Optimisation of Transportation Logistics of Crude Oil and Other Petroleum Products Through Pipelines, Railways and Marine Transport for Economic and Sustainability in Nigeria

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Abstract

Globally, crude oil has become one of the actively transacted commodity. steadily over the decades its demand has been growing. Oil and gas are essential commodities which requires reliable means of conveyed from the upstream to downstream. Despite of the earth's abundance of oil, its gets increasingly scarce. It is crucial to explore the safety and efficiency of the various ways it is transported to great distances. One of the sustainable and reliable means of conveying large quantities of oil and gas from one destination to another is by constructed pipelines. Nigeria also used pipeline as the means of transportation crude oil and other refined products. The constraints of other modes in the carrying of refined products over long distances provide a great challenge and opportunity for the pipeline mode to be recognized. The objectives of this piece of research is to investigate transportation logistics optimization of crude oil movement and other petroleum products at home and outside the country. domestically, internationally through pipelines, railways, maritime transport, present and future challenges in oil industry in northeast in Nigeria. As far as this piece of research is concern the transportation of crude oil and other oil products, pipelines is considering as most favourable. Hence, it is significant to focus into what will be the safest, most efficient, and most cost-effective means of transport for future venture.

Key words: Crude oil, transportation, pipeline, oil, gas.

INTRODUCTION

The global market constraints in terms of price instability, excess capacity, demand shifts as well as environmental regulation has intensified the petroleum industry's due to global economic disorder. Petroleum transportation as the central logistics operation linking the upstream and downstream functions has been paid more attention to (Waleed and Razman ,2012). The significance of the oil industry's impact on the global economy is understandable. Due to globalization, the role of world trade and transportation has increased. The purpose of this piece of research is to investigate transportation logistics optimization of crude oil movement and other petroleum products through pipelines, railways and maritime transport in oil industry north-eastern Nigeria as the limitation of the research, find options for optimizing the supply chain(logistics) in oil industry by tendering questionnaires, interviewing, reviewing and analysing past written literatures. Oil is regarded as number one energy source for many businesses (Mast, 2005). The following organizations; US Department of Energy, the International Energy Agency (IEA) and World Energy Council have predicted that energy demand would increase year in year out as the world population is ever-growing. The demand for crude oil has increased from 60 million barrels per day to 84 million barrels per day, in the past 20 years (Hasan et al. 2010).

Council of logistics management defined logistic as part of the supply chain process that plan, implement and controls the efficient, effective flow, storage of goods, services and related information from the source to the point of consumption in order to meet customers (Ballou, 2004). Christopher (2011) claims that the firm with well logistics and supply chain management can progress and sustain their competitive advantage over the competing firms. Oil supply chain is divided into upstream- and downstream divisions based on activities before and after the refining phase. However, the distance from the upstream to downstream could often be thousands of kilometres (km) and that is the main purpose for the oil supply chain (logistics) having longer lead time than in other firms (Gainsborough, 2006 and Ribas, 2011). The long lead period has also contributed the involvement of various means of transport such as ships, pipelines, rail and road as well (Hussain et al., 2006 and Ribas, 2011).

Supply chain(logistics) optimization according to Geunes (2005) defined as the implementation and application of optimizing prototypes in order to control the supply chain and the mechanisms within the supply chain passage affiliates (Bryan, 1998). Hussain et al. (2006) stated that oil supply chain (logistics) optimization is still in its infancy. This is because, less literatures are available concerning the topic of optimization theory and techniques. The objective of optimizing oil supply chain (logistics) is aligned with the supply chain strategy and achieve profit maximization by being cost efficient and satisfying customers (Jasuja et al., 2009). Optimization attempts to achieve the most efficient, optimal way to manage the supply chain in order to satisfy customers' needs on the lowest cost. (Ratliff, 2007).

Modes of Transportation Considered In The Research

Three modes of transportation were considered as mentioned above on the research topic; pipelines, railways and marine transport. Pipelines mode of crude oil and refined products transportation is among the pioneer transportation means. It is the safest, cheapest and most reliable transporter of energy in the United States of America. 63,500 miles of refined product pipeline approximately linked almost every state in the United States (AOPL, 2014). Two thirds of crude oil and petroleum products nearly transported by pipelines each year (API, 2014). What is currently being proposed for the transportation of crude oil and refined products, pipelines seem to be most favourable. 97% of all petroleum and natural gas products in Canada, are transported via pipelines

(CEPA, 2012). Going back to the history in the 1800's when pipelines were yet to be discovered, eighty percent of the globe's petroleum was supplied through Pennsylvania oil fields (Pipeline 101, 2016). The transportation of oil from upstream to rail was done via teamsters with converted whiskey barrels and horses. The charge for each barrel varies with the increase in need by the customers. In order to reduce the cost transportation in 1879, pipelines were laid from one town to another and were relatively basic and short. when kerosene lamp oil shifted to gasoline in 1900's, pipelines began to be built across the country for domestic, commercial, and industrial transportations (DXP, 2019).

The major positive aspect with respect to pipelines mode unlike other means of transportation such as rails, trucks, and tankers, no carbon traces in the atmosphere that could result in air pollution, ozone depletion, acid rain and less spills. This makes it significantly safer for societies and wildlife animals (DXP, 2019). Pipelines occupied less area compared to other transportation mode due to buried under the surface of the earth, except in places of rock formations. Moreover, pipelines transportation mode navigates through less densely populated areas making the consequences of accidents less (DXP, 2019). With regards to loads capacity pipelines of 110,000 kilometres can fill up to 15,000 tanker truckloads or 4,200 rail cars (CEPA, 2012). So, this ensures measureable efficiency and uninterrupted movement of energy products for domestic and international users at a lesser cost. 99.999% of the time energy products reach their destination (Green & Jackson, 2015). The mode also saves us from extreme fuel usage, reduce cost per transportation and emission of harmful gases from thousands of automobiles (Alliance, 2018).

Pipeline transportation mode has some shortcomings despite it convenient and appear to be better options compared to other transportation mode. Some of these shortcomings are oil spills and employment. (Pipeline 101, 2016). Greenpeace Canada campaigner considers this as an act of aggression to the people, plants and wildlife who live around. Moreover, the leakage of gas through pipelines could lead to fire or out-break in communities. With regards to employment rate, the rate falls down as pipeline construction jobs are momentary compared to other means of transportations (Alliance, 2018). Transportation of crude oil using pipeline is very limited in Nigeria and therefore a lot has to be done as per as one of the major oil exporter in Africa and in the world at large. Pipeline and truck tankers mainly transported and distributed energy products in Nigeria. Majority of the Nigeria crude oil products are transported by trucks to various locations within the Nigeria with high risks and high cost of transport due to absent of pipeline system networks (Ambituuni, 2014).

Regarding the Nigeria crude oil and other products moving through rail transportation, it has become a history. This is because, the issue of rail moving crude oil and other products was initiated again in 2015, Nigeria Railway Corporation (NRC) to start movement of energy products and other goods which are presently being conveyed by trucks and lorries in order to reduce the number of tankers and heavy-duty trucks. This will also help in resultant effect being reduction of killing caused on the roads. As reported by the Daily Independents Trust newspaper, the NRC spokesman Mr. Abdur-raouf Akinwoye make known that the corporation had commenced consultations with oil marketers in the country with the intention of transporting their energy products to all parts of Nigeria. Observers say, restoring of the rail transportation mode system would have more impact on Nigerians (northeast) were energy products and haulage services carry out by NRC. This was the case in the early days when the rail mode of transportation was functional. A lot of organizations has supported the planning including National Union of Textile Garment and Tailoring Workers of Nigeria General Secretary (NUTGTWN). An independent petroleum marketers Comrade Issa Aremu and Alhaji Abdulrasheed Olapade stressed that the

Nigerian National Petroleum Corporation (NNPC) could accept the rail transportation mode to simplify movement of its products to various parts of the country through train cars which is realistic, cheaper than trucks and sustainable. He said "Nothing is difficult for a government to do at any level if they are honest and sincere. The problem we are having in this country Nigeria according to him is that, every policy is not fastened on honesty and sincerity. The only major upside of this mode of rail transport on crude oil in Nigeria is displacement truck drivers off the road. Upto now few petroleum products in Nigeria were able to transported through rail (Ambituuni, 2014 and Daily Independent newspaper, 2015).

A comprehensive assessment was made in a comparison of pipeline and rail from the University of Calgary and Western University on costs associated with the transportation of petroleum products. The paper gathered estimates on the costs of air pollution, greenhouse gases, spill and accident costs associated with the long distance movement of petroleum products. The research paper found that the "emission and accident costs of pipelines outperformed rail in the ratio 2.5:1 in Canadian dollars''. These numbers lean strongly in favour of future investment into pipelines transportation mode, but the magnitudes of building new infrastructure must be accounted for. There will be impacts on the surrounding land when intended to create a new pipeline or railway system, and the cost of building these structures is far from cheap (Vragov et al., 2018).

Regarding the marine transportation mode, maritime logistics for trade and development been more evident than during the last year. Historically high and volatile freight rates, congestion, closed ports and new demands for shipping following COVID-19 and Ukraine war have all had measurable impacts on people's lives. Over 80% of volume of global trade is carrying by ships. Higher shipping costs and lower maritime connectivity lead to higher inflation, shortages of food, and supply chains interruptions all of which are amongst the features of the current global crisis (Review of marine time transport, 2022). Marine transportation mode is the most effective mode of carrying bulky quantities of cargo over long distances. Main maritime routes composed of oceans, coasts, seas, lakes, rivers, and channels. The construction of channels, locks, and dredging that will help in facilitating maritime circulation by reducing its discontinuity, but such actions are far from cheap. Maritime transport mode has high terminal costs in terms of building, operation and maintenance. These high costs also relate to maritime shipping, where the construction, operation, and maintenance of ships are capital-intensive more than any other transport mode. Maritime transportation is linked to heavy industries like steel and petrochemical facilities adjacent to port sites. With containerization, maritime shipping has become now essential of globalization, allowing the trading of a wide range of goods and commodities (Review of marine time transport, 2022).

These high costs related to marine shipping linked with the construction, operation, and maintenance of ships demand high budget than any transportation mode of energy products available. Nigeria was not exempted from the problems faces by developed countries in marine transport such as inflation, poor connectivity, strong macroeconomic headwinds, consumers less spending to some extent moving expenditure from goods to services, policy triggered shutdowns, disrupted manufacturing, logistics, and supply chains issues, Industrial action and labour strikes, port congestion, short of equipment's, labour, storage facilities etc. Therefore, it has become necessary to tackle the above problems mentioned for the optimisation of our sea port in Nigeria (Lexology, 2022).

Materials and Methods

The method carries out for the research is determine from the objectives of the research, method of data collection to be adopted, sources of the information, tool for data collection use

and data analysis use to interpret the results. This research was planned to investigate the analysis of transportation logistics to optimize the transport of energy products through pipelines, railways and marine transport in northeast that involves six states; Borno, Yobe, Adamawa, Taraba, Bauchi and Gombe in Nigeria oil industry. The sample group selected to participate in the structured survey include; NNPC staff administrative, technical and non-technical, crude oil and petroleum marketers (private sector), shipper's drivers and owners and trucks drivers as well. The sampling techniques used for the data collection is random sampling method were three depot of Maiduguri, Yola and Gombe was chosen. The procedures used to convince these different groups agreed and participated in the survey are person's contact and e-mail drop. Secondly an interview will be incorporated in the research, despite the fact that people sometimes are not ready to honour interview.

The data collection tool for the research is questionnaire which will be received as handout or an e-mail drop to the respondents so that the information looking from the target groups can easily be obtain and within a limited period. The reasons for a questionnaire selection to collect the data, it is less expensive and offers greater privacy to the respondents' and at the same time research bias into the study is minimize. The research survey used primary data from the respondents due to the fact that the researcher unable to identify many relevant past publications about the subject matter with respect to northeast in Nigeria and therefore primary data collection in the research is essential. The advantage of primary data collection over secondary data is that, it gives the actual facts from the respondents. Furthermore, primary data will help the researcher to achieve a concrete conclusion and and recommendations at the end of the study (Kumar, 2005). In data collection technique, the researcher used closed-ended questions in the questionnaire. The reasons why closed-ended questions were being chosen, the participants do not have enough time to answer open-ended questions. Secondly, closed-ended questions are easier to answer by merely ticking the possible options provided. Moreover, since the questions were categorized, the researcher would find it easier to analyze the findings (Kumar, 2005).

The research approach used quantitative research method because, it is defined as inquiries that depend on testing assumption. Secondly, the information collected from the questionnaire is not in numerical form but rather in opinion from the respondents. So, data has to be converted from non-numerical to numerical form to be able to interpret them statistically. Similarly, by looking at the research topic, quantitative research method will assist in achieving what the study has predicted for the following reasons (Punch, 2005):

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- ✓ Finding a problem situation in depth and in large sample units.
- ✓ Applicable when testing theories and hypotheses.
- ✓ Variables can be defined when using quantitative method.
- ✓ It is the best when looking at the causes and effect.

The statistical analysis for the study rely on the research objectives, the research methodology used, data availability, data collection type and the variable. Therefore, the anticipation of the statistical analysis of this research is cumulative relative frequency in interpreting the results.

RESULTS

The following results or findings were obtained from the three petroleum depots in the northeast region Nigeria. The respondents are up to 60 includes; NNPC staff administrative, technical and non-technical, crude oil and petroleum marketers (private sector), shipper's drivers and owners and trucks drivers as well. The following

data was collected from the questionnaire as follows:

Pipeline transportation mode questions

A. Did you agree that transportation of energy products by pipeline is the best in; northeast Nigeria as a whole? Yes - 50, No- 10
B. Did you think pipeline transportation of crude oil and refined products as sustainable mode domestically and internationally in Nigeria? Yes- 40, No- 20.
C. Did you suggest the use of only pipeline as a means of transporting crude oil and other petroleum products in Nigeria? Yes- 20, No- 40.
D. Did Nigeria presently have pipeline infrastructures to accommodate and satisfy all state? Yes- 20, No- 40.
E. Did you agree that NNPC do not give much attention towards the transporting energy products by pipe in the country? Yes- 50, No- 10.

Railway Transportation Mode Questions

F. Did you agree that railway mode of transportation of crude oil and petroleum products should be bring back in Nigeria? Yes- 40, No- 20.
G. Did you think that Nigeria have enough railway lines in the northeast to accommodate all the area? Yes- 10, No- 50.
H. Did Nigeria have many and functional railways petroleum depots or terminals in all states and the northeast in particular? Yes- 5, No- 55.
I. Did you agree that transporting Nigeria crude oil and refined products by rail cars is sustainable domestically and internationally? Yes- 20, No- 40.
J. Are you suggesting that Nigeria government to provide a strong budget in order to support energy products to transport by railway in the northeast? Yes- 20, No- 40.

Marine transportation mode questions

K. Did you think and agree that energy products can be transport domestically via marine in northeast and Nigeria at large? Yes- 10, No- 50.
L. Did you agree that Nigeria should continue to use marine in shipping their energy products to Nigeria states and in the world market? Yes- 20, No- 40.
M. Did you agree that crude oil transportation by marine is more sustainable than pipeline or railway internationally? Yes- 55, No- 5.
N. Establishing a port or offshore in water areas across Nigeria is very expensive. Did you think that Nigeria government can afford to build those offshore? Yes- 30, No- 30.
O. Did you accept that where there is no water nearby trucks or railways should be adopted in northeast of Nigeria? Yes- 30, No- 30.
P. Did you agree that marine transportation of crude oil and other petroleum products is cheaper than pipeline and rail transport? Yes- 50, No- 10.

Table 1: cumulative relative frequency of yes respondents

QUESTIONS	FREQUENCY	CUMULATIVE FREQUENCY	CUMULATIVE RELATIVE FREQUENCY
A	50	50	0.11 = 11 %
B	40	90	0.19 = 19 %
C	20	110	0.23 = 23 %

D	20	130	0.27 = 27 %
E	50	180	0.38 = 38 %
F	40	220	0.47 = 47 %
G	10	230	0.49 = 49 %
H	5	235	0.5 = 50 %
I	20	255	0.54 = 54 %
J	20	275	0.59 = 59 %
K	10	285	0.61 = 61 %
L	20	305	0.65 = 65 %
M	55	360	0.77 = 77 %
N	30	390	0.83 = 83 %
O	30	420	0.89 = 89 %
P	50	470	1.0 = 100 %

Table 2: cumulative relative frequency of no respondents

QUESTIONS	**FREQUENCY**	**CUMULATIVE FREQUENCY**	**CUMULATIVE RELATIVE FREQUENCY**
A	10	10	0.02 = 2 %
B	20	50	0.11 = 11 %
C	40	90	0.19 = 19 %
D	40	130	0.28 = 28 %
	10	140	0.30 = 30 %
F	20	160	0.34 = 34 %
G	50	210	0.47 = 47 %
H	55	265	0.56 = 56 %
I	40	305	0.65 = 65 %
J	40	345	0.73 = 73 %
K	50	355	0.76 = 76 %
L	40	395	0.84 = 84 %
M	5	400	0.85 = 85 %
N	30	430	0.91 = 91 %
O	30	460	0.98 = 98 %
P	10	470	1.0 = 100 %

Results and Discussion

Looking at the transportation of energy products, it is critical to know which modes are the most comparable and evaluate them against each other to determine what should be invested in for the future. The most comparable three modes of transport are; pipeline, marine and railway due to the fact that they are all methods of transportation of bulky quantity across land that is separate from a road system (CEPA, 2012). Pipelines is amongst the primary transport mode of energy products. It is the safest, cheapest and most reliable transporter of energy in the United States. 63,500 miles of refined product pipeline approximately linked almost every state in the United States (AOLP, 2014). Two thirds of crude oil and petroleum products nearly transported by pipelines each

year (API, 2014). What is currently being proposed for the transportation of crude oil and refined products, pipelines seem to be most favourable. 97% of all petroleum and natural gas products in Canada, are transported via pipelines (CEPA, 2012). Construction of $2.8 billion gas pipeline project begun in Nigeria which is the biggest in the country's history. The pipeline of 614-km long will run from Ajaokuta to Kano finance by Nigerian National Petroleum Corporation (NNPC). The construction will result in the establishment of a connecting pipeline network between the eastern, western and northern regions of Nigeria. At the same time, it aims to create a steady and guaranteed gas supply network between the northern and southern parts of Nigeria by utilizing the country's abundant gas resources (Pipeline Business Projects, 2020). Transportation of crude oil using pipeline is very limited in Nigeria and therefore a lot has to be done as per as one of the major oil exporter in Africa and in the world at large. The transportation of energy products in Nigeria is largely by pipeline and road truck tankers (Ambituuni, 2014). Pipelines transportation mode is generally deliberated as the safest means of transporting energy, including refined products (Hopkins, 2012). Regarding the questionnaires questions on pipeline transportation of energy products as the best in northeast and Nigeria at large, fifty (50) of the respondents answered Yes while ten (10) responded as No with the cumulative relative frequency of 11%. On the issue of sustainability of the mode, the major positive aspect with respect to pipelines mode unlike other means of transportation such as rails, trucks, and tankers, no carbon traces in the atmosphere that could result in air pollution, ozone depletion, acid rain and less spills. This makes it significantly safer for societies and wildlife animals (DXP, 2019). Pipelines occupied less area compared to other transportation mode due to buried under the surface of the earth, except in places of rock formations. Moreover, pipelines transportation mode navigates through less densely populated areas making the consequences of accidents less (DXP, 2019). With regards to loads capacity pipelines of 110,000 kilometres can fill up to 15,000 tanker truckloads or 4,200 rail cars (CEPA, 2012). So, this ensures measureable efficiency and uninterrupted movement of energy products for domestic and international users at a lesser cost. 99.999% of the time energy products reach their destination (Green & Jackson, 2015). This show that pipeline mode of transportation of energy products is sustainable. The information obtained from the respondents with respect to sustainability pipeline mode of transportation, forty (40) responded as Yes while twenty (20) answered as No with cumulative relative frequency of 19%. The question also moves on using only pipeline as means of energy products transportation, the availability of the pipeline infrastructure in the northeast of Nigeria, twenty (20) of respondents answered Yes on using only pipeline and forty (40) participants answered No. Similarly, on pipeline availability twenty (20) participants responded as Yes while forty (40) answered No. In the entire northeast which comprises of six states has only three depots (Maiduguri, Yola and Gombe) (http://www.petroan.com). So, based on the information above, reliant on pipeline alone as means transporting petroleum products is not realistic. With respect to NNPC attention towards the establishing of new pipeline infrastructure in the country, 10 respondents answered Yes while 50 participants answered No. Nigeria was documented as one of the Africa's main energy producer with 15 operating pipelines only and production of 1.5 million barrels' average daily in 2023. The biggest pipeline gas construction in the history of Nigeria in domestic, is the project ($2.8 billion) that will connect gas pipelines network between the three region of the country despite ranked the 7th most gifted natural gas resources in the world (Ambituuni, 2014, Hopkins, 2012 and Pipeline business, 2020). To be frank, NNPC does not prepared to provide pipeline infrastructure in all the Nigeria states.

Historically, rail was also amongst the primary means of petroleum transportation. Today rail

compete with pipelines and many petroleum products travel from refineries to markets by truck tanks or rail cars. Crude-by-rail exports started to increase, averaging over 230 Mb/d in 2018. Pipeline capacity constraints out of western Canada and widening Canadian crude price differentials were the main reasons for the increase in crude-by-rail exports during this time (Frittelli, 2014). In the questionnaire on railway mode of transportation of crude oil and petroleum products should be bring back in Nigeria? Forty respondents answered Yes while twenty responded as No. Regarding the Nigeria crude oil and refined products moving through rail transportation, it has become a history. This is because, the issue of rail moving crude oil and refined products was initiated again in 2015, Nigeria Railway Corporation (NRC) to start movement of energy products and other goods which are presently being conveyed by trucks and lorries in order to reduce the number of tankers and heavy-duty trucks. This will also help in resultant effect being reduction of killing caused on the roads. As reported by the Daily Independents Trust newspaper, the NRC spokesman Mr. Abdur-raouf Akinwoye make known that the corporation had commenced consultations with oil marketers in the country with the intention of transporting their energy products to all parts of Nigeria. Observers say, restoring of the rail transportation mode system would have more impact on Nigerians (northeast) were energy products and haulage services carry out by NRC. This was the case in the early days when the rail mode of transportation was functional. A lot of organizations has supported the planning including National Union of Textile Garment and Tailoring Workers of Nigeria General Secretary (NUTGTWN). An independent petroleum marketers Comrade Issa Aremu and Alhaji Abdulrasheed Olapade stressed that the Nigerian National Petroleum Corporation (NNPC) could accept the rail transportation mode to simplify movement of its products to various parts of the country through train cars which is realistic, cheaper than trucks and sustainable. He said "Nothing is difficult for a government to do at any level if they are honest and sincere. The problem we are having in this country Nigeria according to him is that, every policy is not fastened on honesty and sincerity. The only major upside of this mode of rail transport on crude oil in Nigeria is displacement truck drivers off the road. Upto now few petroleum products in Nigeria were able to transported through rail (Ambituuni, 2014 and Daily Independent newspaper, 2015).

A comprehensive assessment was made in a comparison of pipeline and rail from the University of Calgary and Western University on costs associated with the transportation of petroleum products. The paper gathered estimates on the costs of air pollution, greenhouse gases, spill and accident costs associated with the long distance movement of petroleum products. The research paper found that the "emission and accident costs of pipelines outperformed rail in the ratio 2.5:1 in Canadian dollars''. These numbers lean strongly in favour of future investment into pipelines transportation mode, but the magnitudes of building new infrastructure must be accounted for. There will be impacts on the surrounding land when intended to create a new pipeline or railway system, and the cost of building these structures is far from cheap (CEPA, 2012).

Marine transportation mode is the most effective mode of carrying bulky quantities of cargo over long distances. Main maritime routes composed of oceans, coasts, seas, lakes, rivers, and channels. The construction of channels, locks, and dredging that will help in facilitating maritime circulation by reducing its discontinuity, but such actions are far from cheap. Maritime transport mode has high terminal costs in terms of building, operation and maintenance. These high costs also relate to maritime shipping, where the construction, operation, and maintenance of ships are capital-intensive more than any other transport mode. Maritime transportation is linked to heavy industries like steel and petrochemical facilities

adjacent to port sites. With containerization, maritime shipping has become now essential of globalization, allowing the trading of a wide range of goods and commodities (Review of marine time transport, 2022 and Lexology, 2022).

Nigeria was not exempted from the problems faces by developed countries in marine transport such as inflation, poor connectivity, strong macroeconomic headwinds, consumers less spending to some extent moving expenditure from goods to services, policy triggered shutdowns, disrupted manufacturing, logistics, and supply chains issues, Industrial action and labour strikes, port congestion, short of equipment's, labour, storage facilities etc. Therefore, it has become necessary to tackle the above problems mentioned for the optimisation of our sea port in Nigeria (Lexology, 2022).

From the questions tendered regarding the marine transport of crude oil and other petroleum products; be transported domestically by marine in the northeast and Nigeria at large? 10 respondents answered Yes while 50 answered No. Nigeria should continue to use marine in shipping their crude oil and petroleum products to Nigeria states and in the world market? Yes- 20, No- 40. Crude oil transportation by marine is more sustainable than pipeline or railway internationally? Yes- 55, No- 5. Establishing a port or offshore in water areas across Nigeria is very expensive. Did you think that Nigeria government can afford to build those offshore? Yes- 30, No- 30. where there is no water nearby trucks and rail should be adopted? Yes-30, No- 30. Marine transportation of energy products is cheaper than pipeline and rail transport? Yes- 50, No- 10. Therefore, from the questions responded on marine transport, the feasibility of marine transport of energy products in the northeast of Nigeria is not realistic due to unavailability of oceans, coasts, seas, lakes, rivers, and channels in the northeast and high terminal costs.

CONCLUSION

Looking at the transportation of energy products, it is critical to know which modes are the most comparable and evaluate them against each other to determine what should be invested in for the future. The most comparable three modes of transport are; pipeline, marine and railway due to the fact that they are all methods of transportation of bulky quantity across land that is separate from a road system. Pipelines is amongst the primary transport mode of energy products. It is the safest, cheapest and most reliable transporter of energy in the United States (CEPA, 2012). Transportation of energy products in Nigeria and particularly northeastern region through pipeline is feasible if Nigeria government is willing to do so. Transportation of crude oil and other petroleum products in Nigeria and in particular northeastern region through rail and marine is not realistic. Among the six states exist in the northeast, no single state that possess crude oil and petroleum product depot of rail cars and no any plan prepared by the Nigeria government. Secondly, main maritime routes composed of oceans, coasts, seas, lakes, rivers, and channels. The construction of channels, locks, and dredging that will help in facilitating maritime circulation by reducing its discontinuity, but such actions are far from cheap. The available rivers and channels in the northeast region need to be expand and dredge before use and they are very few in the area and at the same time no any plan made by the Nigeria government so far. Among the six states exist in the northeast region, only three states have petroleum products depot and they are obsolete in nature and no plan for the upgrade yet by the Nigeria government. In a nutshell, north-eastern region of Nigeria will continue the use of trucks in receiving their petroleum products, because the popular three modes of transporting crude oil and refined products based on the above explanations is not feasible in the northeast region of Nigeria at present situation.

RECOMMENDATIONS

1. Nigeria government must look forward in providing pipeline and depot to all Nigeria states for crude oil and petroleum products transfer.
2. Nigeria government should put large investment in pipeline crude oil and petroleum products transfer for economic and sustainability of the Nation.
3. Where marine transportation of energy products is not feasible like the north-eastern states of Nigeria, rail should be considering and emphasis by providing modern rail line, rail cars depot and other infrastructure to accommodate the services.
4. The trucks that mostly use for transporting petroleum products in Nigeria, the roads should be upgraded to minimize the carnage on the road before the government provide the three major modes of transporting oil and refined products.
5. The concern Nigerian should put sincerity and trust in all their policy toward Nigerian favour instead of personal interest of individuals.

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