Causes of Oil Pipeline Leakages and Their Effect on Economic Growth in Nigeria

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Abstract: The study investigates the causes of oil pipeline leakages and their effect on economic growth in Nigeria. The study covers a period of five years from 2016 to 2020. The study contained three objectives, three research questions guided the study and three null hypotheses were formulated. The study used *ex post facto* research design. The study used multiple regression analysis and analysis of variance (ANOVA) to analyze the data for the study. The results of the analyze data revealed that oil pipeline leakages (sabotage, corrosion and operational failure) has no significant effect on economic growth in Nigeria. The study therefore concludes that there is a positive significant relationship between sabotage, corrosion, operational failure and economic growth in Nigeria. The study therefore recommends that oil companies and the government regulatory agencies should work together to improve the fortunes of the host communities in order to reduce to the bearest minimum incidences of sabotage. Also, the oil pipelines should be checked a regular interval and subsequent replacement be carried out as at and when due on old and expired pipelines so as to reduce the incidences of corrosion of pipelines.
Keywords: Pipeline Leakages, Sabotage, Corrosion, Operational Failure, Economic Growth

Introduction

1.0 Background to the Study

Nigeria is blessed with abundant Natural resources of which Petroleum product plays a major role. Oil was discovered in Nigeria in 1956 at Oloibiri in Bayelsa state in the Niger Delta after half a century of exploration. The discovery was made by Shell BP, which was at that time the sole concessionaire in the sector.

The process of oil and gas exploration, extraction and transportation often impinge on the lives of the people and their environment. The negative effects are usually taken for granted by the multinational oil companies (MNOCs) and the government until there is protest.

Pipeline leakages have been a major concern of the government and the people of the Nigerian state over the years because of the negative impact it has cause. According to Okolo 2010 pipeline leakages have occurred severally in many parts of the country. For example the Jesse Town Tragedy of 1998 which occurred in Ethiope West Local Government Area of Delta State. This incidence left over 1000 people's death as a result of fire explosion from the leakage which the villagers took advantage of it to scope fuel to sell in what is popularly called "black market." Again, in 2002 similar incidence occurred in Adeje Town in Okpe local government area of Delta state barely two years after the Jesse incidence. This time the victims of the pipeline leakages numbered up to 300 with over 5km of farmland burnt.(Adeyemi 2012)

In 2003, Warn North and South-West LGAs experience pipeline leakages which affected about 50 communities including Eketie, Eporo, Ogbege-Eghoruoke and Orere-Yeregbo. These communities were badly affected from the incidence to the extent that they could no longer drink water from their creeks and rivers as they were polluted from the pipeline leakage. This affected their livelihood and make the people live in penury and hunger.

Pipeline leakages leads to serious economic effect on the Nation. For instance the Managing Director of Pipelines and Product Marketing Company (PPMC) revealed that between 2009 and December 2014, the NNPC alone lost about N165 Billion to product theft and repairs of damaged pipelines. According to Nigeria Extractive Industry Transparency Initiative (NEITI), in 2015 indicates that Nigeria lost a whooping sum of 10.9Billion US dollars to oil theft and vandalism between 2009 to 2014 alone. These translate to huge economic loss with far reaching implications for Nigeria's economic growth and development.

1.1 Statement of Problem

Prior to the discovery of oil, the Nigerian nation was operating a diversified economy based on agriculture. During this, period the three regions as at then i.e. (Northern, Eastern and Western) were producing different agricultural products and making remittance to the centre. At that time, the north was producing groundnut, the eastern region palm oil and western region cocoa. The Nigeria economy was sustained from the revenue derived from this agricultural venture which contributed to her economic growth and development. However, upon the discovery of oil in Nigeria, the government attention was completely shifted from

agriculture to mainly oil thereby making her a mono-economic based nation (Adishi & Hunger 2015). Oil was discovered in Nigeria in 1956 at Oloibiri in Bayelsa state in the Niger Delta over half a century ago. The discovery was made by Shell BP, which was at that time the sole concessionaire in the sector. At present, crude oil export accounts for about 90 percent of foreign exchange earnings and 80 percent of government revenue, thus making the country's economy heavily reliant on the oil and gas sector. The oil industry in Nigeria has been facing a lot of monumental challenges amongst which is pipeline leakages. According to kopulokun (2012), over 75 percent of the pipelines have been vandalised leading to a drastic drop in the projected oil revenue of the nation. This has however affected the nation's economic growth and development. The pipelines used by the oil companies to transmit their product need proper management, regular maintenance and subsequent replacement after some years (Alphonsus 2017). But this has been deliberately ignored by the oil companies and the federal government. These pipelines are susceptible to damage from corrosion due to ageing which eventually leads to leakages. According to NNPC Annual Statistical Bulletin 2017, a total of 2589 pipelines leakages occurred on NNPC pipelines, out of which 253 was as a result of vandalism (sabotage) while 55 cases were due to system deterioration like rupture resulting in a loss of 80.93 thousand metric tons of petroleum products worth about N12.36 billion (NNPC 2017). This agrees with the earlier assertion of the researcher that pipeline leakages occur mostly as a result of negligence caused by long usage of the pipelines and corrosion (rupture pipelines). According to NNPC 2016 Annual Statistical Bulletin 2016, a total of 2589 pipelines leakages occurred on NNPC pipelines, out of which 253 was as a result of vandalism (sabotage) while 55 cases were due to system deterioration like rupture resulting in a loss of 80.93 thousand metric tons of petroleum products worth about N12.36 billion (NNPC 2017). This agrees with the earlier assertion of the researcher that pipeline leakages occur mostly as a result of negligence caused by long usage of the pipelines and corrosion (Babatunde 20130. In general, it is observed that pipelines leakages posed a lot of challenges to the oil company's operation which affect the revenue derivable and thereby affect economic growth and development.

1.2 Objective of the Study
The main objective of the study is to examine the causes of oil pipeline leakages on Economic growth of Nigeria. Specifically the study looked at the following sub- objectives
1.   To determine the effect of Sabotage of oil pipeline on economic growth in Nigeria
2.   To ascertain the impact of Corrosion of oil pipeline on economic growth in Nigeria
3.   To determine the effect of operational failure of oil pipeline m affect on economic growth in Nigeria

1.3 Research Questions
In line with study's objectives, the following research questions were raised
1.   To what extent does pipeline Sabotage effect economic growth in Nigeria?
2.   How far does Oil pipeline Corrosion affect economic growth in Nigeria?
3.   To what degree does pipeline operational failure effect economic growth in Nigeria/?

1.4 Research Hypotheses
In line with study's objectives, the following hypotheses were formulated
1. Oil pipeline Sabotage has no significant effect on economic growth in Nigeria.
2. Oil pipeline Corrosion has no significant effect on economic growth in Nigeria.
3. Oil Pipeline operational failure has no significant effect on economic growth in Nigeria.-

2.0 Review of Related Literature.
2.1 History of Oil Pipeline
The history of oil pipeline as a means of transportation dates back to early Christian era when water supplies are known to have been piped over long distances. History recorded that Bamboo pipes were used in China circa 5000BC and pipes made of Clay or Stones were widely used in the Ancient Civilization of Egypt, Mesopotamia and Rome. These early pipelines pioneers were restricted by materials, joining technologies and the ability to 'pump' (raise the pressure) of the fluid, but this did not prevent pipeline systems being developed. In England in the mid 18th century the London Bridge water works company had over 54000 yards (49km) of woods pipes 1800 yards (1.6km) of cast iron. The use of woods, leads, iron and tin pipes were common into the 1 9th century to transport water. In 1821, wood pipes transported natural gas in New York State USA. In 1843 iron pipes was used and this reduced the obvious hurdle of transporting a flammable, explosive gas in a flammable materials. The 19th century was a time of scientific and technological advancement in many industries for example lap-jointed wrought Iron pipe, riveted or flanged together became available, the Bessemer steel making process produced higher quality steel from 1850, and seamless pipes was introduced

towards the end of this century. These advances paved the way for pipeline industry. The first Crude Oil pipeline made of wood was laid in the United States of America in 1861. Thereafter, the first modern Oil pipeline was constructed in Pennsylvania in 1865. Soviet Union, Britain, Venezuela, Canada, Columbia have constructed oil pipelines.

2.1.1 Oil Pipeline in Nigeria

The origin of petroleum pipeline development in Nigeria is closely associated with oil exploration activities which started in 1908, although no oil discoveries were reported before the exploration was disrupted by World War I (NNPC 2012). Post World War I oil exploration activities did not commence until decades after the 1914 amalgamation of the Northern and Southern protectorates of Nigeria under the colonial British Administration. This culminated in the enactment of the mineral Oil Ordinance of 1947 (National Assembly) Shell D, Arcy resumed exploration activities over the whole of Nigeria in collaboration with British petroleum, in a joint venture known as Shell BP. Shell — BP later partially relinquished its exploration rights, limiting its acreage by 1951 to one sixth of the whole country in an area that was mainly concentrated in the Niger Delta. Mobil took advantage of the country relinquishing by Shell- BP to acquire exploration rights of the Sokoto Basin in 1955 using the trade name, Mobil Exploration Nigeria Incorporated (NNPC 2012). Mobil like Shell-BP initiated extensive exploration activities but were unsuccessful. This discovery culminated in full scale commercial oil exploration and in 1958, the associated building of pipelines to transport the crude oil produced began.

Construction activities for the network of pipelines started with the discovery of oil in commercial quantities in Oloibiri in 1956. The subsequent full scale commercial exploration that followed in 1958 by Shell-BP then expanded to all parts of Nigeria (NNPC 2012, Onuoha 2012). Pipe laying for crude oil transportation at the time naturally created a buffer zone which is now protected statutorily under the rights of way for Petroleum Product Pipelines in Nigeria (Brume 2013).

The pipeline Act of 1965 also simplifies the procedures and also determines the condition under which pipelines are constructed in Nigeria.

2.1.2 Causes of pipeline Leakages

Incidences of oil pipeline leakages have been a recurring experience in Nigeria (*Baird .J. 2010).*Most of oil pipeline leakages (spills) occur as a result of pipeline and tanker accidents (50%), other causes are sabotage (28%) oil production operations (21%), and 1% of the spills being accounted for by inadequate or non-functional production equipment In onshore areas most pipelines and flow lines are laid above ground. Pipelines, which have an estimate life span of about fifteen years, are old and susceptible to corrosion. Many of the pipelines are as old as twenty to twenty-five years and above. (Bronwen Manby)

Shell takes responsibility and acknowledges that "most of their oil facilities were constructed between the 1960s and early 1980s to the prevailing standards then which has been changed. SPDC [Shell Petroleum and Development Company] would not build them that way today (Bogumil Terminski 2013) sabotage is performed primarily through what is known as "bunkering", whereby the saboteur tap the pipeline to extract crude oil. This action damaged or destroyed the pipeline and lead to continuous leakages unless detected on time.

2.1.2.1 Sabotage

Sabotage involves the act of deliberate vandalization of pipelines for the purpose of oil theft for bunkering or getting the government's attention. The vandals tap the pipeline to extract the oil for sale. In the process, the pipeline is damaged or destroyed, and this can go unnoticed for days. If repair is not affected in good time, it could result in environmental degradation (Fig. 2.1).

2.1.2.2 Corrosion

Corrosion is the destruction of a material by reaction with its environment (Roberg, 2000) and a natural potential hazard associated with oil and gas production and transportation facilities (Kermani, & Smith 2007). Corrosion of pipelines is the rupturing or leaking of old production infrastructure that often do not receive inspection and maintenance.(Nwilo and Badejo 2010)**.** Almost any aqueous environment can promote corrosion, which occurs under numerous complex conditions in oil and gas production, processing, and pipeline systems (Champions Technologies 2012).

Fig 2.2 Oil Pipeline affected by Corrosion

2.1.2.3 Operational Failure
This is failure to give proper care or attention to something.
 This occurs as a result of inadequate or non- functional production equipment. It also involves the failure of the multinational oil companies to adequately maintain and care for oil pipelines. This act of failure has seriously contributed to oil pipeline leakages

2.2 Economic Growth
According to Anyanwu and Oaikhenan (1995) stated that economic growth, simply defined, refers to the increase, over time, of a country's or an economic capacity to produce those goods and services needed to improve the well-being of the citizens in increasing numbers and diversity.

The International Monetary Fund (2009) and CBN (2010) opine that economic growth is the increase in the amount of goods and services produced in an economy over time. It is measured as the percentage rate of increase in Real Gross Domestic Product (RGDP). Growth is usually calculated in real terms, that is, inflation-adjusted terms, in order to net out the effect of inflation on the price of the goods and services produced. The growth of the Real Gross Domestic Product (RGDP).between 2004 and 2008 was driven mainly by the non-oil sector as reflected in the fall in oil sector GDP (CBN 2008). The major theories on economic growth are based on the fact that growth being is a function of the productivity of factors of production as their basic theme. Adam Smith (1776) states that economic growth depends on the amount of factors of production viz; land, labour and capital. He argued that economic growth (output) depends on the amount of these factors of production which are the inputs that are determined by the population growth, increase in investment and land, and total growth in labour productivity. While Harrod-Domar model stated that rate of growth of GDP is equal

to Savings ratio/Capital-Output ratio, Kaldor model of distribution noted that the process of growth is a function of savings-income ratio.

3.0 Methodology

This study employed the, *expost-facto* research. The study makes use of secondary data sourced from the Annual Statistical Bulletin of National Bureau of Statistics (NBS) on oil sector Gross Domestic Product (GDP) and Shell Petroleum Development Company of Nigeria (SPDC) on causes of oil pipeline leakages for a period of five year (2016-2020).

4.0 Presentation and Analysis of Results

In this section, the study presents the summary of the analysis and their interpretation. The summary of the analyzed results and their corresponding interpretations are as presented below.

Regression Analysis

To ascertain the effect of oil pipeline leakages on economic growth, the study used multiple regression analysis to evaluate the effect of oil pipeline leakages and to test our formulated hypothesis

Table 4.1 Effect of Sabotage on GDP

Regression Statistics	
Multiple R	0.04898
R Square	0.0024
Adjusted R Square	-0.3301
Standard Error	2.03679
Observations	5

Source: researcher's summary of regression analysis

Table 4.2 ANOVA for effect of Sabotage on GDP

Sources of Variation	*Df*	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.030	0.030	0.007	0.938
Residual	3	12.446	4.149		
Total	4	12.476			

The result in table 4.1 shows that R^2 is 0.0024 multiplying this by 100% gave a coefficient of determination of 0.24%. This is an indication that 0.24 % of the variation in economic growth was accounted for by sabotage Fisher's $F (1, 3) = 0.007$, $p > 0.05$ shows that sabotage does not significantly predict effect in economic growth.

Table 4.2 shows that $F (1, 3) = 0.007$, $p > 0.05$ based on this result the null hypothesis is accepted. This indicates that sabotage has no significant effect on economic growth in Nigeria. This however shows that there is a significant relationship between sabotage and economic growth in Nigeria.

4.3 Intercepts for sabotage

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	8.073	2.556	3.158	0.051	-0.062	16.208	-0.062	16.208
Sabotage	0.002	0.021	0.085	0.938	-0.064	0.067	-0.064	0.067

The result from Table4. 3 for intercepts and coefficients show that the constant term is 8.073, coefficient for sabotage is 0.002. This shows that irrespective of number of incidences of sabotage, economic growth will be 0.24%. The coefficient of sabotage is 0.002. This implies that for every unit increase in number incidence of sabotage, economic growth will increase by 0.002.

4.4 Effect of Corrosion on GDP

Regression Statistics	
Multiple R	0.24424
R Square	0.05965
Adjusted R Square	-0.2538
Standard Error	1.97748
Observations	5

Source: researcher's summary of regression analysis

Table 4.5 ANOVA for effect of Corrosion on GDP

Sources of Variation	Df	SS	MS	F	Significance F
Regression	1	0.744	0.744	0.190	0.692
Residual	3	11.731	3.910		
Total	4	12.476			

The result in table 4.4 shows that R^2 is 0.05965 multiplying this by 100% gave a coefficient of determination of 5.965%. This is an indication that 5.965 % of the variation in economic growth was accounted for by corrosion Fisher's $F (1, 3) = 0.190$, p >0.05 shows that corrosion does not significantly predict effect in economic growth.

Table 4.5 shows that $F (1, 3) = 0.190$, p >0.05 based on this result the null hypothesis is accepted. This reveals' that corrosion has no significant effect on economic growth in Nigeria. This however shows that there is a significant relationship between corrosion and economic growth in Nigeria.

4.6 Intercepts for corrosion

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	10.106	4.287	2.357	0.100	-3.537	23.749	-3.537	23.749
Corrosion	-0.610	1.398	-0.436	0.692	-5.060	3.840	-5.060	3.840

The result from Table4.6 for intercepts and coefficients show that the constant term is 10.106, coefficient for corrosion is -0.610. This shows that irrespective of number of occurrences of corrosion, economic growth will be 5.965%. The coefficient of corrosion is -0.610. This implies that for every unit increase in number occurrence of corrosion, economic growth will increase by -0.610.

4.7 Effect of Operational Failure on GDP

Regression Statistics	
Multiple R	0.7508
R Square	0.56369
Adjusted R Square	0.41826
Standard Error	1.34699
Observations	5

4.8 ANOVA for Operational Failure

Sources of Variance	Df	SS	MS	F	Significance F
Regression	1	7.032	7.032	3.876	0.144
Residual	3	5.443	1.814		
Total	4	12.476			

International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 06 - Issue 06 || June 2021 || PP. 87-95

The result in table 4.7 shows that R^2 is 0.056369 multiplying this by 100% gave a coefficient of determination of 56.4%. This is an indication that 56.4 % of the variation in economic growth was accounted for by operational failure Fisher's F (1, 3) = 3.876, p >0.05 shows that operational failure does not significantly predict effect in economic growth.

Table 4.8 shows that F (1, 3) = 0.144, p >0.05 based on this result the null hypothesis is accepted. This reveals' that operational failure has no significant effect on economic growth in Nigeria. This however shows that there is a significant relationship between operational failure and economic growth in Nigeria.

4.9 Intercept for operational failure

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	10.794	1.414	7.635	0.005	6.295	15.293	6.295	15.293
Operational Failure	-0.157	0.080	-1.969	0.144	-0.412	0.097	-0.412	0.097

The result from Table4.9 for intercepts and coefficients show that the constant term is 10.794, coefficient for operational failure is -0.157. This shows that irrespective of number of times operational failure occurs, economic growth will be 56.4%. The coefficient of operational failure is -0.157. This implies that for every unit increase in number occurrence of operational failure, economic growth will increase by -0.157

Table 4.10 Combine effects of sabotage, corrosion and operational failure Coefficient of Determination

Regression Statistics	
Multiple R	0.788871
R Square	0.622317
Adjusted R Square	-0.51073
Standard Error	2.170667
Observations	5

Table 4.11 ANOVA for combine effects of sabotage, corrosion and operational failure

Sources of Variance	Df	SS	MS	F	Significance F
Regression	3	7.764	2.588	0.549	0.730
Residual	1	4.712	4.712		
Total	4	12.476			

The result in table 4.10 shows that R^2 is 0.622317 multiplying this by 100% gave a coefficient of determination of 62.2%. This is an indication that 62.2 % of the variation in economic growth was accounted for by the combine effect of sabotage, corrosion and operational failure Fisher's F (3, 1) = 0.549, p >0.05 shows that the combine effect of sabotage, corrosion and operational failure does not significantly effect economic growth.

Table 4.11 shows that F (1, 3) = 0.144, p >0.05 based on this result the null hypothesis is accepted. This reveals' that the combine effect of sabotage, corrosion and operational failure has no significant effect on economic growth in Nigeria. This however shows that there is a significant relationship between sabotage, corrosion, operational failure and economic growth in Nigeria.

Table 4.12 Intercepts for Combine Effects of Sabotage, Corrosion and Operational Failure

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	8.155	7.077	1.152	0.455	-81.762	98.073	-81.762	98.073
Sabotage	0.008	0.026	0.303	0.813	-0.317	0.332	-0.317	0.332
Corrosion	0.764	2.061	0.371	0.774	-25.419	26.947	-25.419	26.947
Operational Failure	-0.192	0.157	-1.217	0.438	-2.192	1.809	-2.192	1.809

The result from Table4.12 for intercepts and coefficients show that the constant term is 8.155, coefficient for sabotage is 0.008, corrosion is 0.764 and operational failure is -0.192. This shows that irrespective of number of times sabotage, corrosion and operational failure occur, economic growth will be 62.2%. The coefficient of their combine effect is 0.53. This implies that for every unit increase in number of occurrence of sabotage, corrosion and operational failure economic growth will increase by 0.53.

Hypothesis Testing
Hypothesis 1: **Oil pipeline sabotage has no significant effect on economic growth in Nigeria.** The ANOVA result shows an F- calculated value of 0.07 and P- value 0.938. The P- value from the result is greater than the 0.05 level of significance. The ANOVA result shows that there is no significant effect of oil pipeline sabotage on economic growth in Nigeria. Based on this analyzed result, the study accepts the null hypothesis and therefore confirms that oil pipeline sabotage have no significant effect on economic growth in Nigeria.

Hypothesis 2: **Oil pipeline corrosion has no significant effect on economic growth in Nigeria**.
The analyzed result on effect of oil pipeline corrosion on economic growth showed an F-calculated value of 0.190 and P- value of 0.692. The P- value from the result is greater than the 0.05 level of significance. The ANOVA result indicates that there is no significant effect of oil pipeline corrosion on economic growth in Nigeria. As revealed by this result, the study therefore accepts the null hypothesis and concludes that there is no significant effect of oil pipeline corrosion on economic growth in Nigeria.

Hypothesis 3: **Oil pipeline operational failure has no significant effect on economic growth in Nigeria**. The result of the data on effect of oil pipeline operational failure on economic growth revealed an F- value of 3.876 and P- value of 0.144. The P- value as shown from the result is greater than the 0.05 level of significance. This therefore indicates that toil pipeline operational failure has no significant effect on economic growth in Nigeria. From this result the study accepts the null hypothesis and concludes that oil pipeline operational failure has no significant effect on economic growth in Nigeria.

5.0 Conclusion and Recommendation
This study was carried out to ascertain the causes of oil pipeline leakages and their effect on economic growth in Nigeria. The analyzed result of the study shows there is oil pipeline leakages caused by sabotage, corrosion and operational failure has no significant effect on economic growth in Nigeria. The study also revealed that there exist a significant relationship between causes of oil pipeline leakages and economic growth in Nigeria. The therefore concludes that oil companies and the government through their agencies should strive to maintain a healthy relationship with their host communities in order to forestall and reduce the incidences of oil pipeline leakages to the bearest minimum. The study further recommends a regular and routine check on the oil pipeline so as to be able t o detect early corroded pipelines.

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