial problem at each step in the supply chain which is responsible for the petroleum. Fernandes et al. (2015) state that comparatively few industries are able to deal with the complexity of shipping to the point that a product frequently needs to transit a number of different means of transportation before it can arrive at the location of the eventual client.

A extremely inflexible supply chain network exists in Kenya's petroleum industry as a result of the procurement procedures that are utilized by providers of refined oil, the extensive lead times for shipment, the inadequate storage facilities, and the limited transportation choices that are available. A significant amount of uncertainty exists in the transit timeframes as a result of the enormous distances that separate the players in the supply chain. This uncertainty can have a negative impact on the service standards of the suppliers, which in turn can have an adverse effect on the safety stock prices of the final consumers. The transportation process also makes use of ships, trains, pipelines, and trucks, among other modes of transportation. Despite the fact that Kenya possesses all of these choices, they are not sufficient, and the infrastructure that is currently present, such as the railroads, is not being utilized to the extent that it could be (PEA, 2018). When compared to other industries, the oil industry in Kenya has longer lead times from the shipping point to the location of the end customers. This is because of the constraints that are placed on storage facilities and modes of transportation. Due to the fact that supply chains function as a system or network, any issues that arise at a single link in the chain will have an effect on the entire chain. This may lead to an increase in inefficiencies throughout the supply chain; hence, in order to make the most informed decisions for the supply chain as a whole, greater

consideration ought to be given to the manner in which decisions and actions in one part of the network will have an impact on the other parts of the chain (Qrunfleh & Tarafdar, 2013). It is consequently a significant challenge for the petroleum industry to meet the growing demand for oil and its derivatives while also preserving high service standards and efficiency. This is because of the degree of inflexibility that is required.

2.2 The Concept of Logistics Infrastructure

Development of a nation's logistics infrastructure, which attempts to provide the most effective possible distribution of commodities from producer to consumer, is one of the most significant components of any nation's economic growth. This infrastructure is designed to create the most efficient system possible. According to Blyde and Molina (2015), the development of logistics infrastructure is one of the topics that economies all over the world are most concerned about. It is further stated by Lean et al. (2014) that in order to accelerate the development of infrastructure assets, worldwide standards prioritize the improvement of logistics management systems and the elimination of non-physical impediments. It is primarily due to the poor state of Kenya's Transport Infrastructure, which is caused by delays in renovation, a lack of investment in modernizing ports, roads, and airports, and the construction of intermodal terminals. This is the primary reason why the country's logistics infrastructure is ranked lower than that of developed nations in the 2019 Logistics Performance Indicators (LPI) ranking that was published by the World Bank. This discrepancy is the reason why the nation is less able to compete internationally in terms of attracting international commodities transit as compared to Tanzania, which is its neighbor. As a consequence of this, the opportunities to increase the total volume of transit operations are diminished.

Despite the fact that a significant amount of study has been conducted on the effects of logistics infrastructure on regional economies, there is not yet a comprehensive analytical technique that can evaluate these effects on the actual economy as a whole, as well as on various industries and regions. The findings of the research conducted by Raimbekov et al. (2019) led them to the conclusion that when it comes to making decisions on investments in logistics infrastructure, we should not solely concentrate on the physical components of the infrastructure. Instead, we ought to concentrate toward enhancing the management of the infrastructure that supports logistics, enhancing the efficiency of the networks that are already in place, and encouraging regional governments to make better use of it. They go on to say that it is of the utmost importance to create new logistics infrastructure, improve the economics of infrastructure that already exists in each region, and develop comprehensive policies from the public sector, the private sector, and the business community in order to encourage the expansion of logistics infrastructure.

2.2.1 The Concept of Oil Storage Infrastructure

Recent years have seen the oil and gas industry experience remarkable expansion (Downey, 2009). This expansion can be attributed to the growing demand from a wide range of end-use sectors. The need for a wide variety of petroleum products is increasing at an astounding rate, which is making oil storage an increasingly essential requirement. Oil storage sector companies are investing an increasing amount of resources to the development of innovative technologies, the manufacturing of oil storage items, and oil storage techniques in order to establish a strong presence in the present market environment. This is being done in order to gain a solid foothold in the market environment.

As stated by Downey (2009), the majority of oil and gas are transported across international distances that are quite extensive. As a consequence of this, oil storage plays an essential part in the oil supply chain as a whole. Furthermore, it is projected that the oil storage market will experience unprecedented levels of innovation and new development throughout the course of the forecast period. Seelke et al. (2015) state that significant storage systems are required for maritime transportation, notably at export-import terminals. This is essential for the transfer of goods. Because of this, there has been a persistent focus on oil storage, which is anticipated to be a driving force behind the expansion of the market on a global scale during the course of the evaluation period. In addition, they argue that there has been a consistent rise in the demand for oil storage facilities in order to maintain strategic reserves and ensure the continuity of oil delivery in the event of an emergency. Because of this, there is an urgent need for extra storage space; if this does not occur, the production of crude oil will be compelled to cease in a number of locations all over the world due to a lack of storage space (U.S. Department of Energy, 2020)..

2.2.2 The Concept of Transport Infrastructure

For an economy to run properly and for a supply chain to be robust, there must be a transportation infrastructure that is both vast and efficient. According to Agrawal and Chowdhary (2014), transportation networks have the potential to increase productivity and improve the standard of living for the people who are a part of them when they are correctly planned. With the assistance of efficient transportation systems such as ports, railroads, high-quality roads, and air travel, business owners will be able to bring their products and services to the market in a manner that is both secure and effective (World Economic Forum, 2016). The reduction of freight costs and the enhancement of the impact of other cost-cutting initiatives are both facilitated by the

improvement of transportation infrastructure. In spite of this, it is essential to carefully evaluate whether or not infrastructures have a beneficial overall net impact (Combes & Lafourcade, 2005; Waters, 2003). This is because regions that have less access to infrastructures may experience adverse economic consequences and vice versa.

2.2.3 The Concept of Handling Infrastructure

During the process of material handling, a variety of different kinds of equipment are utilized, which ensures that the materials are kept safe. The use of pipelines and pumps allows for the transportation of water, natural gas, and oil, which in turn minimizes the amount of time required for production and distribution (Badi, 2012). He arrives to the conclusion that the utilization of this equipment results in an improvement in the efficiency of material handling, which in turn reduces expenses and material damage, hence increasing the profitability of a corporation.

According to CIPS (2020), the first stage in selecting material handling equipment is to conduct an analysis of the requirements of the organization. This is done in order to devise the most effective pattern for the flow of materials from the point of receipt to the point of shipment. When doing this analysis, it is important to take into account the following three aspects: the places and path that the materials will travel, the procedures that will be used to handle the materials, the preparations that will be made for handling the materials, and the equipment that will be utilized. According to Athitis and Saussier (2010), the optimal utilization of material handling equipment and the implementation of safe material handling techniques can aid in the prevention of severe accidents, process stoppages, and even the closure of existing plants.

2.2.4 The Concept of Clearing Infrastructure

Through the preparation of paperwork and/or electronic submissions, the calculation and payment of taxes, levies, and excises, and the facilitation of communication between government agencies and importers and exporters, Clearing Infrastructure assists importers and exporters in clearing products through customs obstacles (KIFWA, 2018). According to Hwang and Kim (2019), Clearing Infrastructure makes it simpler for the customs department to perform a physical inspection of a consignment after it has arrived. This inspection is performed in order to determine the value of imports, ascertain the description of the items, classify the items in accordance with the applicable customs chapter and tariff, and ensure that there are no instances of the importer being under- or over-invoiced by the customs representative.

2.3 Theoretical Framework

This sub-section is intended to introduce traditional theoretical principles needed to achieve a foundation for the discussion later in the Thesis. First, Supply Chain Operations Reference (SCOR) Theory will be introduced, followed by Queuing Theory and a theoretical approach to Resource-Based View of a company will be addressed prior to Network Theory.

2.3.1 Supply Chain Operations Reference Theory

The Supply Chain Operations Reference (SCOR) model served as the foundation for this study. According to Supply-Chain Council (2014), Supply Chain Operations Reference Theory is by definition a tool that helps users discuss, approve, and share information on all the parties engaged in a supply chain as well as its activities. According to Hwang et al. (2018), the theory explains the business procedures necessary to meet consumer needs, aids in the explanation of the procedures

throughout the whole supply chain and offers a foundation for process improvement. Simchi-Levi et al (2015) asserts that SCOR extends from vendors to clients. According to Lysons & Farringtone (2012), this framework concentrates on the following five aspects of the supply chain: plan, source, make, deliver, and return. Hwang et al. (2018) agree and note that certain regions recur often throughout the supply chain. According to the supply chain council, this procedure involves "the supplier's supplier to the customer's customer."

Planning entails creating plans to accomplish the goals of the supply chain strategy and communicating them. It covers tasks including developing sourcing strategies, organizing inventories, and anticipating demand. It entails deciding on communication throughout the chain and striking a balance between resources and requirements. Along with connecting the supply chain strategy with the company's financial plan, additional aspects of the plan include establishing business rules to measure and enhance supply chain efficiency in respect to assets, transportation, inventory, and regulatory compliance, among other things (Supply Chain Council, 2014). The source outlines how to handle supplier payments and specifies when to receive, verify, and transfer product. It also covers sourcing infrastructure and material acquisition, as well as how to manage inventory, the supplier network, supplier agreements, and supplier performance (Lysons & Farringtone, 2012). In order to satisfy end users, suppliers must set quality standards for their raw materials since they are crucial to ensuring the quality of finished goods. Making entails turning raw materials into completed things and requires managing the production network, facilities, equipment, and transportation in addition to tasks like production planning, scheduling, packaging, product staging, releasing, and quality control (Yu et al., 2019). All of the transformation process's activities, from the raw material to the

finished product, as well as the material and information flows of the production process, must be considered in this process. Therefore, it is important to keep in mind that production is carried out in accordance with client specifications and that customer preferences must constantly be taken into account while planning the activities of the manufacturing process. Methods and quality standards will be suggested to help the step-by-step control of the production process in order to meet these needs of the end user. Shrikant & Kant (2017) states that order management, warehousing, and transportation are all included in delivery. It also entails taking orders from clients, billing them after a product is delivered, managing completed inventory, assets, transportation, product life cycles, and regulations for importing and exporting. During this process, the portfolio of clients will be developed and handled, starting from customer inquiries and requests and ending with product shipments and logistic company selection. Companies need to be ready to manage the return of containers, packing, or damaged products, according to the Supply Chain Council (2004). Managing company rules, assets, transportation, return inventory, and regulatory obligations are all part of the return process. It is important to recognize that even with best practices in place to provide customers with high-quality products, there may always be reasons why our clients or suppliers will want to return our products or raw materials. In order to minimize any potential deterioration in the client-provider relationship, it is therefore suggested that an effective return management service be made available to the client. This service would also enable prompt response to situations of this nature and handle the return process with suppliers in the event that defective, expired, or excessive inputs are received.

According to Kelley et al. (2017), the Supply Chain Operations Reference (SCOR) theory encompasses additional assumptions related to general administration,

information technology, training, and quality. According to Simchi-Levi et al (2015), supply chain operations reference theory emphasizes the best practices that take into account current conditions rather than newly emerging ones, are planned with clearly defined objectives, scope, processes, and procedures, and have a proven track record of success that allows them to consistently have a positive impact on the intended operational outcomes. This theory was significant to the study because it underpins company activities, which are crucial to the operations of oil marketing companies. A well-organized operation boosts a company's productivity. This was the anchor theory.

2.3.2 The Queuing Theory

In accordance with Sundarapandian (2019), the mathematical study of waiting lines, often known as queues, is referred to as queuing theory. The outputs of a queuing model, which is constructed to estimate wait times and queue lengths, are typically used as the basis for business decisions regarding the resources that are necessary to provide a service. Queuing is a tool that can be used to improve overall customer service and is one of the operations management tools that may be used. Assessing and streamlining the requirements for staff, scheduling, and inventory can be accomplished with its help. When there are not enough resources available, queues arise, which makes economic sense. It is possible to create well-balanced systems with the assistance of queuing theory. These systems should be able to deliver timely and effective customer service while also remaining economical enough to be long-lasting. Since this is the case, queuing theory contributes to the development of well-balanced systems that provide users with prompt and efficient service while keeping costs at a level that is low enough to be sustainable over time. All queuing systems are comprised of the entities that are waiting in line for an activity. According to the

queuing theory, the first step in determining the service requirements of a facility is to examine the arrivals that it receives. With the use of queuing theory, a business can develop more efficient pricing strategies, personnel arrangements, arrival management plans, and queuing systems in order to reduce the amount of time that customers have to wait in line and to accommodate a greater number of customers. According to Adan and Resing (2015), a queuing system will ensure that customers will receive input service and that they will be required to wait for it in the event that it is unavailable. The optimization of transit and waiting times, which in turn leads to a reduction in fuel consumption, can be achieved by setting priorities for tasks that belong to any aspect of supply chain management. The accuracy of the centers' locations, the number of fleets that are available to travel between them, the number of trips that are made between the centers, the rate of service that the centers provide to the fleet, the number of service centers, the number of servers in the centers, and the technology that provides services are all significant factors that can contribute to a reduction in the costs associated with logistics. According to Zeliha (2018), in order for a business to have a competitive advantage, it is necessary for the business to take into consideration a wide range of economic elements while it is conducting its operations. Consequently, organizations are able to improve supply chain management activities such as the purchase of raw materials, production, logistics (both internal and external), and waste-reduction reverse logistics by applying the queuing theory to supply chain management chores. The fundamental disadvantage of the theory is that it necessitates a significant amount of effort, time, and energy to evaluate a situation and apply the theory in order to find a solution to the problem, which results in the theory being expensive to execute. One further disadvantage is that prospective consumers are dissuaded from joining the queue if they observe a

lengthy queue when they arrive at the location. The significance of this idea lies in the fact that it encourages efficiency, both in terms of handling infrastructure and clearing infrastructure.

2.3.3 Resource-Based Theory

Intimately connected to the concept of the Resource-Based View is the competitive power and advantage that the organization possesses. According to Simchi-Levi et al. (2015), the development, manufacturing, and delivery of goods and services to customers are all activities that make use of the organizational, financial, physical, and human resources that a company brings to the table. These strategic resources are valuable, unusual, somewhat imitable, and difficult to replace, as stated by Rothaermel (2019). These are the four characteristics that come together to make them a strategic resource. Having resources that are able to fulfill these requirements might be of assistance to the company in maintaining and protecting its competitive edge. On the other hand, this is not a practical option unless the resource in question is useful in the sense that it assists the company in capitalizing on opportunities and mitigating risks. It is argued by Derrouiche et al. (2020) that if a resource is not rare, then numerous competitors will be able to access it, and the advantages that are achieved through the utilization of the resource will not be able to be maintained. This is due to the fact that having a resource is more of a prerequisite for being in the market than it is a competitive advantage. When it comes to replicating critical resources, it is an exceedingly difficult task. This holds especially true in the event that the resources consist of both tangible and intangible assets. In conclusion, it must be difficult to bring strategic resources back into operation. In the event that a substitute is available, it is impossible to keep a competitive advantage. In order for a company to achieve and sustain a competitive advantage, it is necessary for the

company to recognize and cultivate these strategic resources (Lettice et al., 2020; Kelley et al., 2017; Simchi-Levi et al., 2015). On the other hand, application of this theory and determination of the appropriate level of analysis might be difficult due to the fact that resources are defined in a wide sense and that certain resources, such as the reputation or knowledge of a company, are subjective. Additionally, the fact that oil is a resource that is both significant and extremely precious lends credence to this theory. Some examples of supplementary resources include infrastructure and other pieces of equipment.

2.3.4 Network Theory

According to Simchi-Levi et al. (2015), in order for a business to be concerned about the supply chain as a whole, it is necessary for the business to establish a network with each and every other company in the chain. According to Gadde et al. (2020), Network Theory postulates that the ties that a firm has with other companies are frequently the most significant assets that the company possesses. This is because these partnerships provide access to resources that are complementary to those of the other companies concerned. Because of this, it will be necessary to investigate the company from an external perspective in order to ascertain whether or not the information is applicable to other relationships. In the context of a collaboration, this might be considered a significant benefit for both of the companies involved. According to Oh et al. (2016) and Yu et al. (2019), an industrial network is comprised of actors, resources, and activities. Other components include activities. When evaluating the capabilities of the actors, the resources that they manage and the actions that they carry out are taken into consideration. The term "resources" refers to anything and everything that helps to making the final result more valuable. This includes both external and internal resources. For the purpose of achieving the best

possible outcome for the network, it is a fundamental assumption that all of the players would behave in a manner that is honest and trustworthy toward one another. There is the formation of a relationship between two or more companies when they interact with one another. It is possible to achieve this goal through the utilization of either an exchange process or an adaptation process. The first scenario involves two companies moving one resource to the other by utilizing another resource. The second scenario, on the other hand, involves the modification of operations in a more cooperative manner in order to make better use of the resources. The interactions are responsible for establishing connections, and each interaction is fundamentally connected to other interactions as a constituent of the overall system (Håkansson, 2018). According to Simchi-Levi et al. (2015), this often leads to a stronger link between the two parties involved, which can be viewed as an indication of mutual trust between the two parties. There are many different firms within the network, and each of these firms has a unique capacity to influence the movements of other enterprises within the network. The evolution of the network is significantly influenced by the power structure of the network, which can be defined as this ranking that is based on similar interests and different resources as well. When it comes to the establishment of new interactions and contracts, the power structure plays a significant role. This structure is responsible for determining the relative positions of various businesses within the network. This identity of the strategic actor is constructed and shaped by the interactions that take place amongst the various actors. A relationship that is strong and long-lasting will never reach a state of equilibrium; rather, it will always be shifting and changing because networks are inherently dynamic; they are never stable or in a state of equilibrium. As a result, it is feasible to assert that the interpersonal connections inside a network are both dynamic

and stable at the same time. According to Gadde et al.'s research from 2020, the actors' continuing interactions with one another not only contribute to the production of new resources but also shift their attention away from the utilization of their own resources and activities and toward those of the other actors instead. The significance of this theory lies in the fact that it provides support for the multi-part supply chain structure.

2.4 Empirical Review

2.4.1 Storage Infrastructure and Supply Efficiency

According to Hu and Cao (2016), space is defined as the adequate area required for the berthing of ships and the storage of cargo space. Both the seamless movement of products and the prevention of delays require a sufficient amount of space. In spite of this, inventory management is absolutely necessary because of the limited space available in each store. This necessitates precise replenishment at each and every retail location, as well as a rapid response to demand by means of sales. The adoption of a responsive dimension is something that companies need to undertake in order to align themselves with uncertain demand and product life, as mentioned by Chopra and Meindl (2016). That being the case, space must be allotted inside the company in order to fit all of the products that have been bought. This is something that can only be accomplished by implementing storage layouts and procedures that are acceptable and effective, as well as by frequently reviewing the requirements. It is a typical objective in procurement to ensure that things are delivered on time; but, if there is no space to secure the items, this could result in traffic congestion and delays in delivering the items to the spot where they are supposed to be. According to Brettel et al. (2011) and Mayrson (2016), there is an increasing body of research suggesting that the delivery of goods and services that are late or incomplete can lead to a decline in

sales, production halts, and the activation of penalty clauses, which eventually results in dissatisfaction among customers. Immediately berthing ships is necessary in order to reduce the amount of time that is wasted during loading and unloading. The lengthy wait apparently begins as soon as a ship docks in Mombasa, as stated in the study that was published by the Kenya Shippers Council in 2014. Because there is a shortage of space at the port, it takes anywhere from ten to fourteen days for a ship to be granted a berth. Shipping companies are required to pay demurrage costs that range from ten thousand to twelve thousand dollars each day. Kipevu Oil Terminal (KOT) and Shimanzi Oil Terminal (SOT), the two existing oil discharge berths, have struggled to accommodate the increasing vessel arrivals, as stated in the annual report that was published by the Kenya Ports Authority in 2013. This is due to the lack of storage capacity for petroleum products. As a result of this restriction, which results in longer inter-arrival intervals, the waiting periods for vessels are extended. Based on the numbers provided by the KPA in 2015, the single most significant import item in terms of weight is bulk liquid products, which mostly consist of petroleum, oil, and lubricants. The reserves that are required to sustain a gasoline shortage that would persist for more than 15 days are not present in Kenya, as stated in a report that was published by PWC in 2015. It is anticipated that the country's reserves will only last between five and fifteen days, which is far less than the ninety days that the International Energy Agency (IEA) recommends. It has been determined that the prolonged delays at loading places and traffic congestion are to blame for the deteriorating state of the storage tanks and the small pipeline capacity that transports petroleum. This is because suppliers prefer to load their trucks in Mombasa rather than wait for an extended period of time. In order to prevent future crises and to serve as a buffer for the nation during times of instability, the report recommends that

Kenya develop a strategic reserves management strategy. This plan should be able to stabilize pricing and the supply chain.

According to PIEA (2019), KPC has completed the construction of four new storage tanks in Nairobi. These tanks will have the capacity to accommodate the higher product quantities that are anticipated following the implementation of Line 5. In addition to boosting the storage capacity in Nairobi from the current 100 million liters to 233 million liters, the four tanks will improve operational flexibility and speed up tank turnaround for KOSF in Mombasa. At the same time, the storage capacity in Nairobi will increase. It is possible that the nation and the region will now be assured of supply security as a result of the additional storage capacity; nevertheless, the most significant change is that demurrage fees will be reduced because ships will not have to wait as long to discharge products. The efficiency of the supply of petroleum products is impacted by the availability of a diverse selection of products and on-time responses from customers. Because of this, it is necessary to place a greater emphasis on the ability of the OMCs to establish logistical operations that are both efficient and smooth. The relevance of Storage Infrastructure lies in the fact that it is able to function as a node that directs the movement of products throughout the petroleum distribution network, which in turn has an effect on the overall performance of the supply chain.

2.4.2 Transport Infrastructure and Supply Efficiency

"The conveyance of goods and people over land, across water, and through the air" is the definition of transportation that is provided by Aderamo (2012). According to him, transportation is beneficial to both industry and commerce since it enables the delivery of finished goods for consumption as well as the delivery of raw materials to

the location where they are produced. Adding value or utility to a region is the function of transportation. It has an effect on the speed and dependability with which items are transported from one location to another, which is a factor that contributes to the formation of temporal utility. According to Hessler (2010), value chains begin when products, resources, or vessels are brought into an organization. Therefore, transport services must be ongoing in order to ensure an effective flow of goods throughout the supply chain along the supply chain.

In order to transport petroleum products from the Mombasa port, there are a number of challenges that need to be taken into consideration and solved. These challenges include an inadequate pipeline, stringent safety standards for transporters, and a poor road network. The KPA has been strengthening its capacity to manage larger cargo volumes, as stated in the management report for 2011–2012; nonetheless, they are falling short due to the lack of suitable infrastructure. Delivery delays are the result of inadequate transportation since it takes longer for the vehicles to convey cargo from one location to the necessary places. This causes the delivery delays to occur. By increasing the cost of goods, which are then passed on to the final consumer, these delays at Mombasa Port have the effect of lowering sales and earnings. This is because the cost of goods is increased. Transportation services need to be efficient in order for enterprises to be able to manage their operations and services. The port of Mombasa serves as the entrance point for surface traffic along the Northern Corridor, with an average of 900 transport vehicles (trucks) leaving each day, according to KPA's Annual Report (2019). There are a number of operational issues that are involved with road transportation, including roadblocks, which are nontariff barriers that cause delays, weighbridges, police escorts, and other obstacles. The entire train load of bulk goods can be transported by rail from an industrial facility to a seaport.

This is true regardless of whether the cargo is dry or wet. Iron, coal, crude oil, fertilizer, or wood could all fall under this category. Observers have noticed that the quantity of freight has increased following a surge in the activity of the transit system. According to a report published in the Star newspaper (2012), freight forwarders and clearing agents have demanded that the government improve the railway system in order to help alleviate delays at the port of Mombasa. They asserted that a better rail infrastructure would put an end to delays at the port.

Sumayya (2015) identifies a number of significant problems with Kenya's petroleum infrastructure. These problems include the infrastructure's age and inadequacy (it only provides a maximum of ten days' worth of operational stock cover), the absence of strategic petroleum stocks, the concentration of the country's petroleum infrastructure in the south, which necessitates massive product trucking, and an inadequate number of retail gas stations (1,600 stations to serve a population of 50 million Kenyans). The government of Kenya is now working through the Kenya Pipeline Company (KPC) on a number of important petroleum infrastructure projects in order to enhance the supply of fuel in Kenya and the nations that are to its immediate north and south. These projects include the replacement of pipelines, the improvement of storage facilities, and investments in loading facilities. The overarching objective of these projects is to establish a substantial petroleum logistics hub in the country in order to encourage regional trade development. Whether it be in terms of ensuring the continuous, dependable, and efficient supply of petroleum products in the region or ensuring the safety of petroleum transportation, the new 20-inch Line 5 will signal a turning point in the fuel transportation practices of both the nation and the region.

According to the Petroleum Institute of East Africa (2021), the pipeline will be adequate to fulfill the ever-increasing petroleum requirements of both the region and the nation. These requirements are anticipated to reach 24.5 billion liters in 2044 and 11.4 billion liters in 2025. The new pipeline will also expand and improve the dependability of fuel supply to the export markets of Uganda, Rwanda, and the eastern Democratic Republic of the Congo. This will be accomplished by removing hundreds of vehicles that carry petroleum between Mombasa and Nairobi on a daily basis. Not only will this bring about a technological revolution in the petroleum business, but it will also have a beneficial effect on the environment and on transportation by road. A supply chain that is trustworthy in the oil business will be more effective, which will allow oil and gas companies to reduce their transportation expenses, improve their service standards, and minimize the number of times their processes are interrupted.

2.4.3 Handling Infrastructure and Supply Efficiency

Materials handling refers to the process of moving objects all the way through the processes of an organization. In addition to transporting goods from one process to the next, it also transports items that have been selected from retailers to the site that is necessary. The purpose of material handling is to be able to deliver effective movements with short journeys, as well as quick movements that are free of harm by utilizing the appropriate equipment, specific handling and packaging when it is required, and quick movements. Because of this, it is possible that the layout of the factory will need to be reorganized in order to improve the conditions under which materials are handled (Djassemili, 2014). According to Lysons and Farringtone (2012), efficient handling systems are essential for the correct handling of materials. This is because these systems are the method by which objects can be transferred

from one location to another with the least amount of human labor. It is common for a corporation to incur significant costs while making investments in infrastructure and systems necessary for material handling. According to Leuschner and Lambert (2017), decisions about the amount, size, and placement of warehouses can have an effect on a variety of aspects of logistics operations. Materials handling decisions can also have an impact on these aspects.

The fact that firms usually deal with a diverse range of commodities necessitates the utilization of a variety of different kinds of equipment (Kumar & Suresh, 2009). Despite this, the implementation of fully automated handling systems will result in an increase in pressure throughout the offloading process. To ensure that there is a consistent flow of trucks and to avoid congestion, which may necessitate an organization to make additional investments in loading and unloading facilities in order to get rid of congestion, the objective will be to finish the unloading process as rapidly as is practically possible. The KPA Stakeholders Report (2012) provides evidence for the assertion that the facilities at the Mombasa port are "inadequate and in poor condition" and that it is highly improbable that the port will be able to manage increased traffic without making a large investment in equipment.

This growth in oil receipt has put a strain on the existing facilities and compounded the problem of delayed discharge, as stated by the Petroleum Institute of East Africa (2021). The existing oil terminals, which are designed to handle a throughput of one billion liters per year through two berths (Kipevu and Shimanzi oil terminals), handled a total of over 2.5 billion liters in 2017. Importers and clearing and forwarding (C&F) agencies believe that the delays are caused by inefficiencies in the port's freight handling, which is causing them to incur a significant amount of

demurrage. According to Omolo and Mwabu (2014), the facilities of the Mombasa Port are severely overworked and understaffed, which has led to an increase in the number of complaints received from customers and firms located in the surrounding area. Deloitte (2018) reports that the Kenya Revenue Authority (KRA) commissioner general blamed the delay to a number of different issues, one of which being a failure of port handling equipment. This occurred at the same time that the Kenya Ports Authority (KPA) revealed a new initiative to eliminate red tape at the Mombasa port.

According to the Kenya Shippers report from 2017, the infrastructure of Mombasa Port is badly overwhelmed and unable to keep up with demand. According to Swanson et al. (2017), in order for a firm's supply chain activities to flow smoothly and provide value for the customers, the organization must "minimize delays by avoiding having poor or outdated equipment." Due to the KPA's desire to get cargo out of the port zone as quickly as possible, oil marketers have on occasion discharged oil products without fully assessing their handling capacities. The majority of them are crowded not only because they do not have the right and dependable equipment, but also because their operators do not display sufficient planning when it comes to accepting the cargo. The ability of the supply chain for petroleum products to carry products along the chain in a timely manner is not only essential to the chain's success but also contributes to the chain's efficiency. Because of the increasing demand, it is expected that the products would arrive at the final consumer from the provider in a more expedient manner. The effectiveness of the supply chain will be hindered by Handling Infrastructure that is either inaccurate or inefficient, which will lead to deliveries that are delayed and reduce the level of satisfaction experienced by customers.

2.4.4 Cargo Clearing Infrastructure and Supply Efficiency

Cargo clearance refers to the amount of time that is necessary for the processing of goods that have been received, the unloading of goods, the storage of goods, the verification of goods, the movement of cargo within the company, and the transfer of ownership to clearing and forwarding agents, the owner of the cargo, or transshipping in the event that the cargo is in transit. However, if the requisite length of time for document processing, unloading, verification, storage, and cargo issuance is not fulfilled, then there will be a delay in the clearance of the cargo. Infrastructure that is insufficiently constructed, low traffic volume within the constraints of physical and environmental constraints, and inadequate technology are the three primary factors that contribute to delays in the delivery of cargo (Cuadrado et al. 2013). This is something that can be observed in a lot of ports all over the world. The process of clearing via the port of Mombasa in Kenya involves a complex network of administrative procedures, transportation infrastructure, and logistics. According to the Stakeholder analysis conducted by the KPA in 2012, the various state agencies that are responsible for trade facilitation are carrying out their tasks in a manner that is inconsistent.

The Clearing Infrastructure consists of the Kenya Revenue Authority systems as well as the various hardware and software add-ons that are utilized at the Mombasa port in order to process the importation and exportation of various categories of goods. The process of clearing cargo is carried out with the assistance of these add-ons, which can be found in a variety of government departments, divisions, or sectors inside the port. According to the Clearing Infrastructure ranking, information technology (IT) stands at the very top of the list. In order to successfully execute supply efficiency, information technology is essential since it connects people and information. Alink

and Kommer (2011) state that information technology not only improves the quality of service that is provided to customers, but it also considerably boosts productivity, saves money, and saves time.

When it comes to utilizing information technology to enhance supply chain competitiveness, Closs and David (2017) state that supply chain and IT managers are continuously faced with the challenge of determining which applications to invest in and whether or not a major version update is required. According to Jain et al. (2009), a supply chain is a dynamic process that involves the continuous flow of information, resources, and finances between members of the chain as well as between different functional domains. This flow occurs both simultaneously and between members of the chain. According to Simchi-Levi et al. (2015), the primary purpose of information technology in the supply chain is to establish a connection between the location of production and the point of delivery or where the product is purchased. Creating an information trail that follows the physical course of the product is the goal of this project. This will allow for real-time data-driven planning, tracking, and lead time estimation. Access to this information need to be granted to any and all parties that have a vested interest in the location of the products. As far as he is concerned, the primary goals of electronic supply chain management, also known as E-SCM, are as follows: to collect data on every product from the point of production to the point of delivery or purchase and to provide complete visibility to all parties involved; to access any data contained within the system from a single point of contact; and to plan, organize, and analyze activities based on information from entire supply chains.

The systems that are utilized by KPA and KRA for the purpose of processing imports and exports of items are known as Biller Direct, Simba, and ASYCUDA. According

to Swanson et al. (2017), one of the most important components of international logistics is the documentation that needs to be completed and physically submitted to various offices before, during, and after the shipping of a product to a foreign market. This documentation must be completed and sent to multiple offices. On the other hand, failure to do so could result in delays in the timely clearance of the goods. According to a report that was published by Deloitte (2018), the delay in the implementation of the new plan to eliminate bureaucratic hurdles at the Mombasa port was linked to the Kenya Revenue Authority (KRA) commissioner general. He made reference to the requirement to cut down on the amount of signatures that are required on a variety of documents. Because it is web-based, the Simba System has been at the forefront of Kenya's efforts to modernize its customs system. It has made it possible to automate approximately 90 percent of the customs procedures, and it has also eliminated the requirement that traders physically visit the Kenya Revenue Authority (KRA) offices in order to submit registration papers. It is now possible for traders to electronically file entries from a distance if they have access to the internet. Additionally, they are able to use local commercial banks to pay various costs in addition to customs charges (KRA, 2009).

At the conference of stakeholders that took place in 2012 at the Kilindini port, it was mentioned that the manual methods that have been in place for a long time and the electronic communication systems that were just recently introduced continue to be a significant obstacle, which results in consistent delays at the port. The public uproar against the congestion at Mombasa Port ought to encourage the Kenyan government to take action in order to speed up the process of clearing goods and avoid the accumulation of fees that are required by delays from being passed on to importers and consumers. A significant amount of cargo is transported via the port of Mombasa

as a result of its strategic location as the point of entry into and exit from East and Central Africa. On the other hand, the lengthy procedure of cargo clearance, which is especially problematic for oil goods, hinders the efficiency of the supply chain and results in delayed product discharge, which ultimately leads to stock outs. Therefore, it is of the utmost importance to both evaluate and update the clearing software as well as the clearing hardware (Deloitte, 2018).

2.5 Research Gaps

The research gaps from previous studies are presented in the table below:

Table 2.1 Research Gaps

Author	Study	Findings	Gap
Molete (2021)	Logistics Management Strategy and the Performance of the Petroleum Industry in the East African Community	Adoption of effective logistic strategy in the petroleum industry is a critical step seeking to ensure that the vital product is effectively and timely supplied to all regions in the country.	The research heavily relied on qualitative data that make it hard to quantitatively measure the linkage between logistics management strategy and performance of petroleum supply since the sample size was relatively small that could not allow the use of quantitative models like regression.
Maondo (2020)	Effects of downstream supply chain challenges on the performance of the petroleum industry in Kenya.	Oil Marketing companies experience a wide range of downstream supply challenges such as tendering systems, frequent fluctuation of international oil prices, logistics challenges, lack of an integrated process management, inadequate storage capacities, and lack of continuity in supply.	The study was restricted to Oil Marketing companies operating within Nairobi County and therefore could not be used in generalizing on the downstream challenges in Kenya.
Mangala & Moronge (2019)	Influence of Logistics Management Practices on Performance of Oil Marketing Companies In Nairobi County, Kenya	Performance of OMCs in Kenya is affected by supplier management, transport management, warehouse management and information management as the major logistics management practices which mostly influence performance of OMCs in Kenya.	Some new issues influencing logistics management on firm performances are likely to appear due to global supply chain management trends, over time, hence the need to continually research on logistics management to be able to identify when that happens, and learn how to deal with them.
Maeke (2017)	Reverse Logistics and Performance of Liquefied Petroleum Gas Firms in Kenya	There is strong relationship between logistics and the performance of LPG firms in Kenya.	The study only focused on effects of logistics on the operational performance of LPG firms in Kenya hence the finding of this study may not necessarily apply to other petroleum products.
Osoro (2016)	Challenges Affecting Performance of Supply Chain Systems in the Petroleum Industry in Kenya.	The current trends such as timeliness forecasting, proactive stock level management, IT, just in time delivery and e-procurement has not been well embraced by the registered oil companies.	This study could not exhaust all the challenges hindering performance of the supply systems in the petroleum industry in Kenya.

2.6 Critique of the Existing Literature

The SCOR model can be utilized as a common model for assessing, positioning, and putting supply chain plans into practice since it offers a common supply chain framework, standard nomenclature, common metrics with related benchmarks, and best practices (APICS, 2016). The concept is still developing and has not yet established itself as the norm in the business. The SCOR model has many drawbacks in addition to its many benefits for supply chain performance. As per Guhathakurta (2022), the SCOR model is an all-encompassing structure that encompasses numerous processes and activities, rendering it intricate to utilize and necessitating substantial time and resources to execute. Furthermore, its broad applicability to various industries and organizations may result in its lack of customization to the particular requirements of individual organizations, and it might not consistently offer the most pertinent suggestions for enhancement. The SCOR model is also predicated on an organized, linear approach to supply chain management, which may not always be the best course of action for businesses with extremely complex or dynamic supply chains and can make it challenging to adjust to shifting conditions or unforeseen events. Furthermore, other crucial components of supply chain management, such sustainability and social responsibility, may not be sufficiently addressed by the SCOR model since it largely concentrates on conventional supply chain activities like production, shipping, and procurement. Additionally, for the SCOR model to function well, it needs accurate and comprehensive data; in the event that this information is lacking or of low quality, it may not be able to offer trustworthy insights or suggestions for development. Last but not least, the Supply Chain Council (SCC) must improve the SCOR model in order to finally succeed in making it an industry

standard. Change management is crucial in the current global business climate and has not been taken into account in the model (Djassemi, 2014).

2.7 Summary of the Literature Review

The concepts of logistics infrastructure and Supply Efficiency were covered in the literature review in this section. According to the literature, Supply Efficiency can be impacted by logistics infrastructure in one of two ways: negatively or favorably. Additional research in the literature identified many forms of logistics infrastructure needed for the effective supply of petroleum products to the ultimate consumers. According to a review of the literature, storage capacity is strategically employed to stock reserves in order to assure an adequate supply for the purpose of distributing products to customers, making it a critical component of the petroleum products supply chain. The efficient supply of petroleum products depends on a strong road, rail, and pipeline network. Despite being the least expensive mode of land transportation, the nation's pipeline coverage is still inadequate, and the roads are in disrepair. Empirical data also revealed that a high level of information technology application is necessary for the petroleum product delivery function. Every supply chain, including the international oil industry, aims to maximize total value created. The value a supply chain creates for a company, or a country is the difference between the final product's market value and the effort the supply chain invests in meeting the demands of the customers. The literature analysis makes it clear that the supply chain management of petroleum products has received little attention, particularly when it comes to the infrastructure component, which includes the handling, clearing, storage, and transportation infrastructure. Therefore, by conducting a survey among Kenyan oil marketing organizations, this study aimed to

close that research gap by determining the effects of logistics infrastructure on the Supply Efficiency of Petroleum Products in Kenya.

2.8 Conceptual Framework

According to Blumberg (2011), the conceptual framework explains any potential correlations among the variables and is a component of the primary area of inquiry that will be examined, reviewed, and tested as a result of field studies. A conceptual framework is a tool that aids in researchers' comprehension of relevant topics being studied and their ability to communicate clearly. Researchers evaluate the study's helpful meanings by using a conceptual framework. The relationship between the independent and dependent variables employed in the study is further illustrated by the conceptual framework. Petroleum product Supply Efficiency was the dependent variable in this study, whereas storage, transportation, handling, and Clearing Infrastructure were the independent variables. This is the conceptual framework displayed:

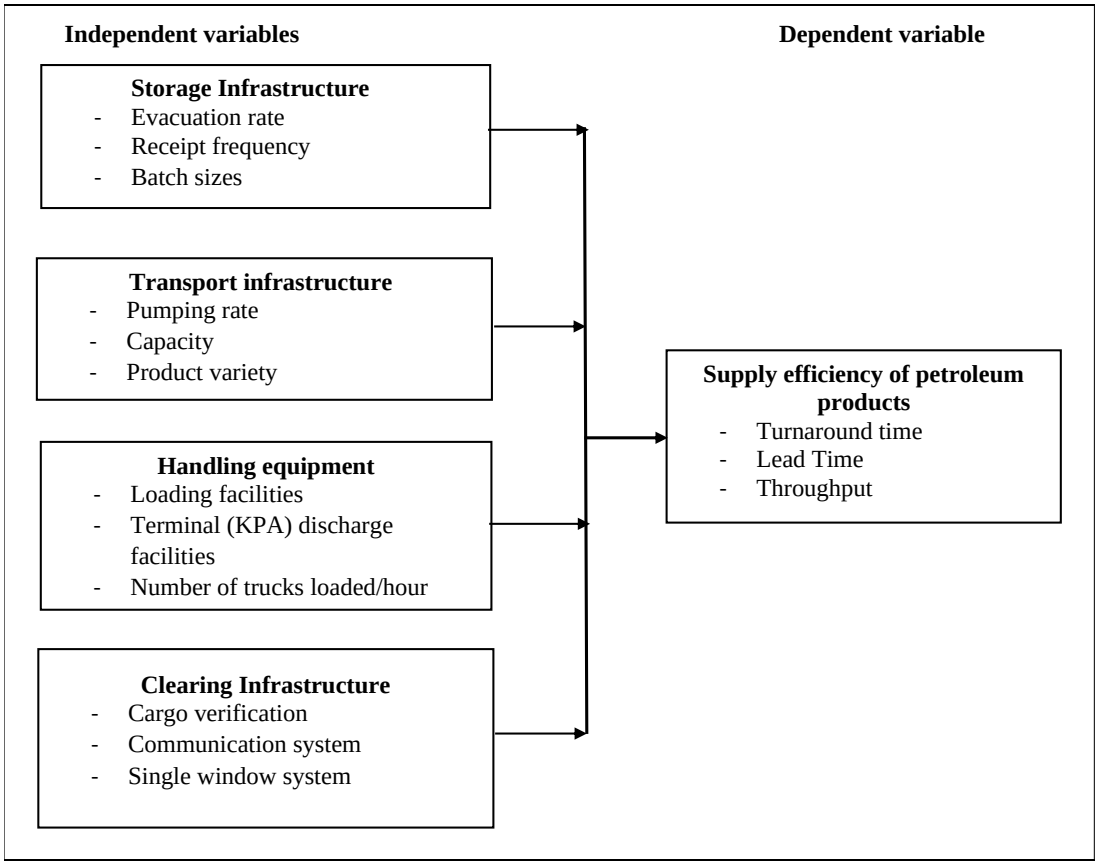

Figure 2.1 -Conceptual Framework
Source: Research data (2022)

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter establishes the research methodology that was adopted in the actual field work and captures the specific approaches, tools and processes that aided the study to meet the pre-established goals. This chapter specifically covers research design, Study area, target population, sample size and sampling procedure, data types, collection and procedures, pilot study, data processing, analysis and presentation and ethical considerations.

3.1 Research Design

In order to determine the impact of Logistics Infrastructure on the efficiency of petroleum product supply in Kenya, this study employed an explanatory research approach. This design was selected with the intention of achieving a comprehensive analysis and explanation of the research question. It does this by improving the comprehension and assessment of complicated issues, so enabling the researcher to conduct a thorough and rigorous investigation. According to Bell et al. (2018), an explanatory research design is useful for illuminating the reasons behind the existence of a certain issue or circumstance. It clarifies the relationships between the particular variables under study in terms of cause and effect. Stemler (2004) go on to say that by addressing the what, why, how frequently, and when of an occurrence, an explanatory research design would aid in explaining the links that exist between the variables of interest. As a result, the study benefited from the research design, which helped highlight the effects of Logistics Infrastructure on Supply Efficiency.

3.2 Study area

The study was conducted among the Oil Marketing companies operating in Kenya.

3.3 Target Population

According to Berg (2009), a population is the total set of people or other entities to which study findings are intended to be applied. Kothari (2019) defines population as everything in any subject of study, sometimes referred to as the universe. A study population is made up of people, homes, or organizations that have the same traits and from which the researcher hopes to draw conclusions (Cooper & Schindler, 2014). The whole group of people or other entities to which study results are intended to be applied is known as the target population (Berg, 2009). The study's target population consisted of 120 respondents, 60 of whom were supply managers and 60 of whom were operations managers from Kenya's 60 operating oil marketing companies.

3.4 Sample Size and Sampling Procedure

The section covered sample size and sampling procedure.

3.4.1 Sample Size

While Kothari (2019) describes a sample as a collection of units selected from the universe to represent it, Bryman (2016) defines a sample as a portion of the entire population. Total population sampling, according to Myneni (2021), is a kind of purposive sampling approach in which a researcher decides to look at the complete population that possesses a certain set of traits, such as particular knowledge, skills, experience, or exposure to an event. In these situations, the population as a whole is frequently selected since there is a relatively small population with the specific collection of traits that the researcher is interested in. In order to examine the entire population of 120 respondents—60 operation managers and 60 supply managers from

each of the 60 operating oil marketing companies in Kenya—the study used total population sampling. This was employed due to the target group's small and manageable size, which allowed them to supply the needed information (Myneni, 2021).

3.4.2 Sampling Procedure

Sampling procedure, according to Bryman and Bell (2015), is the approach used to draw a sample from the target population as a whole. A sample is a portion of the population taken for research purposes. Since a census of the complete target population was conducted, census sampling was used in this study. The 120 managers were chosen through the use of purposive sampling. Due to the relative advantage of time and resources required, this sampling approach—in which the items included in the sample are specifically chosen by the researcher—is perfect for short inquiries and research projects (Akhtar, 2016). Because the entire study sample was small and had a unique combination of features, including exposure to the topic under investigation and a special set of knowledge, abilities, and experience, this technique was chosen (Myneni, 2021).

3.5 Data Types, Collection and Procedures

3.5.1 Types of data

The study used primary data which was obtained from the Operations and Supply managers of the active oil marketing companies in Kenya through administration of structured questionnaires and secondary data was also obtained from records and publications from the industry players which included Ministry of Petroleum and Mining, Energy and Petroleum Regulatory Authority, Petroleum Institute of East Africa, Kenya Ports Authority and Kenya Revenue Authority. Questionnaires are

considered appropriate in primary data collection since they can be used to collect information that cannot be directly observable (Mugenda & Mugenda, 2012).

3.5.2 Research Instruments

Primary data was gathered through the use of structured questionnaires designed with Likert scale questions in mind, which have a 5-point rating system ranging from strongly disagree to strongly agree. Because they had the benefit of gathering data from big populations quickly and cheaply, this was thought to be the most appropriate method for this investigation. Questionnaires are simple to run and evaluate, and they give respondents time to consider their answers, according to Kothari (2019). According to Cooper & Schindler (2014), Burns & Burns (2012), Mugenda & Mugenda (2012), Creswell (2018), each respondent to a questionnaire was asked to answer the identical set of questions in a preset order. Part one of the questionnaires asked questions about basic information, and part two asked questions on the study variables.

3.5.3 Data Collection Procedures

According to Bryman (2016), data collection is the process of gathering information from the chosen subjects of a research or investigation. In contrast, data collecting is the method of gathering information from the chosen subjects of a study or investigation. It speaks of the methods used to retrieve the necessary research data for examination. Before the real data collecting started, permission was obtained from Moi University and the relevant oil marketing businesses. To get ready for the data collection, a pre-visit was carried out, and the information was gathered in 35 working days. A week was allotted to each respondent to complete the questionnaires. Given

their busy schedules, this time was thought to be sufficient for the responders to provide a sufficient response.

3.6 Pilot Study

To find out if the study actually measured what it was supposed to measure and to make sure the research instrument is valid and reliable, a pilot test was employed to assess the validity and reliability of the data collection tool. On 10% of the sample, a pilot research was carried out. Six of the top outsourced petroleum product transport companies—Roy Hauliers, Dakawou Transporters, Roy Transmotors, Dikus Transporters, Mascot Petroleum, and Ashur Ahmed Transporters—based in Mombasa and Nairobi, were used in the pilot study and were not included in the final study. The respective operations managers and transport managers of these organizations received the questionnaires.

3.6.1 Reliability Test

Reliability is the capacity to repeat study findings and pertains to the correctness and consistency of the results gained (Collis & Hussey, 2016). It denotes constancy or dependability. According to Kothari (2019), dependability is the ability to produce the same outcome under the same or very comparable circumstances. However, according to Ranjit (2019), dependability is the degree to which the same results can be acquired repeatedly with the same tools.

Since each questionnaire had many items that respondents were required to answer, the internal consistency of the questionnaires was calculated using the Cronbach's Alpha coefficient in order to establish the reliability of the research instruments. The results ranged from 0.798 to 0.932, which is consistent with Stemler's (2004) recommendation that a Cronbach's alpha value of 0.6 and above be considered

acceptable. Twelve staff members from six of the top transportation companies for petroleum products were given the sample questionnaires. This provided input on how well-defined and sufficient the questions were in obtaining the desired data (Neuman 2014). Prior to beginning the actual data collection process, the project supervisor provided help in correcting the ambiguity that was identified during the pilot study.

3.6.2 Validity Test

As per Robson's (2016) assertion, the validity of a research instrument is evaluated based on how well it measures the intended construct and how true the results are. For this reason, the research tool (questionnaire) must accurately quantify the topics being investigated (Pallant, 2016). It covers the complete idea of the experiment and determines whether the outcomes satisfy all the criteria of the scientific research methodology. The data in this study were found to be normal, with the maximum significance value being 0.016, which is less than the 0.05 significant level. The validity of the data was assessed using the Pearson correlation.

3.7 Data Analysis

The acquired data was edited, processed, classed, and tabulated to prepare it for a number of statistical computations using SPSS statistical software. Following that, the data was examined using regression modeling, correlation analysis, and descriptive statistics. Since the goal of the study was to investigate the causal relationship between Kenya's Logistics Infrastructure and the efficiency of the petroleum product supply, correlation was the method of choice. Descriptive statistics, which involve calculating the mean and standard deviation on the independent variables to summarize and classify the data collected into understandable form for simple interpretation, were employed in a standardized analysis process across all study

objectives. Regression analysis was used in the study to determine the connection between Kenya's Logistics Infrastructure and the country's petroleum Supply Efficiency. Correlation and coefficient determination were done using the output summary. The study's hypothesis, which posited a relationship between Kenya's Logistics Infrastructure and the efficiency of its petroleum supply, was tested using coefficients.

The relationship between the dependent and the independent variables was tested using regression analysis model as follows:

$Y=\alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+ \beta_4X_4+ \varepsilon$

Where:

- Y = Supply Efficiency
- α = Constant
- β_1, β_2, β_3, β_4 = Régression Coefficient
- X_1 = Storage Infrastructure
- X_2 = Transport Infrastructure
- X_3 = Handling Infrastructure
- X4 = Clearing Infrastructure
- ε = Stochastic term or error term

The model assumptions of Normality, Multicollinearity, constant variance and linearity were assessed to determine if they are met. The normality and constant variance assumptions were assessed using graphical inspection of residuals while the multicollinearity was assessed using the correlation coefficient values among independent variables and also using the Variance Inflation Factor (VIF) and linearity assumption was tested using scatter plots.

3.8 Ethical Considerations

The researcher sought proper authorization from Moi University and the relevant OMCs to gather the data for the study. Additionally, the research was planned to prevent participants from experiencing any physical harm, pain, discomfort, embarrassment, or invasion of privacy by informing them of the study's expectations and benefits, their right to privacy and protection, informed consent, and the avoidance of deceit by reassuring them that the study was solely academic and not being used for financial gain.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0 Introduction

This chapter presents the findings of this study, which were obtained from the various analyses after data collection. The objective of the study was to determine effects of Logistics Infrastructure on Supply Efficiency of Petroleum Products in Kenya. The study used descriptive statistics technique to analyze the data since it was quantitative in nature and the findings presented in tables and charts. Descriptive statistics, Pearson correlation and multiple linear regression analysis were used to analyze the collected data. Data interpretation was done in line with the research objectives. The chapter presents the analyzed data in three parts: General information on respondents, descriptive statistics, and inferential statistics.

4.1 Response Rate

The respondents who took part in the study and submitted their questionnaires as requested by the researcher are represented by the response rate. Both personally and by the courier or e-mail, the questionnaires were delivered to the responders. Out of the 120 questionnaires distributed, the study obtained 108 responses in total, or a 90.0% response rate. According to Kothari (2019), who believes that a 65% response rate is sufficient for a study to proceed, this suggests a good response for analysis. This suggests that the majority of the people who were contacted to take part in the survey did so and provided accurate study replies. The mean, standard deviation, and coefficient of variation of the gathered data were examined.

Table 4.1 Response Rate

Characteristics	Frequency	Percentage
Total Response	108	90.0
Total Sample	120	100.0

Source: Research data (2022)

4.2 Demographics Characteristics of Respondents

The study sought to gather broad details regarding the respondents' backgrounds and the oil marketing firms they are employed. The information requested concerned years of operation of each firm and employment experience.

4.2.1 Age of Participating Firms

In order to determine if the oil marketing companies were qualified to provide reliable information on the topic of the study, the study attempted to ascertain how long each had been in business. The outcomes are shown in Table 4.2 below.

Table 4.2 Age of Firms

Characteristics	Frequency	Percentage
0-5 years	7	6.5
6-10 years	31	28.7
11-15 years	52	48.1
16-20 years	7	6.5
Over 20 years	11	10.2
Total	**108**	**100.0**

Source: Research data (2022)

According to the survey, 35.2% of participating firms had been in business for less than ten years, whilst 64.8% of participating enterprises had been in business for more than ten years. As a result, the data gathered was more relevant because the majority of the participating enterprises had sufficient experience in the petroleum distribution industry.

4.2.2 Respondents' Experience

When asked how long they had been in their current jobs, the respondents gave their answers, which are shown in Table 4.3 below.

Table 4.3 Respondents' Work Experiences

Characteristics	Frequency	Percentage
0-5 years	38	35.2
6-10 years	56	51.9
Over 10 years	14	13.0
Total	**108**	**100.0**

Source: Research Data (2022)

The majority of respondents (51.6%) had job experience ranging from six to ten years, followed by those with fewer than five years (35.2%) and those with more than ten years (14%). This was done in order to ascertain the respondents' familiarity with the industry, the company, and the several aspects that were the subject of the study. Based on their own experiences, the majority of respondents seemed to be well-versed on the performance of the petroleum product supply chain in their individual companies.

4.3 Factor Analysis

Factor analysis (FA) is a method that helps to fine-tune and evaluate the data's structure by reducing the number of dimensions in the data. Table 4.4 lists the outcomes of the Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy. These findings demonstrated that the FA was suitable. This is because the Barttlet's Chisquare (1665.927) was significant, as shown by a significant p value of less than 0.0001, and the KMO that was achieved (0.878) was closer to 1.0.

Table 4.4 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.878
Bartlett's Test of Sphericity	Approx. Chi-Square	1665.927
	Df	190
	Sig.	.000

Source: Research Data (2022)

Table 4.5 displays the extracted total variance. The percentage of the original data's variance that is extracted into the smaller datasets is known as the total variance extracted in Factor analysis (FA). Our findings showed that 78.452 percent of the total variance was retrieved. This demonstrates that the decreased dimensions retained a large portion of the original variance. The total variance findings once more displayed the quantity of extracted components. Five components with an extracted eigen value larger than one were found in this research demonstrating that a five-factor structure is represented by the twenty components.

Table 4.5 Total Variance Extracted

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.939	44.696	44.696	3.463	17.313	17.313
2	2.652	13.259	57.955	3.240	16.199	33.512
3	1.609	8.045	66.000	3.103	15.516	49.028
4	1.475	7.377	73.377	3.022	15.109	64.137
5	1.015	5.074	78.452	2.863	14.315	78.452
6	.624	3.118	81.570			
7	.532	2.662	84.232			
8	.478	2.388	86.621			
9	.436	2.180	88.801			
10	.398	1.989	90.790			
11	.324	1.621	92.411			
12	.265	1.324	93.735			
13	.240	1.200	94.935			
14	.194	.972	95.908			
15	.187	.937	96.845			
16	.156	.779	97.624			
17	.155	.775	98.399			
18	.142	.711	99.111			
19	.097	.487	99.598			
20	.080	.402	100.000			

Source: Research Data (2022)

The rotated component matrix values, which are displayed in Table 4.6, are another significant FA output. It displays how each item is loaded into a component. To clearly show the extracted pieces in each component, the components were rotated and only items loading larger than 0.4 were displayed to maintain matrix clarity.

Table 4.6 Rotated Component Matrix

Rotated Component Matrix

	Component				
	1	2	3	4	5
ST01; Our storage capacity is inadequate	.794				
ST02; we have enough storage network in the country	.915				
ST03; Our stores are well located and distributed to give us an added advantage	.905				
ST04; We always have adequate stock to meet the demands	.854				
TR01. We have adequate booster pumps		.733			
TR02. The current pipeline serves us well		.758			
TR03. The pipeline has the ability to transport different product grades at the same time		.882			
TR04 The road transport provides an ideal option in the distribution of our products		.881			
HD01; Loading and offloading equipment used are adequate					.818
HD02; We have the best Loading and offloading equipment used in the sector					.719
HD03; We have adequate truck loading capacity in this sector					.731
HD04; Our dispensing equipment are adequate				.	504
CR01; Cargo verification process at KPA is efficient			.774		
CR02; Cargo verification process at KPA is fast with no delays			.860		
CR03; KPA system used in cargo clearing is user friendly and efficient			.757		
CR04; There are no frequent outages of single window system			.772		
Eff01; We have adequate storage capacity for oil products				.550	.544
Eff02; We have sufficient pipeline and roads infrastructure				.819	
Eff03; We have efficient handling equipment at KPA and depots				.790	
Eff04; We have efficient cargo verification and clearing systems and processes at KPA				.796	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Source: Research Data (2022)

Five distinct structures that represent the five components are seen when the findings are rotated. Typically, one discrete component is supplied with items designed to measure a different construct. It was only one item; Storage capacity for oil products which was adequate that loaded to two components (component 4 and 5). Other than this one, every other item intended to measure the same construct is hung together in a single unique component. All the four items meant to measure the constructs storage loaded to component one. The four items meant to measure transport loaded to component 2 while the four items meant to measure Clearing Infrastructure loaded to component 3. Component four is dominated by Supply Efficiency items and component five is dominated by Handling Infrastructure items.

The items in the same component were averaged to form a construct representing that construct. The four items in component one were averaged to produce the STORAGE construct, the four items in component two were averaged to produce the TRANSPORT construct, the four items in component three were averaged to produce the HANDLING construct, the four items in component four were averaged to produce the CLEARING construct and the four items in component five were averaged to produce the SUPPLY EFFICIENCY construct for analysis. Thus, five constructs were produced, and the descriptive results of each construct were reported.

4.4 Descriptive Results

The goal of the study was to determine how much Kenya's petroleum product Supply Efficiency is influenced by Logistics Infrastructure, Storage Infrastructure, Transport Infrastructure, Handling Infrastructure and Clearing Infrastructure. In the research analysis, the study employed a tool rating system of between 1 to 5 with 5 being the highest and 1 being the lowest. The participants were asked to express how much they agreed or disagreed with a range of propositions. The respondents' opinions were

ranked as follows: 1 is Strongly Disagree, 2 is Disagree, 3 is Neutral, 5 is Strongly Agree, and 4 is Agree. Positive wording in the questions indicates beneficial infrastructure, with a high score of five. Consequently, favorable infrastructure was represented by a high mean greater than 3. Conversely, a low mean score denoted inadequate infrastructure, while a mean score of roughly three indicated moderate. The variation in agreement between different oil marketing companies was displayed by the standard deviation.

Table 4.7 Descriptive Results

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
STORAGE	2.49	1.018	.999	.233	.265	.461
TRANSPORT	2.36	1.027	.804	.233	.114	.461
HANDLING	2.23	.838	.896	.233	.859	.461
CLEARING	2.31	.932	.762	.233	-.007	.461
EFFICIENCY	3.06	.687	-.788	.233	1.551	.461

Source: Research Data (2022)

The majority disputed that there were good infrastructure in response to questions about their companies, as can be seen from the mean findings, which show that the infrastructure is a challenge. The mean values were about 2. In other words, several of Kenya's oil marketing enterprises face difficulties due to Logistics Infrastructure inadequacy. The standard deviation in this study demonstrated the range of responses with respect to the infrastructure that the oil marketing corporations had access to. The SD was found to range from 1.018 to 0.687. If the response distribution differed from the normal distribution, it was informed by both skewness and kurtosis taken

together. The five constructs show no discernible deviation from the normal distribution, as demonstrated by values of skewness and Kurtosis that are less than 1.

4.4.1 Storage Infrastructure

The initial goal was to determine how Kenya's oil Storage Infrastructure affected the country's petroleum product Supply Efficiency. The Storage Infrastructure descriptive result was provided to illustrate the state of the Storage Infrastructure that is now available or in use in the oil marketing companies. It was a requirement for the respondents to provide a fair appraisal of the Storage Infrastructure in their respective organizations. Table 4.8 displays the mean and standard deviation for the data.

Table 4.8 Descriptive Results for Storage Infrastructure

Storage Infrastructure indicators	Mean	SD
Our storage capacity is adequate	2.450	0.443
we have enough storage network in the country	2.160	0.352
Our stores are well located and distributed to give us an added advantage	2.941	0.435
We always have adequate stock to meet the demands	2.120	0.294

Source: Research Data (2022)

The results on the state of the oil Storage Infrastructure among the sixty Oil Marketing Companies in Kenya were displayed in Table 4.8. The results showed that there are issues with the Storage Infrastructure, as seen by the low mean values of less than three for each of the four storage indicators. From a minimum of 2.120 (SD=.294) to a maximum of 2.941 (SD=.435), the mean shows that the Storage Infrastructure was, in fact, not as beneficial as it should have been. The data showed that the enterprises were facing issues with inadequate space and weak storage networks, which resulted in frequent stock outs in most parts of Kenya. The country's supply chain for petroleum products was probably going to suffer as a result of this inadequate infrastructure for storage. This included not having enough room to store

the items, which causes delays in getting them to their intended location (Brettel, et al, 2011). Hu and Cao (2016) state that as each store has a limited amount of space, efficient inventory management is important to prevent delays and facilitate the flow of products. This entails accurate restocking at every store location and a prompt reaction to demand (sales). Long wait times and penalties are the outcome throughout the supply chain. The problems with the Storage Infrastructure also suggested that the oil marketers would not be able to precisely restock each store in response to client demand (sales), and that there would be product transportation issues, confusion, and congestion.

4.4.2 Transport Infrastructure

The state of Kenya's Oil Marketers' transportation infrastructure was also examined in the study. The Transport Infrastructure descriptive result was provided to demonstrate the suitability of the nation's existing Transport Infrastructure for the transportation of oil products. The mean and standard deviation were found as indicated in table 4.9.

Table 4.9: Descriptive Results for Transport Infrastructure

Transport Infrastructure indicators	Mean	SD
We have adequate booster pumps in this company	2.340	0.609
The current pipeline serves us in most profitable ways	2.270	0.505
The pipeline has the ability to transport different product grades at the same time	2.480	0.595
The road transport provides an ideal option in the distribution of our products	2.524	0.560

Source: Research Data (2022)

The results on the state of the oil Transport Infrastructure among Kenya's sixty oil marketing enterprises were displayed in Table 4.9. The mean values showed a low range that indicated inadequate Transport Infrastructure, ranging from low values of

2.270 (SD=.505) to a low value of 2.524 (SD=.560). For example, the data showed that the companies struggled with having insufficient booster pumps, that the current pipeline is unprofitable, and that the pipeline cannot transport several product grades simultaneously, which is a crucial component of the supply chain for marketers. Insufficient Transportation Infrastructure implies that businesses miss out on the cumulative benefits of well-designed Transportation Infrastructure. Value and place utility were included in this. Value chains start as soon as products, materials, or vessels are brought into an organization. Inadequate infrastructure impedes the smooth flow of goods along the supply chain by preventing transport services from continuing (Hessler, 2010). In order to support the national and regional economies, PIEA (2021) agrees that the rise in local and regional demand for petroleum products in recent years has not been matched by the development of the necessary infrastructure to meet supply chain and market requirements. It identifies this as the strategic gap that the government, through KPC, should work to bridge with the construction of a new pipeline.

4.4.3 Handling Infrastructure

The study evaluated Kenya's petroleum product Handling Infrastructure as well. First, the goal was to ascertain whether or not Handling Infrastructure supporting the supply chain was advantageous to the Oil Marketing Companies. Table 4.10 displays the Handling Infrastructure indicators' mean and standard deviation.

Table 4.10 Descriptive Results for Handling Infrastructure

Handling Infrastructure indicators	Mean	SD
Loading and offloading equipment used are adequate	3.160	0.676
We have the best Loading and offloading equipment used in the sector	2.280	0.747
We have adequate truck loading capacity in this sector	2.470	0.587
Our dispensing equipment are adequate	3.040	0.502

Source: Research Data (2022)

The results of 60 oil marketing companies in Kenya were analyzed as presented in Table 4.10 showing the state of the oil Handling Infrastructure. An overall mean of 2.74 (SD=.628) was found in the survey, indicating that the respondents were not very convinced that Kenya's petroleum product Supply Efficiency is positively impacted by the inadequate Handling Infrastructure. However, with a mean score of 3.16 (SD=.676) and 3.04 (SD=.502), respectively, the respondents felt that the dispensing equipment employed at the stations and the loading and unloading equipment in the depots were only mediocrely sufficient. The aforementioned low mean values suggest that the current Handling Infrastructure is not optimal for oil marketing, despite its crucial role in improving supply chain efficiency. This suggests that the oil firms did not entirely achieve the goal of materials handling. One of the main objectives was to guarantee quick and easy movements, the use of suitable equipment with minimal damage, and the use of specific packaging and handling when necessary. The most important conclusion from this study was that managing infrastructure posed additional difficulties, which made it difficult for oil marketers to attain supply chain efficiency. In order to maintain a steady product flow and prevent congestion, which could require an organization to invest more in loading and unloading facilities in order to eliminate congestion, Kumar & Suresh (2009) state that the primary objective of material handling is to complete the unloading process as quickly as feasible.

4.4.4 Cargo Clearing Infrastructure

The time it takes to handle received cargo, unload it, store it, verify it, move it internally, and transfer ownership to clearing and forwarding companies, the cargo owner, or transshipping in the event that the cargo is in transit is known as cargo clearance in logistics. The goal of the study was to evaluate Kenya's petroleum product cargo Clearing Infrastructure. Determining how advantageous it was for the Oil Marketing Companies to turn around vessels at the Port of Mombasa was the primary goal. Table 4.11 displayed the average and standard deviation of the oil marketers' Clearing Infrastructure status.

Table 4.11 Descriptive Results for Clearing Infrastructure

Clearing Infrastructure indicators	Mean	SD
Cargo verification process at KPA is efficient	2.180	0.481
Cargo verification process at KPA is fast with no delays	2.500	0.638
KPA system used in cargo clearing is user friendly and efficient	2.310	0.716
There are no frequent outages of single window system	2.056	0.681

Source: Research Data (2022)

The results of the state of the oil products Clearing Infrastructure among the sixty oil marketing businesses in Kenya were displayed in Table 4.11. The range of mean values displayed in Table 4.11 indicated that the procedure of clearing cargo is not seamless for enterprises involved in oil marketing. The clearing indicators' low mean, which varied from 2.056 (SD=.681) to 2.500 (SD=.638), suggested a subpar Clearing Infrastructure. These results showed that processing the received cargo, unloading, storing, verifying, moving the cargo internally, and giving ownership of the cargo to the eventual owner were all taking too long. Additionally, the single window system's frequent interruptions and inefficiency in the cargo verification procedure were present. These findings align with those of Mansidão & Coelho (2014), who investigated the relationship between logistics performance and technology adoption

with respect to service dependability and came to the conclusion that technology-related activities directly affect logistics performance. As the gateway to and from East Africa, the port of Mombasa has strategically positioned itself, according to Deloitte (2014). This has resulted in high cargo traffic and a slow cargo clearance process, particularly for oil products, which interferes with the efficiency of the supply chain and delays the discharge of products, leading to stock outs. As a result, upgrading and reviewing cleaning hardware and software is highly necessary.

4.4.5 Supply Chain Efficiency of Petroleum Products in Kenya

Lastly, an investigation was conducted into the current state of Oil Marketers' Supply Efficiency. The effectiveness with which the resources in the supply chain are used is known as supply chain efficiency. Table 4.12 presents the results of the examination of the supply chain efficiency indicators.

Table 4.12 Descriptive Results for Supply Efficiency of Petroleum Products in Kenya

Supply chain efficiency indicators	Mean	SD
We have adequate storage capacity for oil products	3.35	0.48
We have sufficient pipeline and roads infrastructure	3.34	0.648
We have efficient handling equipment at KPA and depots	3.28	0.685
We have efficient cargo verification and clearing systems and processes at KPA	3.75	0.725

Source: Research Data (2022)

The results on the oil marketers' general perceptions of Kenya's oil product Supply Efficiency were shown in Table 4.12. The mean values fell into the moderate range of 3.28 (SD=,685) to 3.75 (SD=.725). This suggested that the majority of oil marketers believed they had some degree of Supply Efficiency. They managed to have a controllable client demand, have enough amount to satisfy customer expectations, meet delivery schedules, and give the quantity to consumers as agreed. The most

important conclusion drawn from this study was that the firms had not yet reached their maximum potential for efficiency, indicating that considerable work remained to be done in order to reach the necessary level of sectorial efficiency that is essential to creating a viable supply chain.

The results of the Logistics Infrastructure analysis's descriptive analysis demonstrated how unfavorable the current infrastructure in oil marketing was. The descriptive findings had demonstrated the significant infrastructure issues that Kenyan oil marketing companies were facing at the time. The infrastructure for storing, transporting, handling, and clearing goods was inadequate, but it nevertheless had an impact on how quickly goods moved from the point of receipt to the point at which they were released to the subsequent individual or business in the supply chain. Once more, it was discovered that the supply chain's efficiency was only moderate and not ideal. According to supply chain literature, Supply Efficiency and the severity of the infrastructure problems that arise during a product or service's supply chain are inversely correlated (Lysons & Farringtone, 2012).

4.5 Correlation Analysis

The investigation of the relationship between supply chain efficiency, the dependent variable, and these Logistics Infrastructure variables, the independent variables, took up this section. One method for determining the link between variables is correlation analysis. In order to determine how much Logistics Infrastructure affects Kenya's petroleum product Supply Efficiency, this study used Pearson Correlation analysis. Table 4.13 presents the correlation data.

Table 4.13 Correlation Results

		storage	Transport	Handling	Clearing	Efficiency
Storage	Pearson Correlation	1				
	Sig. (2-tailed)					
Transport	Pearson Correlation	.194*	1			
	Sig. (2-tailed)	.044				
Handling	Pearson Correlation	.386**	.406**	1		
	Sig. (2-tailed)	.000	.000			
Clearing	Pearson Correlation	.206*	.453**	.318**	1	
	Sig. (2-tailed)	.032	.000	.001		
Efficiency	Pearson Correlation	.239*	.419**	.436**	.562**	1
	Sig. (2-tailed)	.013	.000	.000	.000	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
c. Listwise N=108

Source: Research Data (2022)

The findings demonstrated a positive and substantial relationship between all infrastructure factors and supply chain efficiency, i.e., an improvement in Logistics Infrastructure led to an improvement in supply chain efficiency. The results showed that Handling Infrastructure (r=.436, p<.001) and Clearing Infrastructure (r=.562, p<.001) had the second-strongest positive correlation with supply chain efficiency. These findings suggested that supply chain efficiency for Kenyan oil marketing enterprises was positively correlated with Logistics Infrastructure. The main takeaway from these results is that oil marketing companies with highly efficient logistical systems will typically be able to achieve higher levels of efficiency than those with less efficient systems. In other words, increased Storage, Transport, Handling, and Clearing Infrastructure all contribute to increased petroleum product Supply Efficiency in Kenya.

4.6 Validity and Reliability

A research instrument's validity is evaluated based on how well it evaluates the variables it is intended to examine and how accurate the results are (Robson, 2016).

The Pearson correlation was used to assess the research instrument's (questionnaire) validity. Conversely, repeatability of study results is a key component of dependability, which is concerned with the correctness and consistency of the findings (Collis & Hussey, 2016). The internal consistency of the questionnaires was calculated using the Cronbach's Alpha coefficient to assess the reliability of the research instruments, as shown in table 4.14.

Table 4.14 Cronbach's Alpha; Reliability Test Results

Factor	Number of items	Cronbach's alpha
STORAGE	4	.876
TRANSPORT	4	.854
HANDLING	4	.798
CLEARING	4	.932
EFFICIENCY	4	.887

Source: Research Data (2022)

The findings demonstrated that every item satisfied the requirement for reliability, which was a Cronbach's alpha of better than 0.7. The clearing construct had the best reliability, at 0.932, while the handling construct had the lowest, at 0,798. This demonstrated the study instrument's internal consistency, which allowed it to reproduce the results in a similar setting (Neuman 2014). Conversely, the data was found to be normal when the validity was assessed using the Pearson correlation; the greatest significance value of the data was 0.016, which was below the 0.05 significant limit.

4.7 Multiple Regression Analysis

The study employed multivariate regression analysis to ascertain the correlation between the dependent variable (Supply Efficiency of Petroleum Products in Kenya)

and the independent variables (Storage Infrastructure, Transport Infrastructure, Handling Infrastructure, and Clearing Infrastructure).

4.7.1 Model Assumptions

Multicollinearity, normalcy, and linearity assumptions are among the presumptions that underpinned classical regression modeling. According to the multicollinearity assumption, a model's independent variables shouldn't have a lot of correlation with one another. According to Wooldridge (2012), multicollinearity looks at the strength of the correlation between independent variables. Correlation shouldn't be higher than 0.8. Variance inflation factors and tolerance limits were used to test for multicollinearity; the correlation results in table 4.15 demonstrated the absence of multicollinearity. Additionally, no independent variable with a VIF larger than 10 was revealed by the Variance Inflation Factor Test. Since each VIF was smaller than 2, there was no collinearity between the independent variables. Baltagi (2005) states that a regression model cannot be fitted with two variables if the independent variables have a strong correlation. One of them should be discontinued, or the model should be respecified.

Table 4.15 Multicollinearity Test Results

		Collinearity Statistics	
		Tolerance	VIF
	Storage	.844	1.186
	Transport	.718	1.392
	Handling	.725	1.379
	Clearing	.768	1.303

a. Dependent Variable: efficiency

Source: Research Data (2022)

Normality Test Results

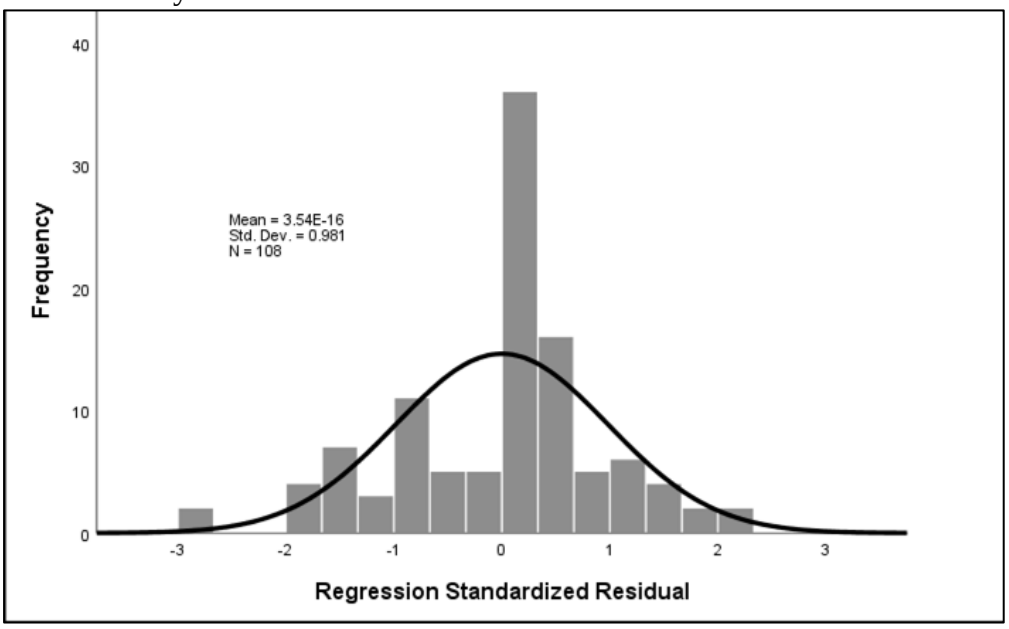

Figure 4.1 The Histogram to Assess the Normality Assumption
Source: Research Data (2022)

According to the normality assumption, the regression function's residual should have a normal distribution. According to Hansen (2020), normalcy is the state in which the data being examined has a bell-shaped distribution. The distribution appeared to be approximately normal on a plot of the residuals, indicating that the normality condition was also satisfied.

The consistent deviation Assumption: in order for the assumption to be satisfied, it is assumed that the regression's variance is constant throughout the dependent variable's complete range and that there is no discernible pattern of fanning out in the errors. To verify this assumption empirically, a plot of the regression residuals against the expected values was employed. Figure 4.1's data revealed no pattern, suggesting that the assumption was likewise satisfied.

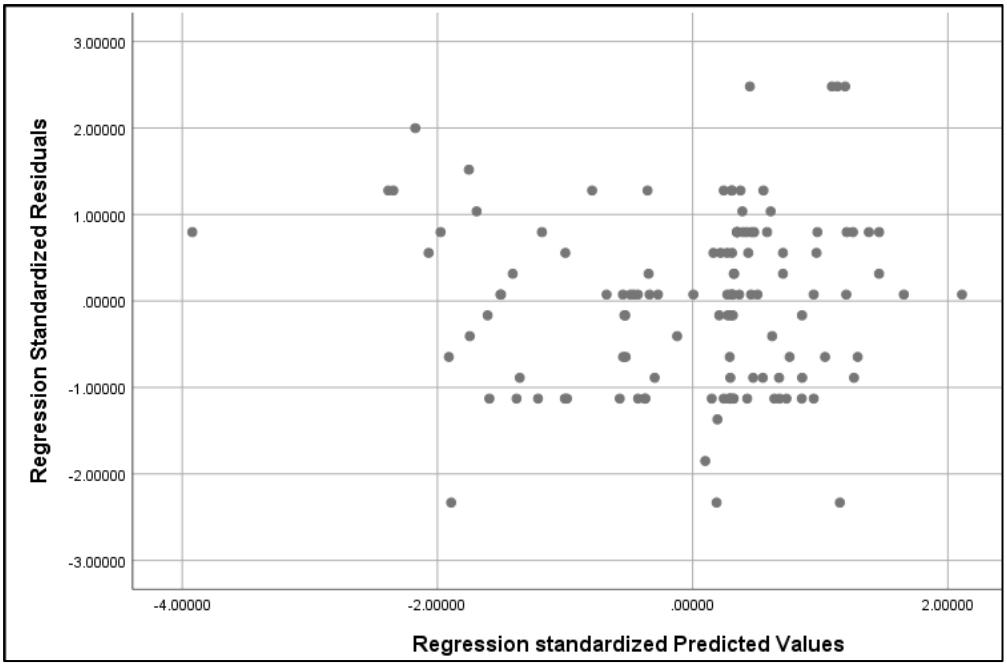

Figure 4.2 Linearity Assumption
Source: Research Data (2022)

According to the linearity assumption, there is a linear relationship between the independent and dependent variables. The linearity assumption is satisfied when the constant variance and normalcy assumptions are satisfied. In order to achieve this, the study determined that all of the presumptions were true, and as a result, the model belonged to one of the several families of models that connect Supply Efficiency and Logistics Infrastructure.

4.7.2 Model Summary

The study sought to establish the effect of Logistics Infrastructure on Supply Efficiency of Petroleum Products in Kenya and the results were as shown in Table 4.16 below.

Table 4.16 Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.634[a]	.402	.379	.582

Predictors: (Constant), horizon_1, perfrom_1, vertical_1, congrom_1

Source: Research Data (2022)

The dependent variable's variance, as explained by the independent variables in the regression between Kenya's Logistics Infrastructure and Supply Efficiency of Petroleum Products, is shown in Table 4.16 above. Thus, how well the data fits the linear model is indicated by the model summary findings. Multiple correlation coefficients are represented by the R value from the regression model findings. The Logistics Infrastructure (Storage, Transport, Handling, and Clearing Infrastructure) and Supply Efficiency of Petroleum Products in Kenya have a strong positive link, as indicated by the R value (R = 0.634). The R square was 0.402, meaning that Logistics Infrastructure variables—Storage, Transport, Handling, and Clearing Infrastructure—accounted for 40.2% of the variance in supply chain efficiency in oil marketing firms. Other factors in Kenya's oil and gas sector, which were not examined in this research, explained the remaining 59.8% of the variance. The four Logistics Infrastructure measures—Storage, Transport, Handling, and Clearing Infrastructure—account for 37.9% of the variation in Supply Efficiency among Kenyan oil marketers when the model is corrected for the independent variables, according to the adjusted R square of 0.379.

Table 4.171 ANOVA

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.404	4	5.851	17.294	.000[b]
	Residual	34.846	103	.338		
	Total	58.250	107			

a. Dependent Variable: Efficiency

b. Predictors: (Constant), Storage, Transport, Handling, Clearing

Source: Research Data (2022)

The model significance in general is shown in Table 4.17. Analysis of Variance (ANOVA) was employed in the study to determine the regression model's significance. The overall model fit to the data was displayed by the ANOVA. Regression model significance was determined by looking at Table 4.17 above, which shows that the model was significant overall. Results from a significant ANOVA show that the model fits. A good linear model with Supply Efficiency as the dependent variable and Logistics Infrastructure variables as independent variables was shown by the results, which had a significant p value ($F_{(4,107)} = 17.294$, $p<.001$).

Table 4.18 Regression Coefficients

Coefficients

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta β	t	Sig.	Hypothesis Test
1	(Constant)	.529	.411		1.289	.200	
	Storage	-.027	.060	.037	.446	.657	Fail to reject H_O1
	Transport	.134	.037	.124	3.616	.000	Reject H_O2
	Handling	.183	.069	.236	2.640	.010	Reject H_O3
	Clearing	.504	.104	.423	4.863	.000	Reject H_O4

a. Dependent Variable efficiency

Source: Research Data (2022)

The regression coefficient for the independent variables Storage, Transport, Handling, and Clearing Infrastructure as well as Supply Efficiency is shown in Table 4.18. The model coefficient results offered crucial statistics for testing hypotheses. The 0.529 Y

intercept suggests that Kenya's petroleum product Supply Efficiency would be 0.529 if all other variables (Storage, Transport, Handling, and Clearing Infrastructure) remained unchanged.

The β coefficient results indicate the degree to which, when all other predictors are held constant, each predictor variable influences the petroleum product Supply Efficiency results. Table 4.18 revealed that Storage Infrastructure had a negative impact on petroleum product Supply Efficiency, with $\beta_1 = -0.027$. This indicated that the nation's Supply Efficiency of petroleum products was negatively impacted by Storage Infrastructure. This negative beta means that the Supply Efficiency of Petroleum Products in Kenya is reduced by 0.027 for every unit change in the current Storage Infrastructure. At $\beta_2 = 0.124$, Transport Infrastructure positively impacted Kenya's Petroleum Product Supply Efficiency. This indicated that Kenya's petroleum product Supply Efficiency is directly impacted by its Transport Infrastructure. According to the positive beta, there will be a 0.134 gain in petroleum product Supply Efficiency for every unit change in Transport Infrastructure. At $\beta_3 = 0.183$, Handling Infrastructure had a favorable impact on petroleum product Supply Efficiency. This indicated that the efficiency of petroleum product supply in Kenya is directly impacted by Handling Infrastructure. According to the positive beta, there is a 0.183 gain in petroleum product Supply Efficiency for every unit change in Handling Infrastructure. At $\beta_4 = 0.504$, Clearing Infrastructure positively impacted Petroleum Product Supply Efficiency. This indicated that the Supply Efficiency of petroleum products is directly impacted by Clearing Infrastructure. According to the positive beta, there is a 0.504 gain in petroleum product Supply Efficiency for every unit change in Clearing Infrastructure.

The four research hypotheses that the study attempted to examine were rejected or failed to be rejected based on the coefficient and the p values that went along with it. The findings indicated that Supply Efficiency was positively and non-significantly impacted by Storage Infrastructure (β_1=.027, p=.657). The null hypothesis, according to which Storage Infrastructure has no appreciable impact on the Supply Efficiency of Petroleum Products in Kenya, was therefore accepted. Therefore, the Supply Efficiency of the OMCs under study is not significantly impacted by Storage Infrastructure. At the 0.05 significant level, the HO_1 was therefore not rejected. On the other hand, supply chain efficiency was positively and significantly impacted by the transportation infrastructure (β_2 = 0.134, p<.001). The null hypothesis, according to which there is no discernible relationship between Transport Infrastructure and the Supply Efficiency of Petroleum Products in Kenya, was thus rejected. Therefore, the Supply Efficiency of the OMCs under study is significantly impacted by the Transport Infrastructure. Thus, at the 0.05 significant threshold, the hypothesis HO_2 was rejected. In a similar vein, it was discovered that the Handling Infrastructure significantly and favorably affected the oil marketers' Supply Efficiency (β_3 = 0.183, p =.010). This is the reason the null hypothesis—that Handling Infrastructure has no appreciable impact on petroleum product Supply Efficiency in Kenya—was rejected. As a result, Handling Infrastructure has a big impact on the examined OMCs' Supply Efficiency. As a result, the HO_3 hypothesis was rejected at the 0.05 significant threshold. Ultimately, the findings also demonstrated that the presence of Clearing Infrastructure in the oil marketing industry significantly and favorably affected supply chain effectiveness (β_4=.504, p<.001). This led to the rejection of the null hypothesis, which stated that Clearing Infrastructure had no appreciable impact on Kenya's petroleum product Supply Efficiency. Thus, Clearing Infrastructure has a big impact

on the OMCs under study's Supply Efficiency. Additionally, the HO_4 hypothesis was rejected at the 0.05 significant threshold. Accordingly, the study discovered that Supply Efficiency was significantly positively impacted by three of the four Logistics Infrastructure variables. When taken as a whole, the findings suggest that Supply Efficiency was significantly impacted by logistical infrastructure.

Thus, the optimal derived empirical model of study was of the form:

$$\text{Supply Efficiency} = .037\text{STORAGE} + .124\text{TRANSPORT} + .236\text{HANDLING} + .423\text{CLEARING}$$

4.8 Discussion of Key Findings

Although the country's Logistics Infrastructure is thought to be essential to the efficient supply of petroleum products, the descriptive results showed that the infrastructure is often subpar from storage, transport and handling to clearing. Inadequate Storage Infrastructure might make it more difficult for the business to fulfill client needs on schedule and in full since it can lead to frequent stock outs. While on-time delivery is a common goal in procurement, it might cause traffic jams and delays in getting the items to their intended location if there is not enough room to secure them. According to Brettel et al. (2011) and Mayrson (2016), more evidence indicates that delayed delivery of goods and services can result in decreased sales, production halts, and the activation of penalty clauses, which can ultimately cause discontent among consumers. Thus, a company facing a major Storage Infrastructure difficulty will ultimately be at a disadvantage. It was found that the current Transport Infrastructure was insufficient to move oil products efficiently around the nation and the region, which resulted in multiple stock-outs. Delivery delays are the result of inadequate Transport Infrastructure, as it takes longer for trucks to move cargo from one site to the necessary places. Lower sales and earnings are the outcome of these

delays since they raise the cost of goods that are passed on to the final consumer. In order to keep up with the operations and services of organizations, transportation services should be effective. Long wait times at loading locations and traffic jams have also been attributed to the pipeline's limited ability to carry fuel, as suppliers prefer to load in Mombasa to avoid lengthy waits. Delays in product evacuation at the depots and vessel offloading at the Mombasa port have been found to be exacerbated by a shortage of loading equipment and oil discharge berths. The existing two oil discharge berths, Kipevu Oil Terminal (KOT) and Shimanzi Oil Terminal (SOT), are having trouble handling the increased vessel arrivals, which is causing longer inter-arrival periods, longer vessel waiting times, and higher demurrage charges, according to KPA's annual report for 2019. The general consensus was that the nation's inefficient supply of petroleum products is greatly hampered by the Clearing Infrastructure that exists today.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter outlines the summary of the major findings which is done in line with the objective of the study based on the output of the descriptive and inferential statistical analysis guided by the research hypothesis of the study. The chapter also contains the conclusions that were drawn from the study as well as managerial and policy recommendations. The chapter equally highlights the limitations of the study and the suggested areas for further studies.

5.1 Summary

Using the four main objectives that the researcher aimed to achieve as a framework, this section summarizes the study's major findings.

It was evident from the research conducted on Kenyan Oil Marketing Companies regarding the state of the oil Storage Infrastructure that the industry faces significant Storage Infrastructure issues, which result in a low port turnaround time for vessels and frequent stock outs throughout the majority parts of the nation. The results of the assessment of the state of the oil Transport Infrastructure showed that inadequate infrastructure causes the Oil Marketing Companies to miss out on the value and place utility that come with an efficient transit system.

The research conducted on the Oil Marketing Companies in Kenya on the state of their oil Handling Infrastructure revealed that, although essential for improving supply chain efficiency, the current Handling Infrastructure is also not very conducive to the selling of oil. The implication was that the oil marketing businesses were not entirely fulfilling the goal of materials management.

In conclusion, the results on the condition of oil products Shipping clearance is a difficult procedure for businesses engaged in oil marketing, as demonstrated by Clearing Infrastructure managed by both KRA and KPA. These results indicated that an excessive amount of time was being spent on the receiving cargo processing, unloading, storing, verifying, internal cargo movement, and ultimate owner ownership transfer. A common outage characteristic of a single window system was the cargo verification process, which was also inefficient. The research came to the conclusion that, in order to achieve Supply Efficiency of Petroleum Products in Kenya, a thorough review and modernization of the country's current Logistics Infrastructure—specifically, its Storage, Transport, Handling, and clearing, infrastructure—was imperative. Even so, the Oil Marketing Companies shown resilience by claiming a moderate level of supply chain efficiency in spite of these infrastructure difficulties. Supply chain effectiveness and Logistics Infrastructure have a positive relationship, according to the correlation findings. A company's capacity to grow and generate the much-needed cheap cost of living and job possibilities is correlated with high supply chain efficiency, which is facilitated by good infrastructure.

Transport Infrastructure has a strong positive impact on supply chain efficiency, according to regression analysis results. As a result, it became clear that supply chain efficiency is greatly impacted by transportation. The conclusion was reached that managing infrastructure had a favorable, considerable impact on supply chain efficiency. Additionally, Handling Infrastructure demonstrated a strong beneficial influence on Supply Efficiency of petroleum products. Further investigation showed that the efficiency of the supply chain can be restored by optimizing the cargo Clearing Infrastructure. Clearing Infrastructure also has a positive and significant impact on supply chain efficiency. In Oil Marketing Companies, Storage

Infrastructure has a favorable but non-significant impact on Supply Efficiency, according to the regression results. The effectiveness of Kenya's petroleum product supply chain is, thus, significantly influenced by the country's logistical infrastructure.

5.2 Conclusions

Based on the findings of the study, the study concluded that the Oil Storage Infrastructure currently available in the oil industry positively but not significantly affects supply chain efficiency while Transport Infrastructure, Handling Infrastructure, and Clearing Infrastructure all positively and significantly affects Supply Efficiency of Petroleum Products in Kenya. The overall effect of the analyzed factors was very high as indicated by the coefficient of determination. This implies that the studied independent variables namely Transport Infrastructure, Handling Infrastructure, and Clearing Infrastructure all have significant effect on Supply Efficiency of Petroleum Products in Kenya.

5.3 Recommendations

The study made the following recommendations:

5.3.1 Managerial Recommendations

The study recommends that Kenya Pipeline Company constructs storage facilities countrywide to solve the problem of limited storage for petroleum product, fast track construction of line 4 to Eldoret and improvement of the new line 5 from Mombasa to Nairobi to eliminate limited evacuation of product in Nairobi and eliminate losses experienced along the line during transfer and install flow meters and construct common user truck loading facility in Nairobi terminal to address limited evacuation of product in Nairobi and Kenya Pipeline Company system as a whole while OMCs to install flow meters to be able to receive and pump products at the same time. On

the other hand, the government through The Ministry of Mining and Petroleum to fast-track building of additional jetty to supplement the current two jetties at the port and establish a modern laboratory at the port of Mombasa to facilitate faster clearing of oil products imports and exports.

5.3.2 Policy Recommendations

The study also recommends that the OMCs formulate the criteria for ullage allocation in KPC and inform Ministry of Petroleum and Mining accordingly. The study further recommends that the Government compels OMCs to use SGR in transferring products from Mombasa to Nairobi to reduce congestion on the roads and impose stiffer penalties to OMC's products overstaying in the KPC system. Finally, the study recommends that KRA sets up a manual back up system that can be used to update the online system (COSIS) and upgrade their ICT system to improve the process of releasing transit entries lodged from western Kenya and Mombasa oil depots to address instability of their network.

5.4 Limitations of the Study

The primary limitation of the research was the extensive scope of the data collection, which resulted in a lengthy process. I overcame this difficulty by sending emails to people I was unable to reach in person to save time taken in the questionnaire administration process.

5.5 Suggestions for Further Research

As to the study, the Supply Efficiency of Petroleum Products in Kenya was only impacted by 40.2% by the Logistics Infrastructure, which includes Storage, Transport, Handling and Clearing Infrastructure. This suggested that there were additional factors influencing Supply Efficiency that this study did not examine, and as a result,

it was important to identify these factors in subsequent research. The report recommends that comparable investigations be carried out in the future. In order to fully comprehend the state of affairs in the oil marketing industry, qualitative methodologies ought to be taken into consideration in the future. Since the study only looked at oil marketing companies, its conclusions can be confirmed by expanding its scope to include investigations into other significant players in Kenya's oil sector, including the Kenya Pipeline, Kenya petroleum refineries, Kenya Ports Authority, Energy & Petroleum Regulatory Authority. To confirm or refute the study's findings, research can also be done to evaluate supply chain management in industries other than the oil and gas sector.

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APPENDICES

Appendix I: Sample Introduction Letter

From: Silas Otieno Okitte

P.O Box 89165-80100

Mombasa

Date …….

To: Operations/Supply Manager

Organization ……

Dear Sir/Madam,

RE: REQUEST FOR INFORMATION CONCERNING ACADEMIC RESERCH WORK

I am a student at Moi University - Mombasa campus pursuing a Master's Degree in Logistics and Supplies Management. As part of the requirement of the course, I am carrying out a research study entitled LOGISTICS INFRASTRUCTURE AND SUPPLY EFFICIENCY OF PETROLEUM PRODUCTS IN KENYA. The research study is a partial requirement for the award of Master's Degree. The attached questionnaire is therefore issued to collect data purely for academic purpose. Your cooperation will be highly appreciated. Please note that the information you give will be treated with confidence and will be used for academic purpose only.

Appendix II: Questionnaire

Questionnaire for Operations and Supply Managers

This research questionnaire is specifically prepared to assist in data collection relating to effects of Logistics Infrastructure on Supply Efficiency of Petroleum Products in Kenya. As a respondent in relation to the study, you are kindly requested to fill in appropriate responses to the best of your knowledge. The researcher assures you that all responses will be treated with confidentiality and will only be used purely for academic purpose.

1. Section A: Background Information.

A1. Age of the firm ……

0 – 5 years { } 6 – 10 years { } 11 – 15 years { }

16 – 20 years { } Over 20 years { }

A2. Experience of respondent …….....

0 – 5 years { } 6 – 10 years { } Over 10 years { }

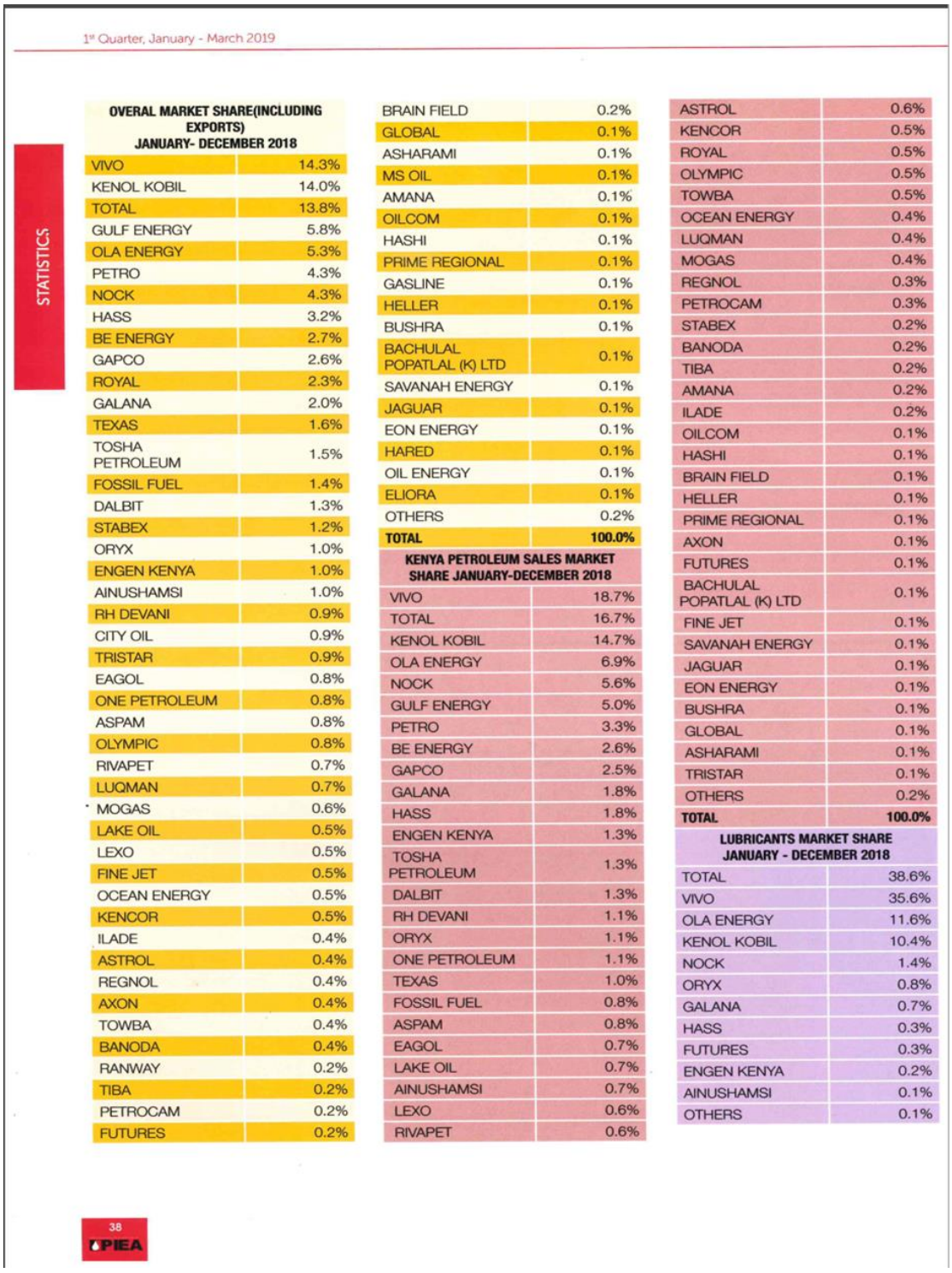
2. Section B: Logistics Infrastructure and Supply Efficiency

Kindly indicate your level of agreement to each of the following statements regarding this organization by using either 5 for Strongly Agree; 4 For Agree; 3 for Neutral; 2 for Disagree or 1 for Strongly Disagree

	STORAGE indicators Compared to our competitors	5	4	3	2	1
ST01	Our storage capacity is inadequate					
ST02	we have enough storage network in the country					
ST03	Our stores are well located and distributed to give us an added advantage					
ST04	We always have adequate stock to meet the demands					

	TRANSPORT Parameters					
TR01	We have adequate booster pumps					
TR02	the current pipeline serves us well					
TR03	The pipeline has the ability to transport different product grades at the same time					
TR04	The road transport provides an ideal option in the distribution of our products					
	HANDLING Parameters					
HD01	Loading and offloading equipment used are adequate					
HD02	We have the best Loading and offloading equipment used in the sector					
HD03	We have adequate truck loading capacity in this sector					
HD04	Our dispensing equipment are adequate					
	CLEARING Parameters					
CR01	Cargo verification process at KPA is efficient					
CR02	Cargo verification process at KPA is fast with no delays					
CR03	KPA system used in cargo clearing is user friendly and efficient					
CR04	There are no frequent outages of single window system					
	SUPPLY EFFICIENCY Parameters					
EF01	We have adequate storage capacity for oil products					
EF02	We have sufficient pipeline and roads infrastructure					
EF03	We have efficient handling equipment at KPA and depots					
EF04	We have efficient cargo verification and clearing systems and processes at KPA					

Appendix III: List of Oil Marketing Companies in Kenya



1st Quarter, January - March 2019

STATISTICS

OVERAL MARKET SHARE(INCLUDING EXPORTS) JANUARY- DECEMBER 2018

VIVO	14.3%
KENOL KOBIL	14.0%
TOTAL	13.8%
GULF ENERGY	5.8%
OLA ENERGY	5.3%
PETRO	4.3%
NOCK	4.3%
HASS	3.2%
BE ENERGY	2.7%
GAPCO	2.6%
ROYAL	2.3%
GALANA	2.0%
TEXAS	1.6%
TOSHA PETROLEUM	1.5%
FOSSIL FUEL	1.4%
DALBIT	1.3%
STABEX	1.2%
ORYX	1.0%
ENGEN KENYA	1.0%
AINUSHAMSI	1.0%
RH DEVANI	0.9%
CITY OIL	0.9%
TRISTAR	0.9%
EAGOL	0.8%
ONE PETROLEUM	0.8%
ASPAM	0.8%
OLYMPIC	0.8%
RIVAPET	0.7%
LUQMAN	0.7%
MOGAS	0.6%
LAKE OIL	0.5%
LEXO	0.5%
FINE JET	0.5%
OCEAN ENERGY	0.5%
KENCOR	0.5%
ILADE	0.4%
ASTROL	0.4%
REGNOL	0.4%
AXON	0.4%
TOWBA	0.4%
BANODA	0.4%
RANWAY	0.2%
TIBA	0.2%
PETROCAM	0.2%
FUTURES	0.2%
BRAIN FIELD	0.2%
GLOBAL	0.1%
ASHARAMI	0.1%
MS OIL	0.1%
AMANA	0.1%
OILCOM	0.1%
HASHI	0.1%
PRIME REGIONAL	0.1%
GASLINE	0.1%
HELLER	0.1%
BUSHRA	0.1%
BACHULAL POPATLAL (K) LTD	0.1%
SAVANAH ENERGY	0.1%
JAGUAR	0.1%
EON ENERGY	0.1%
HARED	0.1%
OIL ENERGY	0.1%
ELIORA	0.1%
OTHERS	0.2%
TOTAL	**100.0%**

KENYA PETROLEUM SALES MARKET SHARE JANUARY-DECEMBER 2018

VIVO	18.7%
TOTAL	16.7%
KENOL KOBIL	14.7%
OLA ENERGY	6.9%
NOCK	5.6%
GULF ENERGY	5.0%
PETRO	3.3%
BE ENERGY	2.6%
GAPCO	2.5%
GALANA	1.8%
HASS	1.8%
ENGEN KENYA	1.3%
TOSHA PETROLEUM	1.3%
DALBIT	1.3%
RH DEVANI	1.1%
ORYX	1.1%
ONE PETROLEUM	1.1%
TEXAS	1.0%
FOSSIL FUEL	0.8%
ASPAM	0.8%
EAGOL	0.7%
LAKE OIL	0.7%
AINUSHAMSI	0.7%
LEXO	0.6%
RIVAPET	0.6%
ASTROL	0.6%
KENCOR	0.5%
ROYAL	0.5%
OLYMPIC	0.5%
TOWBA	0.5%
OCEAN ENERGY	0.4%
LUQMAN	0.4%
MOGAS	0.4%
REGNOL	0.3%
PETROCAM	0.3%
STABEX	0.2%
BANODA	0.2%
TIBA	0.2%
AMANA	0.2%
ILADE	0.2%
OILCOM	0.1%
HASHI	0.1%
BRAIN FIELD	0.1%
HELLER	0.1%
PRIME REGIONAL	0.1%
AXON	0.1%
FUTURES	0.1%
BACHULAL POPATLAL (K) LTD	0.1%
FINE JET	0.1%
SAVANAH ENERGY	0.1%
JAGUAR	0.1%
EON ENERGY	0.1%
BUSHRA	0.1%
GLOBAL	0.1%
ASHARAMI	0.1%
TRISTAR	0.1%
OTHERS	0.2%
TOTAL	**100.0%**

LUBRICANTS MARKET SHARE JANUARY - DECEMBER 2018

TOTAL	38.6%
VIVO	35.6%
OLA ENERGY	11.6%
KENOL KOBIL	10.4%
NOCK	1.4%
ORYX	0.8%
GALANA	0.7%
HASS	0.3%
FUTURES	0.3%
ENGEN KENYA	0.2%
AINUSHAMSI	0.1%
OTHERS	0.1%

38 PIEA

Source: Petroleum Institute of East Africa (2019)

Appendix IV: Plagiarism Certificate

SR423

ISO 9001:2019 Certified Institution

THESIS WRITING COURSE

PLAGIARISM AWARENESS CERTIFICATE

This certificate is awarded to

SILAS OTIENO OKITTE

LSM/002/17

In recognition for passing the University's plagiarism

Awareness test for Thesis **entitled: LOGISTICS INFRASTRUCTURE AND SUPPLY EFFICIENCY OF PETROLEUM PRODUCTS IN KENYA: A SURVEY OF OIL MARKETING COMPANIES IN KENYA** with a similarity index of 5% and striving to maintain academic integrity.

Word count: 21142

Awarded by

Prof. Anne Syomwene Kisilu
CERM-ESA Project Leader Date: 07/12/2023