

# Strategic Factors Influencing Transport and Distribution of Petroleum Products in Kenya: A Case Study of Kenya Pipeline Company

Keter Samson Kipkirui, Ronald Chepkilot, John Kipkorir Tanui

**Abstract**— The transport and distribution of the petroleum products by Kenya Pipeline Company is key in the social economic development of the country. Efficiency in the transport and distribution of the petroleum products ensures that the right volumes of the products are delivered, at the right price, and in a sustainable manner. This study sought to examine the extent to which strategic factors (infrastructure, information communication and technology information) affect transport and distribution of the petroleum products. The study was anchored on resource-based theory and dynamic capabilities theory. The study adopted a descriptive research design. The target population was sourced from safety, security, maintenance, operations, Information Technology Support, senior management staff at Head Office, and Corporate Social Responsibility Staff. The study therefore used a target population of 234 staff members for the study. The sample size of the study was 148 respondents. The statistical analysis that was undertaken included the frequency distributions, chi square, correlation analysis and multiple linear regression analysis. From the finding the study concluded that there is a positive influence of infrastructure on the transport and distribution of petroleum products. In addition the study concluded there was a positive influence of ICT on transport and distribution of petroleum products at KPC. The study recommended that all the strategic factors that is infrastructure, ICT, security, and pipeline capacity should be emphasized at Kenya Pipeline Company in order to improve on the performance of transport and distribution of the petroleum products.

**Index Terms**— ICT, Petroleum, Products Strategy, Transport and Distribution.

## I. INTRODUCTION

The world depends on petroleum products for energy provision for various domestic and industrial applications in diverse sectors. According to Girgin and Krausmann (2016), petroleum products refers to the materials derived from crude oil also referred to as petroleum. Due to the vast application uses of petroleum products, there is often a need to transport and distribute them from various processing units to consumer points across the country (Salifu, 2015). Transport has been defined as the movement of items from a given point to another point. On the other hand, distribution may cover a wider scope of activities compared to transport. The distribution involves the movement of the items to the consumers and may involve diverse aspects such as storage,

order processing, packaging, and delivery to clients amongst other aspects. Within the context of the petroleum products, various means are used for the purposes of transport and distribution. These means of transport and distribution include rail cars, trucks, tanker vessels and pipelines (Godin, 2014)

The transport and distribution of petroleum products face diverse challenges across the world. In India, Rao et al., (2014) noted that in 2013 the Oil and Natural Gas Corporation (ONGC) had its main pipeline burst resulting into an oil spill. The total oil lost to the leak was estimated to be about 5,000 litres of crude oil being transported from Mumbai high fields (Rao et al., 2014). In Yemen, challenges on the transport of petroleum products exist. In this context, Mills & Alhashemi (2018) noted that the Hadramawt region saw protests and attacks on the pipelines by the locals demanding employment opportunities from the oil firms

The security of the petroleum product transport and distribution platform is a major concern to oil companies globally. In Nigeria, Nsikan, Ekeins-Wilson, Anyandike, and Ortencia (2019) noted that in 2016 the Niger Delta Avengers militants blew up the Nembe 1, 2 and 3 trunkline in Bayelsa and Rivers states which is owned by the Aiteo group. These attacks had the effect of disrupting the transport and distribution of the petroleum products (Nsikan et al., 2019). Still in Nigeria, Olaniyan (2015) notes that transport and distribution of the petroleum products remain a major challenge in the Niger delta region. In the region, the pipeline vandalism, the resultant oil spills and oil theft are a major challenge to the petroleum products transport.

In Kenya, Gicharu (2017) noted that petroleum products included products such as automotive diesel, kerosene, super and regular petrol amongst others. The transport and distribution of the petroleum products in Kenya and from Kenya is a critical activity given that the wider eastern and central Africa are dependent on petroleum products refined in Kenya (Mikwa, 2014). These countries include Uganda, Rwanda, Northern Tanzania, Southern Sudan, and Eastern Democratic Republic of Congo amongst other countries (Lambaino, Guyo, Odhiambo, & Getuno, 2018). Efficiency in the transport and distribution of the petroleum products is therefore key in ensuring that the right volumes of the products are delivered, at the right price, and in a sustainable manner (Muthini, Namusonge, Guyo, & Shale, 2016)

The Kenya Pipeline Company was established in 1978 and is fully owned by the Government of Kenya (Kenya Pipeline Company., 2019a). The objective of the company is the

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provision of efficient petroleum products transportation from Mombasa to the hinterland (Kenya Pipeline Company., 2019a). The transportation must be undertaken in a reliable, safe, and cost efficient manner (Kenya Pipeline Company., 2019a). Other functions include the building and maintaining of an oil pipeline for conveyance of petroleum products. The company also processes and distributes petroleum products.

### A. Statement of the Problem

Kenya Pipeline Company documents various challenges with the transport and distribution of the petroleum products. The capacity of the pipeline has been limited in addressing the increasing petroleum products demand in the country and other landlocked countries dependent on Kenya for their products. The company has also had challenges with its infrastructure that hampers the transport and distributions of the petroleum products. In this context, (Kenya Pipeline Company., 2019d) indicated that on 30th of March, 2019 there was an oil spillage at Kiboko, Makueni County, on its newly commission Mombasa-Nairobi line 5 that had only been operational for a year. In its 2017 annual report, KPC noted a need for its to strengthen its pipeline network and storage facilities in order for it to meet increasing local and regional demands for petroleum products (Kenya Pipeline Company., 2018). This study seeks to examine the strategic factors (infrastructure, information and communication technology, security, and pipeline capacity) influence on transport and distribution of the petroleum products. While Gicharu, (2017) examined factors influencing supply of petroleum products in Kenya by Kenya Pipeline Company, the study presented a conceptual gap that this study filled. The study had focused on regulations, and quality control on the supply of petroleum products. This study focused on different strategic factors influence on both transport and distribution of petroleum products.

### B. Objectives of the Study

- i. To establish the extent to which pipeline infrastructure influence transport and distribution of petroleum products at Kenya Pipeline Company
- ii. To assess how information communication and technology influence transport and distribution of petroleum products at Kenya Pipeline Company .

### C. Research Hypotheses

H01: There is no statistically significant influence of pipeline infrastructure on transport and distribution of petroleum products in Kenya pipeline.

H02: There is no statistically significant influence of information communication and technology on transport and distribution of petroleum products in Kenya pipeline.

## II. LITERATURE REVIEW

The study was based on resource based view theory traces its origins to the works of various scholars that elaborated on each over views over a period. Amongst the various scholars contributing to the theory included Wernerfelt in 1984 and Jay Barney in 1991 amongst other scholars (Tuyon, Bujang, & Jidwin, 2012). The theory defined resources as those tangible and intangible assets that are tied semi permanently

to the firm. The resources have also been examined as all those input factors, both tangible and intangible, human and nonhuman, that are owned and controlled by the firm and that enter into the production of goods and services to satisfy human wants (Enrique et al., 2016). This theory is applicable to this study as the study seeks to examine on how various resources such as infrastructure, ICT, security and pipeline capacity can be used for the purposes of gaining superior results in the core functions of the firm. The infrastructure, ICT, security and pipeline capacity can be thought as resources at the disposal of KPC in undertaking of its core mandates of transport and distribution of the petroleum products. The study examined the manner in which the possession of these resources influences the transport and distribution of the petroleum product.

The study was also based on Dynamic Capabilities Theory. The theory was developed by David Teece, Gary Pisano and Amy Shuen. The theory indicates that it is therefore not only the existence of the resources that is of important but also the manner in which they are utilized. This theory is applicable to this study as the study seeks to examine on how various resources such as infrastructure and ICT can be used for the purposes of gaining superior results in the core functions of the firm. The infrastructure and ICT can be thought as resources at the disposal of KPC in undertaking of its core mandates of transport and distribution of the petroleum products. The study examined the manner in which the possession of these resources influences the transport and distribution of the petroleum products.

### A. Infrastructure and Transport and Distribution of Petroleum Products

The transport and distribution of various petroleum products are dependent on the existent infrastructure for such purposes. In a study based in Akwa Ibom State of Nigeria, Akpan (2014) undertook a meta-analysis study looked on the influence of infrastructure on transport and distribution of petroleum products amongst other aspects. The study revealed that outdated and poorly maintained oil pipeline grinds often led to oil spills during transportation of the commodity. Akpan (2014) further revealed that the rusty oil pipelines has led to Nigeria to have amongst the highest number of oil spills across the globe. The study recommended that the Nigerian government should consider the oil refineries within the delta region which is the source of oil. This mitigated the need to transport oil to great distance for refinery purposes.

In a study focusing on the Kaduna Refinery and Petro-Chemical Company, Obasanjo (2013) examined the influence of the various modes of transport and their influence on the transport and distribution of petroleum products. Amongst the infrastructure examined were aspects of roads, rail and pipelines. The study used a mixed methodology in which both the qualitative and quantitative methods were utilized for the study. The study further used a sample size of 182 respondents. Obasanjo (2013) noted the poor state of the roads impacted on the transport and distribution of the petroleum products. The problem of the

poor road state has led to the delays, high levels of accidents, cost of vehicle maintenance and lower speeds all which have an influence on the distribution of the petroleum products. Obasanjo (2013) further noted infrastructure constraints in terms of insufficient pipeline networks. In the context of the rail transport, insufficient liquid tanks, insufficient rail network, and poor infrastructural development were noted as key challenges (Obasanjo, 2013). The study further revealed several infrastructure requirements for the pipeline in order for it to work optimally. This included storage infrastructure in the form of depots and associated array of equipment such as pumps, valves, loading arms and meters as well as generators.

The state of the pipeline infrastructure has been noted to have an influence on the distribution of the petroleum products. In a study in Nigeria, Cooper, Macisaac, Pochec, and Petersen (2015) noted that pipeline malfunction was one of the greatest challenge in transport and distribution of the petroleum products. In this context, the study revealed that lack of repair and repeated cases of vandalism of the oil pipeline contributed to the slowdown in transport and distribution of petroleum products. The study in similar results to Obasanjo (2013) noted that the poor state of roads led to frequent accidents of the oil tankers. Similar to Obasanjo (2013) and Cooper et al (2015), Abioye, Shubber, and Koenigsberger (2019) also found that challenges in the road transport infrastructure led to cost inefficiency in petroleum products transport leading to higher prices at the pump.

The challenges of the infrastructure on the transport and distribution of the petroleum products is also present in the developed countries. In a study on oil industry in Canada, Kilian & Zhou, (2018) noted various infrastructure challenges with the oil and gas pipeline in the country. The study identified the disruptions in the oil transport infrastructure by human or natural elements undermined the distribution of the petroleum products. In this context, the study cites the case of the shutdown of the Keystone pipeline from Canada to the United States following a pipeline rupture in South Dakota in November 2017.

#### *B. ICT and Transport and Distribution of Petroleum Products*

The use of Information and Technology is a critical component in the efficiency of transport and distribution of the petroleum products. In the Russian context, Chernyaev and Kreydenko, (2018) undertook a study that amongst other aspects noted the role of technology in transport and distribution of the petroleum products. The study was meta-analysis study that was dependent on secondary data sources. The study noted the need for Russia to use technology in the transport of petroleum products in order to systemize control and monitoring as well as efficiency in petroleum products transportation.

Noting pilferage and adulteration as risk in petroleum products transportation, Pallavi, Dubey, Saha, Megha, and Ezhilarasan (2018) undertook a study in India to examine the

use of technology in mitigation of these risks. The study used an experimental design to conceptualize technology that mitigate the pilferage and adulteration risks. The study faulted the existed technologies that only detected the changes in the pressure on the oil tankers. The study designed and experimentally tested a technology design that measured the changes in pressure in the oil tankers, detection of changes in fuel level in the oil tanker through a fuel sensor, and monitoring of the actual location of the tanker through Global Positioning Technology (GPS). The study noted that the tested technology would be ideal as anti-pilferage and anti-adulteration technology.

Leaking of the oil pipes as well as the clogging of the pipes is a challenge to transport and distribution of petroleum products. In this context, Sharma, Qavi, and Kumari (2014) undertook a study in India to illustrate the manner in which technology that can be used for leakage detection and cleaning of the pipes. The study similar to Pallavi et al (2018) used an experimental research design. The study proposed a crawling robot that could be used in detection of leakages and the cleaning of the pipes.

A study by Salam, Selintung, and Maricar (2014) undertaken in Indonesia sought to examine the role of technology in detecting leakages within a pipeline set up. The study noted that leakages within pipelines delayed that transport and distribution of the pipeline contents. Salam et al., (2014) used an experimental research design to test a proposed system for leakage detection. The study noted that the proposed technological intervention, Radial Basis Function Neural Network (RBF-NN), was proficient in detecting the location of leak within a pipeline and its magnitude through pressure analysis. The study thus recommended need for pipeline companies to be able to detect the leaks within the pipelines in order to mitigate these challenges that may impact on the distribution aspects.

In Nigeria, Cooper, Macisaac, Pochec, and Petersen (2015) undertook a study that sought to examine the influence of technology on the distribution of the petroleum products in the country. The study noted that RFID technology had been adopted in the country in order monitor the movement of tankers during petroleum products distributions. This is prevent diversion of the petroleum products and siphoning of these products while on transit. Cooper et al., (2015) further noted that technology was used for the purpose of verification and reconciliation of the deliveries of the loaded trucks.

In a study on oil transportation by oil marketers in Kenya, Thuo (2015) examined the influence of use of technology in risk mitigation. The study adopted a descriptive research design and used a sample size of 75 respondents composed of risk managers, depot managers, financial officers and operations officers. In concurrence to the results by Chernyaev and Kreydenko, (2018) in Russia, Thuo (2015) had also found that in Kenya technology was used in monitoring the oil on transit with a view of reducing the oil loss.

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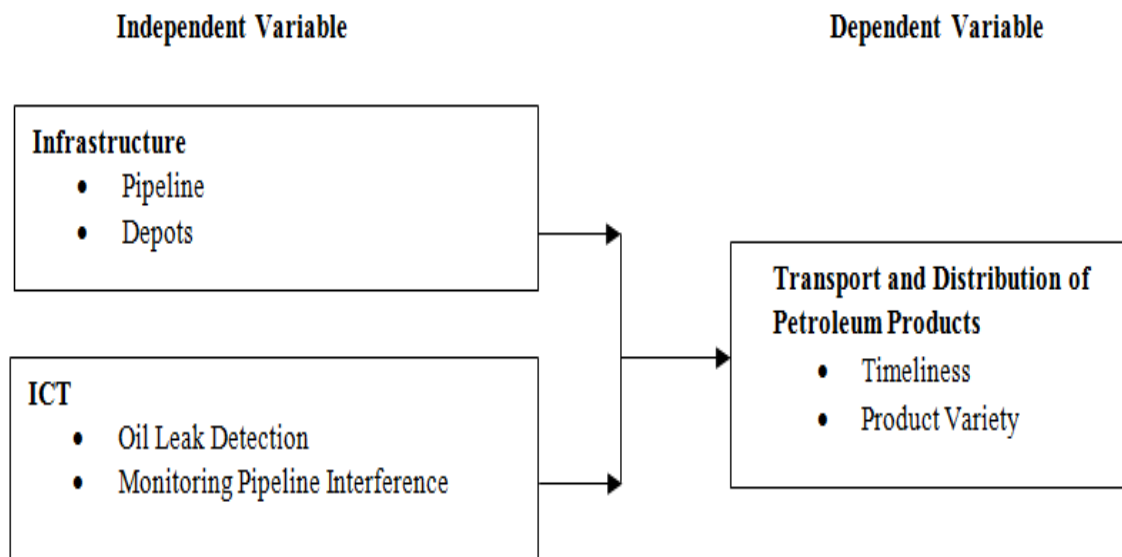
## C. Critique of Literature Review

In a study on oil industry in Canada, Kilian and Zhou, (2018) noted various infrastructure challenges with the oil and gas pipeline in the country. The study identified the disruptions in the oil transport infrastructure by human or natural elements undermined the distribution of the petroleum products. The study however does not indicate the human or natural elements that undermined the oil transport infrastructure. In a study in Russia, Chernyaev and Kreydenko, (2018) noted the need for Russia to use technology in the transport of petroleum products in order to systemize control and monitoring as well as efficiency in petroleum products transportation. The study does not reveal the inadequacies of the existent technology (if any) and the technology that may be used for monitoring and control aspects. Pallavi, Dubey, Saha, Megha, and Ezhilarasan (2018) in India proposes a technology that used for anti-pilferage and anti-adulteration purposes. The study however does not elaborate on the validity of such technology beyond the theoretical discussion of the same

## D. Summary of Reviewed Literature

The transport and distribution of various petroleum products are dependent on the existent infrastructure for such purposes. In a study based in Akwa Ibom State of Nigeria, Akpan (2014) revealed that outdated and poorly maintained oil pipeline grinds often led to oil spills during transportation of the commodity. Akpan (2014) further revealed that the rusty oil pipelines has led to Nigeria to have amongst the highest number of oil spills across the globe. In a study

## E. Conceptual Framework



## III. METHODOLOGY

The study adopted a descriptive research design. The design was used for the purpose of the describing both the independent and the dependent variables of the study. The unit of analysis was KPC as an organization. The target population was sourced from safety, security, maintenance, operations, Information Technology Support, senior management staff at Head Office, and Corporate Social

Responsibility Staff. These are the staff with adequate knowledge of the research variable being pursued. The study therefore used a target population of 234 staff members for the study. The sample size of the study was calculated using the Taro Yamane formula to get a sample size of 148 respondents. The study further used stratified random sampling where the sample size of each department of employees was drawn in proportion to the size in the population. Stratified sampling method was utilized due to its

focusing on the Kaduna Refinery and Petro-Chemical Company, Obasanjo (2013) noted the poor state of the roads impacted on the transport and distribution of the petroleum products. The problem of the poor road state has led to the delays, high levels of accidents, cost of vehicle maintenance and lower speeds all which have an influence on the distribution of the petroleum products. Obasanjo (2013) further noted infrastructure constraints in terms of insufficient pipeline networks. In the context of the rail transport, insufficient liquid tanks, insufficient rail network, and poor infrastructural development were noted as key challenges (Obasanjo, 2013).

The use of Information and Technology is a critical component in the efficiency of transport and distribution of the petroleum products. In the Russian context, Chernyaev and Kreydenko, (2018) noted the need to use technology in the transport of petroleum products in order to systemize control and monitoring as well as efficiency in petroleum products transportation. In India, Pallavi, Dubey, Saha, Megha, and Ezhilarasan (2018) that technology can be to measure pressure in the oil tankers, detection of changes in fuel level in the oil tanker through a fuel sensor, and monitoring of the actual location of the tanker through Global Positioning Technology (GPS). This would be for anti-pilferage and anti-adulteration measures. Sharma, Qavi, and Kumari (2014) further indicated that technology can help in leakage detection and cleaning of the pipelines. The study by Salam, Selintung, and Maricar (2014) revealed that technology can be used in detecting leakages within a pipeline set up through pressure analysis.

advantage of ensuring that each sub group of the population is represented in the sample. Primary data was collected using structured questionnaires. The study undertook a pilot study before the commencement of the final study to determine the logistics required for the data collection phase. In this context 15 respondents was used for the pilot study. This study used the content validity for the purposes of measuring on whether the structured questionnaire is valid for the study which was examined using the supervisors and the pilot study respondents who are deemed to be experts of the subject phenomenon. The questionnaire was self-administered due to the high literacy rates of the target population. The study was administered through the Drop Off Pick Up later method. The collected data in this study was quantitative in nature and was analysed using the SPSS statistical software. The statistical analysis that was undertaken include the frequency distributions, means, standard deviation and the multiple linear regression analysis.

#### IV. RESULTS

##### A. Response Rate

The sample size of the study that was utilized for the study was 148 respondents that were drawn from Safety, Security, Maintenance, Operations, IT Support, Senior Management Staff and CSR Staff of Kenya Pipeline Company. The data was being collected using structured questionnaire and thus 148 questionnaires were deployed to the target population

##### Frequency Distribution of Infrastructure

	NE Freq %	SE Freq %	ME Freq %	LE Freq %	VLE Freq %	Chi-Square $\chi^2$	P
All KPC pipelines are adequately maintained	2 1.6%	5 3.9%	34 26.8%	73 57.5%	13 10.2%	18.807	0.016
All KPC pipelines are adequately protected from natural elements interference	1 0.8%	11 8.7%	28 22.0%	81 63.8%	6 4.7%	17.304	0.027
All KPC pipelines are adequately protected from unauthorized human activities	0 0.0%	14 11.0%	40 31.5%	59 46.5%	14 11.0%	8.191	0.224
The KPC depots have capacity to hold pipeline outputs all times	4 3.1%	13 10.2%	43 33.9%	56 44.1%	11 8.7%	22.000	0.005
The KPC depots are able to hold sufficient products for their oil marketer companies	3 2.4%	7 5.5%	35 27.6%	70 55.1%	12 9.4%	15.428	0.049

When asked on whether the KPC pipelines are adequately maintained a majority of the respondents at 57.5% of the respondents indicated it influenced to a large extent. A further 10.2% of the respondent indicated that it influenced to a Very Large Extent. This is compared to 1.6%, 3.9%, and 26.8% of the respondents who indicated to no extent, small extent and moderate extent. In respect to whether the indicator had statistically significant association with distribution of petroleum products, the overserved chi square of

18.807 with a probability value of 0.016 were deemed to have a statistically significant association at 5% level of significance. The maintenance of the of the pipeline is important for the distribution of the oil. In a study based in Akwa Ibom State of Nigeria, Akpan (2014) undertook a

##### Response Rate

Issued Questionnaires	Returned Questionnaires	Response Rate
148	127	85.8%

The response rate of the study was 85.8% which is considered adequate as it exceeds the 80% of the response rate that is recommended for the survey results.

##### Job Group Distribution

Staff Category	Frequencies	Sample Size
Safety	8	6.2%
Security	14	11.0%
Maintenance	50	39.3%
Operations	24	18.8%
IT Support	7	5.5%
Senior Management Staff	9	7.0%
CSR Staff	15	12.2%
<b>Total</b>	<b>127</b>	<b>148</b>

The job group distribution of the study revealed that a majority of the respondents at 39.3% of the respondents were from the maintenance department while 18.8% were from the operations department. The study further found that 12.2% of the respondents were from CSR staff while 11.0% of the respondents were from security department. The IT support and senior management staff had the lowest number of respondents at 5.5% and 7.0% respectively.

meta-analysis study looked on the influence of infrastructure on transport and distribution of petroleum products amongst other aspects. The study revealed that outdated and poorly maintained oil pipeline grinds often led to oil spills during transportation of the commodity.

A cumulative percentage of 68.5% of the respondents were in agreement that all KPC pipelines are adequately protected from natural elements interference compared to 9.5% of the respondents who were in disagreement and a further 22.0% of the respondents who moderately agreed. The observed chi square 17.304 and p value of 0.027 indicated that all pipelines being protected from natural elements interference had a statistically significant association with distribution of petroleum products at 5% level of significance. All pipelines being adequately protected from unauthorized human

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activities was examined. The study found that 46.5% of the respondents agreed with the respondent for a large extent while 11.0%, 31.5% and 11.0% of the respondents agreed to a small extent, moderate extent and very large extent respectively. This study's results on the importance of the protection of the pipeline from unauthorized human activities are consistent with other scholar's findings on the aspect.

The security of the petroleum products during the transport and distribution of these products is important to the efficiency of the process. The products needed protection to avoid theft and spillage amongst other aspects (Borok, Agandu, & Morgan, 2013; Chernyaev & Kreydenko, 2018). In Nigeria, Borok et al., (2013) revealed the need for security for the pipeline infrastructure to avoid vandalization aspects that reduce the capacity for petroleum products distribution. In Nigeria, Akpan (2014) indicated that sabotage and pipeline vandalism being a security challenge in the region. Oil bunkers posed these security challenges for the purposes of illicit oil trade activities. In respect to KPC depots having capacity to hold pipeline outputs all times had 3.1%, 10.2%, 33.9%, 44.1%, and 8.7% of the respondents were in agreement with the indicator to no extent, small extent, moderate extent, large extent and very large extent respectively. The indicator with a chi square value of 22.000 and p value of 0.005 was found to have a statistically

significant association with KPC depots having capacity to pipeline outs at time and distribution of the petroleum products.

Finally, in respect to KPC depots being able to hold sufficient products for their oil marketer companies had 2.4%, 5.5%, 27.6%, 55.1%, and 9.4% of the respondents indicating to a no extent, small extent, moderate extent, large extent and very large extent respectively. The study further revealed that the achieved chi square of 15.428 and a p value of 0.049 for the KPC depots being able to hold sufficient products for their oil marketer companies. This demonstrated that the indicator had a statistically significant association on the distribution of the petroleum products. The importance of the pipeline capacity on the holding of the petroleum products has also been noted by diverse scholars across the world. The pipeline capacity to transport petroleum products has been a challenge in the United States in respect to transport of gas for domestic use (Boersma, Mitrova, & Losz, 2018). In this context, Boersma et al., (2018) noted that insufficient pipeline capacity was noted in the Permian resulting to gas flaring within 2018. Boersma et al., (2018) further noted that the export of petroleum products from the United States to Mexico is currently hampered by the bottlenecks in the pipeline in Mexican side. Natural disasters often pose challenges to the physical infrastructure involved in petroleum products.

### Frequency Distribution of ICT

	NE Freq %	SE Freq %	ME Freq %	LE Freq %	VLE Freq %	Chi-Square $\chi^2$	P Value
The used ICT at KPC is able to adequately locate oil leaks in the pipeline	2 1.6%	9 7.1%	41 32.3%	62 48.8%	13 10.2%	19.204	0.013
The used ICT at KPC is able to adequately magnitude of oil leaks in the pipeline	3 2.4%	11 8.7%	46 36.2%	50 39.4%	17 13.4%	19.108	0.014
The used ICT at KPC is able to adequately monitor pipeline structural integrity at all times	0 0.0%	7 5.5%	43 33.9%	70 55.1%	7 5.5%	20.350	0.002
The used ICT at KPC is able to adequately monitor illegal human activities on the pipeline at all times	1 0.8%	8 6.3%	51 40.2%	55 43.3%	12 9.4%	19.615	0.013
The used ICT at KPC is able to adequately monitor petroleum products flow rates at all times	4 3.1%	12 9.4%	52 40.9%	49 38.6%	10 7.9%	13.346	0.100

The extent in which use of ICT at KPC is able to adequately locate oil leaks in the pipelines had 1.6%, 7.1%, 32.3%, 48.8%, and 10.2% of the respondents indicating to no extent, small extent, moderate extent, large extent and very large extent respectively. The study further found that the observed chi square results value was 19.204 and p value of 0.013. This indicated that there was a statistically significant association between the used ICT at KPC being able to adequately locate oil leaks in the pipeline and distribution of the oil products at 5% level of significance. The results of this study correlate with those of other studies. Sharma, Qavi, and Kumari (2014) further indicated that technology can help in leakage detection and cleaning of the pipelines. The study by Salam, Selintung, and Maricar (2014) revealed that technology can be used in detecting leakages within a pipeline set up through pressure analysis.

The extent in which the used ICT at KPC was able to adequately detect the magnitude of oil leaks in the pipeline had 2.4%, 8.7%, 36.2%, 39.4%, and 13.4% of the respondents indicating no extent, small extent, moderate extent, large extent and very large extent respectively. The indicator further observed a chi square value of 19.108 and a p value of 0.014 which indicated that there was a statistically significant association between used ICT at KPC being able to adequately detect the magnitude of oil leaks in the pipeline and distribution of the oil products. Salam, Selintung, and Maricar (2014) notes a need to detect the location of leak within a pipeline and its magnitude. On whether the used ICT at KPC is able to adequately monitor pipeline structural integrity at all times, a cumulative percentage of 60.1% of the respondents were in agreement compared to 5.5% who

disagreed and 33.9% of the respondents indicated that it influenced the oil distribution to a moderate extent.

The study further found that in respect to used ICT at KPC being able to adequately monitor pipeline structural integrity at all times and its association with the oil products distributions had chi square value of 20.350 and a p value of 0.002. This indicated that there was a statistically significant association between the indicator and oil distribution at 5% level of significance. The study's results were collaborated by other scholars. In the Russian context, Chernyaev and Kreydenko, (2018) undertook a study that amongst other aspects noted the role of technology in transport and distribution of the petroleum products. The study was meta-analysis study that was dependent on secondary data sources. The study noted the need for Russia to use technology in the transport of petroleum products in order to systemize control and monitoring as well as efficiency in petroleum products transportation. The respondents were asked on whether the used ICT at KPC was able to adequately monitor illegal human activities on the pipeline at all times. The respondents had 0.8%, 6.3%, 40.2%, 43.3%, and 9.4% of the respondents indicating to no extent, small extent, moderate extent, large extent and very large extent respectively.

The study further found that there was an observed chi square value of 19.615 and a p value of 0.013 in respect to use of ICT at KPC to adequately monitor illegal human activities on the pipelines at all times and distribution of oil products. This indicated that there was a statistically significant association between use of ICT at KPC to adequately monitor illegal human activities on the pipelines at all times and distribution of oil products at 5% level of significance.

**Frequencies of Transport and Distribution of Petroleum Products**

	NE Freq %	SE Freq %	ME Freq %	LE Freq %	VLE Freq %
The KPC transports and distributes the petroleum products in a timely manner	8 6.3%	9 7.1%	48 37.8%	51 40.2%	11 8.7%
The KPC transports and distributes various petroleum products as per demands	1 0.8%	6 4.7%	54 42.5%	56 44.1%	10 7.9%
The KPC transports and distributes various petroleum products with cost efficiency	0 0.0%	7 5.5%	53 41.7%	54 42.5%	13 10.2%
The KPC transports and distributes various petroleum products with operational efficiency	2 1.6%	10 7.9%	55 43.3%	48 37.8%	12 9.4%

In respect as to whether KPC transports and distributes the petroleum products in a timely manner, 6.3%, 7.1%, 37.8%, 40.2%, and 8.7% of the respondents indicated to a no extent, small extent, moderate extent, large extent, and very large extent respectively. The question as to whether the KPC transports and distributes various petroleum products as per demands had a majority of 44.1% of the respondents indicating to a large extent. This was followed by 42.5% of the respondents who indicated to a moderate extent while 7.9% of the respondents indicated to a very large extent and

Finally, when asked on whether the used ICT at KPC was able to adequately monitor petroleum products flow rates at all times a majority of the respondents had 40.9% indicating to a moderate extent. On the other hand, a cumulative percentage of 46.5% of the respondents were in agreement with the indicator while 12.5% of the respondents cumulatively were in disagreement. The observed chi square value of 13.346 and p value of 0.100 indicated that there was no statistically significant association between the used ICT at KPC being able to adequately monitor petroleum products flow rates at all times and oil products distributions.

The petroleum flow rates are important in the distribution of the oil products. The capacity of the pipeline has been limited in addressing the increasing petroleum products demand in the country and other landlocked countries dependent on Kenya for their products. This has necessitated the need to build a 20 inch line from Mombasa to Nairobi with a higher flow rate of 1.9 million liters per hour by the year 2023 (Kenya Pipeline Company., 2019c). The KPC had constructed a 14-inch diameter parallel pipeline from Nairobi to Eldoret that enhanced the flow rate to Western Kenya by 311,000 liters per hour (Kenya Pipeline Company., 2019c). However, the two pipelines are yet to achieve their maximum flow rate of 750,000 liters per hour due to lack of additional pumps along the way (Kenya Pipeline Company., 2019c). Due to growing demand for petroleum products in western Kenya and the Eastern Africa region, KPC has commissioned a new 121 km 10-inch diameter parallel pipeline from Sinendet to Kisumu with a flow rate of 350,000 litres per hour (Kenya Pipeline Company., 2019c).

0.8% of the respondents indicated to a no extent. The KPC transporting and distributing various petroleum products with cost efficiency had 5.5%, 41.7%, 42.5%, and 10.2% of the respondents indicating to a small extent, moderate extent, large extent, and very large extent respectively. Finally, in respect to the KPC transporting and distribution various petroleum products with operational efficiency, 1.6%, 7.9%, 43.3%, 37.8%, and 9.4% of the respondents indicated to no extent, small extent, moderate extent, large extent and very large extent respectively.

**Correlational Analysis**

		Infrastructure	ICT	Transport and Distribution
Infrastructure	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	127		
ICT	Pearson Correlation	.187*	1	
	Sig. (2-tailed)	.036		
	N	127	127	
Transport and Distribution	Pearson Correlation	.635**	.637**	1
	Sig. (2-tailed)	.000	.000	
	N	127	127	127

The study results revealed that there was Pearson correlation coefficient of 0.635 between transport and distribution on infrastructure. The findings further revealed that there was Pearson correlation coefficient of 0.637 between transport and ICT. The study thus noted that all correlational coefficients were positive in nature implying that an increase in one variable was associated with an increase in another variable and vice versa. The study further found that all the correlational relationship between the variables was statistically significant in nature. This implied that the observed relationships would also be found in the population of the study.

**Multiple Linear Regression Analysis**

**Coefficients<sup>a</sup>**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error			
(Constant)	.322	.224		1.437	.153
1 Infrastructure	.217	.045	.280	4.822	.000
ICT	.261	.043	.350	6.052	.000

a. Dependent Variable: Transport and Distribution

The study results indicated that a unit increase in the infrastructure was associated with 0.217 increase in the transport and distribution of the petroleum products with the other variables kept constant. The study results indicated that a unit increase in the infrastructure was associated with 0.217 increase in the transport and distribution of the petroleum products with the other variables kept constant. The study was also interested in testing the following research hypothesis; H01: There is no statistically significant influence of infrastructure on transport and distribution of petroleum products in Kenya pipeline. The findings revealed a t test statistic of 4.822 and a p value of 0.000 which indicated that there was a statistically significant relationship between infrastructure on the transport and distribution of the petroleum products at Kenya pipeline. This led to the rejection of the null hypothesis (H01) and acceptance of the alternative hypothesis. The results of this study are consistent with those of other scholars. In a study based in Akwa Ibom State of Nigeria, Akpan (2014) undertook a meta-analysis study looked on the influence of infrastructure on transport and distribution of petroleum products amongst other aspects.

The study revealed that outdated and poorly maintained oil pipeline grinds often led to oil spills during transportation of the commodity.

The study further examined the influence of information communication and technology on the transport and distribution of petroleum products at Kenya Pipeline. The study results revealed that were  $\beta_2 = 0.261$ ,  $t = 6.052$  and  $p$  value = 0.000. The study results thus indicated that a unit increase in the ICT usage led to a 0.261 increase in the transport and distribution of the petroleum products with the other variables kept constant. The study was also interested in testing the following research hypothesis. H02: There is no statistically significant influence of information communication and technology on transport and distribution of petroleum products in Kenya pipeline. The findings revealed a t test statistic of 6.052 and a p value of 0.000 indicated that there was a statistically significant relationship between ICT on transport and distribution of the petroleum products at Kenya Pipeline. This led to the rejection of the null hypothesis (H02) and acceptance of the alternative hypothesis. The results of this study are consistent with those of other studies that have examined ICT components and distribution of petroleum products. In the Russian context, Chernyaev and Kreydenko, (2018) undertook a study that amongst other aspects noted the role of technology in transport and distribution of the petroleum products. The study noted the need for Russia to use technology in the transport of petroleum products in order to systemize control and monitoring as well as efficiency in petroleum products transportation. The achieved beta coefficients of the strategic factors that is 0.217 and 0.261 for infrastructure and ICT led to the construction of the following regression analysis model:

$$Y = 0.322 + 0.217X_1 + 0.261X_2$$

**V. CONCLUSION & RECOMMENDATION**

**A. Conclusion**

The study results concluded that the various variables of the strategic factors that is ICT and Infrastructure as well as the transport and distribution of the petroleum products were positively and significantly correlated amongst themselves. This indicated that change in each of the variable was observed to be associated with changes in any other variable



in a pairwise manner which was observable in the sample and would be observable in the population. In respect to the relationship between the strategic factors and transport and distribution of petroleum products the study concluded that strategic factors had a huge influence on transport and distribution of the petroleum products due to a high correlation coefficient and coefficient of determination. In respect to the influence of infrastructure on the transport and distribution of the petroleum products, the study concluded that there would be a positive influence of infrastructure on the transport and distribution that would also prevail in the population. Similarly, in respect to the influence of ICT on the transport and distribution of the petroleum products at KPC, the study concluded that there was a positive influence of ICT on transport and distribution of petroleum products at KPC.

### B. Recommendation

Based on the conclusions of the study, the study recommended that both infrastructure and ICT related factors should be emphasized by Kenya Pipeline Company in order to improve on the performance of transport and distribution of the petroleum products. Based on the regression coefficients, the study recommends that the strategic factors should be emphasized in terms of ICT and infrastructure due to their relative strengths on the transport and distribution of the petroleum products. The study recommends that other factors influencing the transport and distribution of the petroleum products should be examined by other scholars.

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