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ASSESSMENT OF THE EFFECT OF HOUSE BUILDING AROUND PIPELINE RIGHT OF WAY ON CRUDE OIL TRANSPORTATION IN NIGERIA.

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ABSTRACT

This study; "Assessment Of The Effect of House Building Around Pipeline Right of Way On Crude Oil Transportation in Nigeria' assesses the effects of house building/construction around pipeline right of way on crude oil transportation in Nigeria (Niger Delta Area in particular). This research contributed to the existing knowledge by assessing the human activity around PROW. For the purposes of this work, only one (1) human activity was considered namely- House Building/Construction. Primary data was the data source used to conduct this study which was collated through a well-structured multi-choice questionnaire. Statistical models used to analyze collated data are -frequency distribution table and one way analysis of variance (ANOVA). The results/findings of the analysis shows that there is significant relationship between the human (house building construction) activity around PROW used. The analytical tool also revealed p-value of 0.000 and F-calculated values greater than the critical value (F-calculated value > Critical value) With the decision rule that if the F-calculated value is more/greater than the critical value, then reject null hypothesis and accept alternate hypothesis. The result of this study shows that p-value = 0.000 and F-calculated values is greater than the critical value which shows that there is significant relationship between human activity(house building/construction) around PROW and crude oil transportation in Nigeria.

Keywords: Pipeline, Right of Way, Encroachment, Crude oil, Transportation

Background Information

Obviously, Nigeria is one of the largest oil producing country in Africa and also the 6th largest in the world today; and crude oil has remained the major source of Nigerian's economy. Okoli & Orinya, (2013) submitted that oil and gas sector has remarkably brought buoyancy to the country's economy. Also, refined crude oil products from the central refineries are typically transported to various pump stations and depots by rail, road, coastal waterway, and pipeline systems.

According to Daniel (2016), oil and gas Pipeline network in Nigeria is a system of pipes designed for the haulage of petroleum-based products over long distances. These systems of

pipes were designed to carry either mixed or monotype fluids from one part of the country to another. They are used to transport crude oil and its derivatives from the oilfields to the terminals where they are either exported or used as raw materials by refining plants to produce end products.

Phillips 66 Pipeline (2012) defined pipeline right-of-way (PROW) as a strip of land over, under, and around crude oil pipelines where some of the property owner's legal rights have been granted to a pipeline operator. Usually, a PROW is established about 15 m from each side of a pipeline, except special conditions like swamps and coastal areas. Right of way restrictions prohibit building or planting on this area. Unauthorized building or planting in the pipeline right of way is known as encroachment. Therefore, encroachment by host communities on pipeline right-of-way (PROW) constitutes a major problem for the oil and gas sector of the economy as well as their transportation in Nigeria.

For more understanding, encroachment means intrusion on a person's territory, right etc or a gradual advance beyond usual/acceptable limits. On the other hand, right of way (ROW) is the legal right established by usage or grant to pass along a specific route through grounds or property belonging to another. Moreover, right of way encroachment is any activity/object /obstacle occurring /placed/constructed/located upon over/within the public right of way or easement and that is owned/possessed/controlled by an entity other than a governmental body or a public utility.

Problem Statement

In Nigeria, particularly the Niger Delta area, crude oil exploitation, production and transportation from origin to destination and by their characteristics are observed to have wide-range of environmental effects on the productive ecosystems.

Pipeline as a mode of transportation plays a very important roles in transporting crude oil from production site (wells) to oil refineries. They also facilitate convenient and uninterrupted supply of finished petroleum products to dependent industries and other end users. Conversely pipelines right of way have been encroached by human activities thereby hindering transportation of crude oil and its end products to their end users through a good pipeline networks.
It is against this back drop that this work seeks to assess factors that constitute pipeline right of way encroachment (human activities within and around) which affects transportation oil and gas from area of higher concentration to area of lower concentration. For the purposes of this work, one human activity (building of houses) will be considered as pipeline right of way encroachment factor affecting transportation of crude oil in Nigeria.

Objective of the Study

1. To assess the effect of house building around pipeline right of way on crude oil transportation in Nigeria.

Research Questions
The following research questions will guide this work:

1. What is the relationship between house building around pipeline right of way and crude oil transportation in Nigeria?

Research Hypothesis

The following research hypotheses will guide this work:

Ho_2: There is no statistical relationship between house building around pipeline right of way and crude oil transportation in Nigeria.

Justification of the Study

The result of this work will help Nigerian government and pipeline construction companies to put in place policies; that will help in curbing the human activity within and around pipeline right of way which constitutes encroachment in Nigerian crude oil transportation. It is useful to scholars who may have interest in carrying-out research in related topics and also to the investors in pipeline transportation. In addition, it is beneficial to all the maritime stakeholders in Nigerian Maritime industry and beyond.

Conceptual Framework

According to Umar, Abdul-Khanan ,Ogbonnaya , Shiru , Ahmad and Baba (2021) "Pipeline networks play important roles in efficient transportation of oil from production wells to oil refineries". They also facilitate convenient and uninterrupted supply of finished petroleum products to dependent industries and other end users. However, over the years, pipelines have not only been exposed to incessant attacks but also remained potential targets for socioeconomic sabotage and sources of environmental degradation (Phil-Eze and Okoro, 2009; Sojinu et al., 2010; William and Benson, 2010).This chapter gives a detailed review of concepts that relate to the topic of discussion as well as the related literatures on the challenges associated with the management of pipelines and their Right Of Way (ROW).

History of Pipeline Transportation

Back in the 1800's when pipelines were yet to be discovered, 80% of the world's petroleum was supplied by Pennsylvania oil fields (Pipeline 101, 2016). The transportation of oil from oil fields to rail was done through teamsters with converted whiskey barrels and horses. The charge for each barrel increased with the increase in demand by the users. In order to overcome the high charges, pipelines were laid from one town to another and were relatively basic and short in 1879. Later, in the early 1900's when kerosene lamp oil shifted to gasoline, pipelines began to be built across the country.

Pipelines are used for domestic, commercial, and industrial transportations. They are divided into two main categories to transport energy products for industrial purposes (DXP, 2019). The first category is petroleum pipelines which include crude oil lines, Carbon dioxide lines, refined product lines, and highly volatile liquid lines. Natural gas liquids are also transported from production wells to refineries. Refined products are then transported to distribution stations or storage places (Frac Tracker Alliance, 2018). The other category is natural gas pipelines, which collect the raw material from gas wells and transport them to distribution systems across different towns and cities. The distribution system then transfers the processed product to individual households (FracTracker Alliance, 2018). Pipeline intended for transporting crude oil or liquid oil derivatives by means of pumping, and including branches and oil pipelines between the coast and oilrigs.

The major upside of pipelines is that unlike other means of transportation like rails, trucks, and tankers, it does not leave carbon traces in the atmosphere that could result in poor air quality, ozone depletion, and acid rain. They are mostly sealed, therefore reducing impact on wildlife. The sealed nature also causes less spills of highly volatile liquids, which greatly reduces the risk

of explosion during transport. This makes it significantly safer for wildlife and people (DXP, 2019). Pipelines require minimal area above ground as compared to other ways of movement. This is because most pipelines are buried under the surface of the earth, except in places with natural rock formations. Moreover, pipelines navigate through less densely populated areas of people, making the consequences of accidents far less disastrous for the affected areas (DXP, 2019).

Every new system has some drawbacks. Although Pipelines are convenient and appear to be better options compared to other means of transportations, there are issues to be concerned about like spills and employment. The TransCanada pipeline that transports oil to the U.S. Midwest has experienced 14 spills, with the latest spill at North Dakota pipeline pumping station in May 2011 (Pipeline 101, 2016). A campaigner with Greenpeace Canada considers this as an act of aggression towards plants, wildlife and people who live in the path of pipelines. Moreover, the leakage of gas through pipelines could lead to combustion or outspread of toxic gases. Furthermore, the rate of employment will fall down once the pipelines are constructed as construction jobs are temporary compared to other means of transportations (Minicucci, 2019).

Nevertheless, pipelines of 110,000 kilometers can fill up to 15,000 tanker truckloads or 4,200 rail cars (Canadian Energy Pipeline Association, 2012). This ensures quantitative efficiency and uninterrupted movement of energy products at a lesser cost for domestic and international users. Crude oil and Petroleum reach their destination 99.999 percent of the time as stated in the statistics by NR Canada (Green & Jackson, 2015). They also save us from extreme fuel usage and reduce cost per transportation and emission of harmful gases from thousands of automobiles.

Pipeline as a Means of Transportation

Safe pipeline transportation of energy resources is a major concern for the public and the pipeline industry. Today, the pipeline owners and operators are under increasing pressure to produce accurate maps of pipeline routes to assure safety in design, construction, operation, maintenance, and emergency response of pipeline facilities. Pipeline safety problem starts before the actual construction begins and exists in the all life cycle of a pipeline since it has been built and been placed into services. Since a pipeline has been built and buried, geologic hazards, corrosions and third-party damages all pose cumulative internal and environmental risks to the pipeline's integrity. Excavation damage is the single greatest cause of pipeline failures with all other underground utilities being equally vulnerable. The most widely used methods for pipelines monitoring include foot patrols along the pipeline routes and aerial surveillance using drones, small planes or helicopters. These patrols perform facility inspections, check for construction activity in the vicinity of the pipeline, and maintain the pipelines‟ ROW. Heavily congested areas are inspected and patrolled more frequently. In addition, the pipelines undergo periodic maintenance inspections, including leak surveys, and safety device inspections so the developments and events that could place high-pressure on pipelines, the surroundings of pipelines or security of supplies at risk could be prevented. In a continuing effort to remove the guesswork from pipeline operations and reduce costs, many new techniques have been employed to develop software and hardware systems that analyze pipeline risks and maintenance needs in a scientific fashion.

Pipelines and Oil Transportation in Nigeria

The relative economic advantage, administrative convenience and speed of oil product transportation by means of pipelines, already established in other countries like India, Britain and Canada, was relied upon in the rapid post-oil discovery activities in Nigeria (Nwilo & Badejo, 2016). In the last two decades, petroleum industry has become of strategic importance in the

Nigerian economy, accounting for as high as 78 percent of Gross Domestic Product and up to 90 percent of the country's total annual revenue and foreign exchange earnings (National Bureau of Statistics, 2018). Movement of products from depots to service stations numbering several thousands of kilometers - where they are retailed to the final consumers all over the country involves the use of road as the mode of transportation and the products are moved by large trucks. Rail transport was the first mode that was used for the distribution of petroleum products in the early 1960s, subsequently; road transport was then engaged in the distribution while pipeline was used lately. The state of the railway system gave rise to the usage of road transport as a major mode of distributing petroleum products while pipeline transport is limited due to underutilization and vandalization. Movement of products in large quantities sometimes necessitates the use of sea as the mode of transportation. Marine tankers and coastal vessels are used for coastal transportation of petroleum products and to ferry from the coastal refineries of Warri and Port Harcourt, to Lagos.

The most suitable means of transportation of liquid substance is the pipeline. Hence PPMC uses pipelines frequently to convey products from refineries to depots which are located in strategic places across the country. However, according to Kupolokun (2016), over 75% of the pipelines have been vandalized, and are not currently in use. The petroleum products available for distribution through an elaborate 3,949 kilometres of pipelines used to be intercontinental to 21 widely dispersed depots. The products were obtained either from the four local refineries or in the event of a supply short-fall from offshore refineries by way of import of processed Nigerian crude oil. In some cases, and mostly through vandalization, these pipelines burst into flames, causing serious damages to life and property. By multiplier effect, the environmental, economic and social negative impact of such damages is usually enormous. In most cases, the four refineries produce about 61% of the total petroleum needs of the country. The distribution of petroleum products is facing a lot of challenges in the Nigerian environment (Ehinomen and Adeleke, 2012).

Pipeline Transportation and House Building (Construction)

Daniel (2016) submitted that "the encroachment on the pipeline ROW by buildings in Mahuta (Kaduna State) was 3.02, 5.27 and 6.77 hectares for 2003, 2009 and 2015 respectively. There was an increase in the amount of land encroached upon by residential areas. This was because of the increasing demand for land for economic and residential purposes in the area.

This settlement is about two kilometers from the Refinery, and one will expect that the encroachments around the refinery should be less or highly controlled, but it is not so. There are residential buildings that have fully encroached on the pipeline ROW (Fig. 1). Most of the property owners did not give the researcher a listening ear probably because they know their offence or because they are comfortable with the situation and want the status quo maintained. Marketing activities are increasing around the refinery junction. This is a major pull factor that is responsible for the encroachments observed in the area".

It is obvious that some of the residential buildings that have encroached on the pipeline ROW had been marked for demolition by PPMC. The area that encroached on the ROW is popularly called "pipeline". The residents are fully aware of the fact that they are not safe in the event of any pipeline accidents, but were not willing to do anything about it. There was a building that was less than 2 meters from the pipeline marker, and the residents were not ready to hear anything like a research that involves pipeline. This was because there were houses that had been

marked for demolition by PPMC, and they were scared of the fact that the government had embarked on demolition of structures that encroached into any government property.
Residential buildings were constructed right on the ROW and people are comfortably settled probably because no pipeline accident or maintenance had affected them in the past. Buildings were constructed without any caution, provided the land was available and affordable. Observations in Mahuta revealed that new residential buildings are springing up very close to the pipeline markers and if no precautionary measure is taken, more residential buildings will encroach on the pipeline ROW.

Plate 1: Encroachment by Residential Buildings on PROW along kilometer 2 site light town, Lagos pipeline right of way
Source: PPMC Annual Report on Pipeline Encroachment MOSIMI Area Office Ogun State, 2017.

Right of Way (ROW)
Right of way is a term used to describe "the legal right, established by usage or grant, to pass along a specific route through grounds or property belonging to another", or "a path or thoroughfare subject to such a right". A further definition is that it is a type of easement granted or reserved over the land for transportation purposes, this can be for a highway, public footpath, railway, canal, as well as electrical transmission lines, oil and gas pipelines (Paul, 2019). The ROW allows pipeline operators access for inspection, maintenance, testing or in an emergency; it also helps to identify areas where certain activities are prohibited to protect public safety and the integrity of the pipeline.
Pipeline ROW can be identified by the pipeline markers – located at roads, railways, and other intervals along the ROW – which include the name of the operator, emergency contact

information, and a general description of the product in the pipeline. ROW must be kept free of buildings, trees, storage materials and other obstructions. ROW clearing, tree trimming and removal are part of the routine maintenance carried out by the pipeline operators, and are necessary to maintain the integrity of the pipeline and to facilitate ground and aerial inspection (Paul, 2019).

Generally, property owners are prohibited from installing any structures, digging, storing anything that could be an obstruction, or planting trees or shrubs along the right-of-way. Unauthorized building or planting in the pipeline right-of-way is known as right-of-way encroachment. Pipeline operators will regularly conduct aerial and ground inspections to check right-of-way conditions, test for leaks, install and maintain pipeline makers and to clear bushes that restrict access to the right-of-way or visibility during inspections. Rights-of-way are kept clear so the pipeline operator can safely operate, inspect, maintain and repair its pipelines.

Types of Right Of Way

According to Daniel (2016), there are four (4) types of right of way namely – Private right of way, Property right of way, Public right of way as well as Pipeline right of way.

Private Right of Way

A Private Right of Way is a type of ROW that allows an individual access to a property owned by another person to reach a public road. This type of ROW is common for properties that are landlocked and impossible to access by foot or by vehicle without going through another person's property.

Property Right of Way

Property Right of Way is a type of ROW that allows individual access to a property owned by another person to reach a different location. This type of ROW is common for properties that are adjacent to another property owned by a different person, which has the only access to a public area such as a swamp, lake, or river.

Public Right of Way

Public Right of Way is a type of ROW that allows the public to travel over a private piece of land unhindered. This type of ROW is in reference to sidewalks and roads that are adjacent to private land.

Pipeline Right of Way

A pipeline right-of-way (PROW) shown in figure 2, is a strip of land over, under, and around crude oil pipelines where some of the property owner’s legal rights have been granted to a pipeline operator. Usually, a PROW is established about 15 m from each side of a pipeline, excepting special conditions like swamps and coastal areas (Phillips 66 Pipeline, 2012).

The PROW in most cases is used to construct, operate, protect, inspect, maintain and/or replace one or more pipelines. Rights-of-way vary in width; depending on whether there is one pipeline or multiple pipelines within the ROW. The pipeline ROW are often recognizable corridors that are clear of trees, buildings or other structures except for pipeline markers. Another thing that might be seen is a fence and secured area with some above ground piping; these secured areas provide access to valves along the pipeline system (Paul, 2011).

Plate 2: Pipeline Right of Way (PROW)
Source: Mosimi Area Office Right of Way Report after Clearance, 2017.

Oyinloye, Oladosu & Isaac Olamiju (2017) asserted that "Pipeline operation can be compromised by accidental manmade threats such as seismic disturbances caused by legitimate civil engineering works in the area or even by farming activity. Pipeline safety and security, therefore, generally involve federal agencies, oil and gas pipeline associations, and pipeline operators as well as the local communities through which the pipelines pass".
According to PPMC (2015) "Nigeria has a total pipeline grid of just above 5000 km. This consists of 4315 km of multiproduct pipelines and 666 km of crude oil pipelines. These pipelines traverse the country, forming a network that interconnects the 22 petroleum storage depots and the four refineries (two of which are at Port-Harcourt, one at Kaduna, and one at Warri) and connecting the off-shore terminals at Bonny and Escravos and the jetties at Alas Cove, Calabar, Okirika, and Warri". This system of oil pipelines transports crude oil to the refineries in Port-Harcourt, Warri, and Kaduna, covering a total distance of 719 km. The multiproduct pipelines are used to transport products from the refineries and import-receiving jetties to the 22 petroleum storage depots at various places in the country. The storage infrastructure, consisting of 22 loading depots where the products are stored for distribution, linked by pipelines of 6 to 8 inches diameter range, have combined installed capacities of 1,266,890 metric tons of Premium Motor Spirit (PMS); 676,400 metric tons of Dual Purpose Kerosene (DPK); 1,007,90 metric tons of Automotive Gas Oil (AGO); and 74,000 metric tons of Aviation Turbine Kerosene (ATK).

Theoretical Framework

According to Grant and Osanloo (2014), theoretical review is the 'blueprint' or guide for a research. It is a framework based on an existing theory in a field of inquiry that is related and/or reflects the hypothesis of a study. They went ahead to submit that it is a blueprint that is often 'borrowed' by the researcher to build his/her own house or research inquiry. It serves as the

foundation upon which a research is constructed. For the purposes of this research, three transport theories/models are considered namely – Ullman's theory of spatial interaction, Haulage Cost Gradient theory and Gravity Model.

Ullman's Theory of Spatial Interaction

The basic theory relevant to this study is Ullman's theory of spatial interaction. Spatial interaction is a dynamic flow process from one location to another. It is a general concept that may refer to the movement of human beings such as intra-urban commuters or intercontinental migrants but may also refer to traffic of goods such as raw materials or to flows of intangibles such as information. In Ullman's conception there are three bases for spatial interaction these are: complementarily, transferability, and intervening opportunity (Ullman, 1980).

Complementarily refers to the presence of a demand at one location and a supply at another without which there is no economic rationale for any movement. A refinery is a place with a supply for petroleum product while filling stations and consumers demand for the petroleum products. To adapt a metaphor from physics, complementarity is like a potential gradient with goods and people flowing from higher energy state where they are in surplus to a lower energy state, where they are in deficit. The complementary surplus-deficit relationship is commodity-specific, and if the deficit is precisely specified, the direction and distance of movement will depend on the location where there is a surplus of just that kind of good. Complementary relationships may be the impetus for interaction between distant regions such as the flow of petroleum over thousands of miles from the point to the other and within regions such as the flow of shoppers from residential neighborhoods to small convenience stores over a distance of less than a mile or two (Ullman, 1980). With a supply for petroleum product while filling stations and consumers demand for the petroleum products. To adapt a metaphor from physics, complementarity is like a potential gradient with goods and people flowing from higher energy state where they are in surplus to a lower energy state, where they are in deficit (Dimitriou, 2016). The complementary surplus-deficit relationship is commodity-specific, and if the deficit is precisely specified, the direction and distance of movement will depend on the location where there is a surplus of just that kind of good. Complementary relationships may be the impetus for interaction between distant regions such as the flow of petroleum over thousands of miles from the point to the other and within regions such as the flow of shoppers from residential neighborhoods to small convenience stores over a distance of less than a mile or two (Ullman, 1980).

With the usage of various modes of transport (in this case pipeline), petroleum products are transferable from one mode to the other. For example, pipeline transport can be used from the refinery to the nearest depot, from where the petroleum products will be transferred to either rail or road transport based on the relative distance as the cased may be, which will eventually aid easy distribution of the products and reduce cost of transportation (Ullman, 1980). The petroleum products in question must be capable of being moved so as to be able to overcome the distance friction.

Intervening opportunity is the third basis for interaction, although, it is typically considered as the reason for a lack of interaction between two complementary locations. Complementarity will only generate a flow if there is no intervening, or closer, location. The flow of goods that would otherwise occur between two complementary; locations may be diverted to a third location if it represents an intervening opportunity: a closer complementary alternative with a cheaper overall cost of transportation. However, Ullman noted that the trade diverting effect of an intervening opportunity could eventually facilitate interaction between more distant complementary

locations. For example, the nearest (intervening) source of petroleum products would justify construction of a refinery from the raw material source and when it was produced, the pipeline would be extended to the next intervening opportunity and so on until it ultimately reached a more distant complementary location. Flows to the more distant complementary location might never have been established had the transportation infrastructure not been constructed in a series of incremental extensions to a series of intervening opportunities. For destinations where there is no interaction between modes of transport, the intervening opportunity will be the next available mode of transport to distribute the product. This implies that there can be an intervening circumstance between the demand and supply locations.

Empirical Framework

Oyinloye, Oladosu & Olamiju (2017) carried out a research on Pipeline right-of-way encroachment in Arepo, Nigeria. They used remote sensing and geographic information system (GIS) technologies to assess the level of vulnerability of people living along the PROW in Arepo, Ogun State, Nigeria. A satellite imagery of the community was acquired and processed using ArcGIS computer software. A GIS buffering operation was performed on the PROW using 15 m, 30 m, 60 m, and 90 m distances, respectively. Three hundred and forty buildings were identified in the buffered zones, out of which 200 (60%) were randomly selected for the study. A structured questionnaire was administered to household heads in the sampled buildings. Empirical analysis shows that 140 buildings (70%) observed less than a 30 m setback to the pipeline. Also, residents benefit from incidents of oil spillage and see these as an avenue to vandalize the pipeline, making them more vulnerable. GIS analysis shows that more than 30% of respondents are highly vulnerable to the hazard of pipeline explosion incidents. Enforcement of setback regulations by the Town Planning Authority and public education and awareness of risks associated with encroachment on the PROW are canvassed among others.

Study Design

For the purposes of this research, descriptive survey design will be used together with multi-choice questionnaire as method of obtaining information needed from respondents.

Area of Study

The area of study covers some selected south-south states of Niger Delta areas - Rivers State, Delta State, and Bayelsa State.

Population of Study

The targeted population of the study comprised of civil servants and others in the selected study area. The total population of respondents will be 130and the sample size is 98 (using Taro Yamane formular).

Sampling Techniques

A sample is a subset/portion of the population selected for a study while the method of selecting the sample from the population is called sampling techniques. In this work, the whole population will not be used. A sample size of 98 was drawn from the total population using Taro Yamane formular as shown below:

Where n = the derived sample size

N = the finite population

e = the limit of tolerable error (0.05)

1= unity

Using the formular,

= 98

Instrument of Data Collection

The data of this work was collected using well-structured self-developed questionnaire. The questionnaire was structured in such a way that the researcher can easily elicit and achieve the aim and objective of the study. The questionnaire have four sections: section A contains the demography of the respondent while section B, C, and D contains questions relating to three human activities on PROW that affect transportation of crude oil in Nigeria. The questions will be presented in a likert scale format and the answers will be stated in a way to eliminate possible bias so as to increase reliability of the responses.

Reliability of the Instrument

The reliability of the instrument will be determined through a pilot study. Copies of the questionnaires were administered to few respondents in the area of study and data obtained from the pilot study was analyzed using Guttman split half coefficient formula. The instrument were collected and divided into two halves using even and odd numbers of items in the instrument. One half (10 each) will be the even numbers while the other half (10 each) will be odd numbers. Note, the result with 70% or 0.7 coefficient and above reveals that the instrument was reliable. For the purpose of this work, Guttman Split-Half Coefficient is 96.9% or 0.97 (See Appendix 2).

Method of Data Collection

Data for this research were collected using a well self-structured questionnaire which was distributed to the respondents after approval has been obtained from my supervisor. Five assistants were used in the administration of questionnaire after being trained (1 day training) on how to administer the questionnaire. The literate ticked the right answer while the illiterate ones were assisted by the researcher or assistant by reading out the questions and interpreting them; also helped them to tick the answer they chose. This method of data collection gives nearly hundred percent return rates.

Method of Data Analysis

Descriptive method was used to summarize the data characteristics. Frequency distribution tables were constructed for all variables and were all expressed as the percentage of the distribution. The data collated for this research was analyzed using frequency distribution tables and ANOVA (Analysis of Variance) with the help of IBM-SPSS Software version 20.

Frequency Distribution

The frequency of a value is the number of times it occurs in a dataset. A frequency distribution is the pattern of frequencies of a variable. It's the number of times each possible value of a variable occurs in a dataset.

Types of Frequency Distributions

There are four types of frequency distributions namely:
a. Ungrouped frequency distributions: The number of observations of each value of a variable. You can use this type of frequency distribution for categorical variables.
b. Grouped frequency distributions: The number of observations of each class interval of a variable. Class intervals are ordered groupings of a variable's values. You can use this type of frequency distribution for quantitative variables.
c. Relative frequency distributions: The proportion of observations of each value or class interval of a variable. You can use this type of frequency distribution for any type of variable when you are more interested in comparing frequencies than the actual number of observations.
d. Cumulative frequency distributions: The sum of the frequencies less than or equal to each value or class interval of a variable. You can use this type of frequency distribution for **ordinal** or quantitative variables when you want to understand how often observations fall below certain values**.**

Analysis of Variance (ANOVA)
Analysis of variance (ANOVA) is a statistical test used to evaluate the difference between the means of more than two groups. This statistical analysis tool separates the total variability within a data set into two components: random and systematic factors.
A one-way ANOVA uses one independent variable. A two-way ANOVA uses two independent variables. Analysts use the ANOVA test to determine independent variables' influence on the dependent variable in a regression study.
An ANOVA test can be applied when data needs to be experimental. Analysis of variance is employed if there is no access to statistical software and ANOVA must be calculated by hand. It is simple to use and best suited for small samples. It is employed with subjects, test groups, and between and among groups.
ANOVA is similar to multiple two-sample t-tests. However, it results in few type I errors. ANOVA groups differences by comparing each group's means and includes spreading the variance into diverse sources. Analysts use a one-way ANOVA with collected data about one independent variable and one dependent variable. A two-way ANOVA uses two independent variables. The independent variable should have at least three different groups or categories. ANOVA determines if the dependent variable changes according to the level of the independent variable. The formula is stated below:

F=MST
MSE
Where: F=ANOVA coefficient
MST=Mean sum of squares due to treatment
MSE=Mean sum of squares due to error.

Results

Table: Showing the Age Group of Respondents

Age Group	Number	Percentage
15-20 Years	15	15.3%
21-25 Years	25	25.5%
26-30 Years	28	28.6%
Above 30 Years	30	30.6%
Total	98	100%

Source: Field Survey (2024).

The table , shows that 15.3% of the respondents are between 16-20 years, 25.5% are between 21-25 years, 28.6% are between 26-30 years and 30.6% are above 30 years. This shows that most of the respondents are in their active years.

Table: Showing the Sex of Respondents

Sex	Number	Percentage
Male	45	45.9%
Female	53	54.1%
Total	98	100%

Source: Field Survey (2024).

The table, shows that 45.9% of the respondents are Males and 54.1% are Females.

Table: Showing the Educational Qualifications of Respondents.

Educational Level	Number	Percentage
Primary	10	10.2%
Secondary	20	20.4%
Tertiary	50	51%
Others	18	18.4%
Total	98	100%

Source: Field Survey (2024).

In table 4.1.4, the educational levels of the respondents show that primary level is 10.2%, secondary level is 20.4%, tertiary level is 51%,and others is 18.4%.

Table: Showing Religion of Respondents.

Religion	Number	Percentage
Christian	60	61.2%

Moslem	10	10.2%
Pagan	8	8.2%
Others	20	20.4%
Total	98	100%

Source: Field Survey (2024).

In table, the religions of the respondents show that Christian is 61.2%, Moslem is 10.2%, Pagan is 8.2%, and others is 20.4%.

Presentation of Relevance Questionnaire Responses of Respondents.

Note: SA= Strongly Agree which represents 4-points, A= Agree which represents 3-points, D= Disagree which represents 2-points and SD= Strongly Disagree which represents 1-point.

Question: House building or construction around/near pipeline causes breaking/damaging of pipeline thereby affect transportation of crude oil.

Table: Showing the Responses of the Respondents on the effect of house building or construction around/near pipeline causes breaking/damaging of pipeline thereby affect transportation of crude oil.

Responses Category	SA	A	D	SD	TOTAL
Farmers	20	8	2	0	30
Civil Servants	38	2	0	0	40
Others	20	8	0	0	28
Total	78	18	2	0	98

Source: Field Survey (2024).

Table shows that 78 respondents strongly agree, 18 respondents agree, 2 respondents disagree and no respondent strongly disagree that house building or construction around/near pipeline causes breaking/damaging of pipeline thereby affecting transportation of crude oil.

Question: Lack of adequate information/knowledge contributes to number of buildings constructed within PROW in the area.

Table: Showing the Responses of the Respondents on the lack of adequate information/knowledge contributes to number of buildings constructed within PROW in the area.

Responses Category	SA	A	D	SD	TOTAL
Farmers	25	5	0	0	30
Civil Servants	30	8	2	0	40
Others	20	5	3	0	28
Total	75	18	5	0	98

Source: Field Survey (2024).

Table shows that 75 respondents strongly agree, 18 respondents agree, 5 respondents disagree and no respondent strongly disagree that lack of adequate information/knowledge contributes to number of buildings constructed within PROW in the area.

Responses from Respondent on Relevant Questionnaire Questions (Q6-Q14)
Table : Showing Frequency Distribution Table of Responses, Mean and Standard Deviation

Items	SA (%)	A (%)	D (%)	SD (%)	Mean	STD	Decision
Q6	65 (66.3)	22 (22.5)	7 (7.1)	4 (4.1)	3.51	0.80	Low perception
Q7	80 (81.6)	16 (16.4)	2 (2.0)	0 (0.0)	3.80	0.45	High perception
Q8	87 (88.8)	11 (11.2)	0 (0.0)	0 (0.0)	3.89	0.32	High perception
Q9	78 (79.6)	18 (18.4)	2 (2.0)	0 (0.0)	3.78	0.47	Low perception
Q10	91 (92.9)	7 (7.1)	0 (0.0)	0 (0.0)	3.93	0.26	High perception
Q11	75 (76.5)	18 (18.4)	5 (5.1)	0 (0.0)	3.71	0.56	Low perception
Q12	82 (83.7)	9 (9.2)	5 (5.1)	2 (2.0)	3.74	0.65	Low perception
Q13	92 (93.9)	6 (6.1)	0 (0.0)	0 (0.0)	3.94	0.24	High perception
Q14	89 (90.8)	6 (6.1)	2 (2.0)	1 (1.0)	3.87	0.47	High perception

Note: N= 98, SA=Strongly Agree, A=Agree, D=Disagree, SD=Strongly Disagree, Q=Questions from Questionnaire (6-14). Decision=Weighted Average = 3.80. (Mean sum/n= 34.17/9=3.80)

In this study, decision was made using the perceptions of the respondents. To do this, weighted average value was used to march individual Mean value; any one with higher value than weighted average value has high perception while otherwise shows low perception.

Testing of Research Hypothesis

Table : Showing ANOVA Results of all the Factors used for Hypothesis Testing.

ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
	Between Groups	3.087	2	1.543	21.954	.000
3	Within Groups	6.679	95	.070		
	Total	9.765	97			
	Between Groups	12.347	2	6.173	67.301	.000
4	Within Groups	8.714	95	.092		
	Total	21.061	97			
	Between Groups	1.250	2	.625	11.310	.000
5	Within Groups	5.250	95	.055		
	Total	6.500	97			
	Between Groups	20.000	2	10.000	95.000	.000
6	Within Groups	10.000	95	.105		
	Total	30.000	97			
	Between Groups	15.944	2	7.972	30.688	.000
7	Within Groups	24.679	95	.260		
	Total	40.622	97			
	Between Groups	.918	2	.459	9.253	.000
8	Within Groups	4.714	95	.050		
	Total	5.633	97			
	Between Groups	4.311	2	2.156	12.071	.000
9	Within Groups	16.964	95	.179		
	Total	21.276	97			
	Between Groups	43.151	2	21.575	105.984	.000
1	Within Groups	19.339	95	.204		
	Total	62.490	97			
	Between Groups	10.204	2	5.102	49.895	.000
2	Within Groups	9.714	95	.102		
	Total	19.918	97			

Source: Analysis of Variance (ANOVA) Result Output

In table 4.1.16,the decision rule is that if the F-value calculated is more than the critical value, then there is a significant difference (ie, F-value calculated > table value). In addition, small p-values (under 5%) usually indicate that a difference is significant (ie p-value < 0.05).

Ho_2: There is no statistical relationship between house building around pipeline right of way and crude oil transportation in Nigeria.

Based on result of our analysis, it shows that **F-values calculated** forquestions**(Q9 = 67.30, Q10 = 11.31 & Q11 =95.00) >critical value (1.98)** at **0.05** levels of significance. This means that we reject null hypothesis and accept alternate that "there is statistical relationship between house building around pipeline right of way and crude oil transportation in Nigeria".

Also, p-value (0.000) < 0.05, shows that there is significant relationship between house building around pipeline right of way and crude oil transportation in Nigeria..

Discussion of Results

Here a detailed discussion of the results found using one way ANOVA analysis was carried out base on our research objectives. The results/finding found using one way ANOVA shows that:

b. There is significant effect of house building around pipeline right of way on crude oil transportation in Nigeria. This means that there is a significant relationship between house building around pipeline right of way and crude oil transportation in Nigeria, with statistical proof of F-calculated value higher than the critical value as well as p-value of 0.000 which is lower than 0.05 level of significant.

Moreover, this study agrees with the findings of Daniel (2016) and Oyinloye et al (2017) that human activities around and within pipeline affects both crude oil supply as well as environment. Though the method of data analysis varies, but they revealed the same result. Whereas Daniel (2016) uses Google imageries as analytical tool, Oyinloye et al(2017) used remote sensing and geographic information system (GIS) technologies to assess the level of vulnerability of people living along the PROW.

The result of Johnson, Laing, Bjeirmi and Leon (2022) with structural equation model (SEM) as analytical tool is also in agreement with the findings of this study that human activities affects environment and crude oil supply.

CONCLUSION AND RECOMMENDATION

Conclusion

This study assessed the effect of house building/construction activities on crude oil transportation in Nigerian. From the result of our analysis, the following were drawn:

1) There is significant relationship between house building/construction around PROW and crude oil transportation in Nigeria.

In summary, this shows that there is positive effect house building/construction activities around PROW on Crude Oil Transportation in Nigeria. The statistical tools – one way analysis of variance (ANOVA) has played great roles here. Using the model to estimate the relationship between parameters used (house building/construction activities around PROW) and Crude Oil Transportation in Nigeria show a significant relationship.

Related literatures were considered to note short falls in other researcher's work. The analysis of collected data was also carried out to give the result or findings of the work. These criteria formed the basis of assessment. Moreover, analysis of variance made a great revelation. This gives a significant value, suggesting that the values of F-calculated value is greater than (>) the critical value (table value) which shows that all variable affect crude oil transportation in Nigeria in Nigerian significantly.

Recommendations

In order to cushion effects of pipeline right of way (PROW) encroachment on Crude Oil Transportation in Nigeria, the following recommendations were made:

1. Nigerian Government should mount 24-hours surveillance security and digital cameras/searchlight stop pipeline oil theft/vandalizm thereby increase the supply capacity of crude oil in Nigeria.

2. There should be stringent law and equivalent punishment to any person that build/construct houses around the PROW so that it will serve as deterrent punishment to defaulters by relevant government agencies.

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