

Modelling the Implications of Oil Pipeline Vandalism on the Nigeria Economy: A Case Study of Niger Delta Region

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Abstract

The purpose of this paper is to establish a management approach that may address the problems caused by oil pipeline vandalism in Nigeria, with a particular emphasis on the Niger-Delta pipeline vandalism. The vast majority of the Nigerian federal government's income come from the Niger-Delta area. However, because of the oil spill from the oil pipeline vandalism and the oil and gas operations of oil companies, this region experiences a variety of deteriorating problems, such as poverty, unemployment, environmental degradation, and lack of infrastructure, displacement of indigenes. This paper aims to critically analyse the various manifestations of oil pipeline vandalism in the Delta region of Nigeria, the potential causes of these oil pipeline vandalism, and the consequences of these oil pipeline vandalism in order to develop a comprehensive understanding of the issue and make recommendations to address the problems identified. The paper used a systems thinking (ST) approach, which is necessary for capturing the involvement of host communities and oil and gas companies in causing oil spillages in the Niger Delta region. The oil pipeline vandalism in the Niger Delta is the result of complex interactions between host communities, oil and gas activities, and the surrounding environments. ST is a qualitative technique that seeks to understand this relationship holistically. In order to convey unbiased insights and understanding of the causes of oil pipeline vandalism as experienced in the Niger Delta, ST enables the application of Causal Loop Diagram (CLD) usage to capture the problem as a whole. The data collected from the literature review were analysed using computerised simulation software as Stella Architect®. Additionally, data were analysed to draw the conclusion that oil pipeline vandalism is a significant cause of oil spills in Niger Delta region, which has resulted in an ongoing rise in oil pipeline incidents, deaths from fire explosions, and negative socio-economic effects. However, the main motivation for oil pipeline vandalism is the need for the inhabitants to survive since the government and oil and gas companies have fallen short of their residents' expectations. Therefore, this paper concluded that there is need for a sustainable management strategy that can handle the issues of

oil pipeline vandalism in the oil-producing region using the Nigeria Niger Delta as a case study.

Keywords: Nigerian Niger Delta, Oil and Gas Management, Oil Producing Region, Oil pipeline Vandalism, Oil pipeline Management, Systems Thinking

1. Introduction

The inhabitants of the Niger Delta entered a new stage of existence after oil crude was discovered in Oloibiri (in present-day Bayelsa state) in 1956. As a result, oil was immediately discovered in other areas of the region, including Isoko and Warri in Delta and Eket in Akwa Ibom state. Following the discovery, the region attracted global investors and the development of the nation's economy. Approximately 2 million barrels per day of Nigeria's total crude oil production are now produced in the Niger Delta. Although the discoveries have significantly improved Nigeria's economy, the Niger Deltas, whose territory the oil is discovered, have not benefited from the production or exploitation of oil [1]. Since the region began bringing revenue into the country, not much has been developed there. The rural areas are still quite underdeveloped and backward. In addition, the little development in some of the places was primarily for the benefit of the companies and was never meant to improve the quality of life for the inhabitants. Shell, Mobil, ELF, and Agip are among the global multinational oil dealers reaping the benefits of these extremely expensive resources.

Due to the vast number of skilled inhabitants who are unemployed and the fact that they are allocated to menial work includes cleaning up spills, it appears that Texaco, Chevron, and their contractors do not recognize the host communities. Furthermore, Environmental impacts pose a threat to people's lives together with their abject poverty and desolation. The area's death rate has risen because of contaminated air, water supplies, and agriculture damage. Additionally, deaths have occurred in fire explosions brought on by oil spills and pipeline leaks. Along with murderous attacks and the murdering of those who are demonstrating against injustices, they experience [2]. Overall, the

emergence of the oil industry in Nigeria has not exactly given the Niger Delta's residents pleasure, happiness, or monetary fulfilment. Instead, it resulted in a severe deterioration of the Niger Delta's ecosystem, which was accompanied by poverty, disaster, and homicide. As a result of this hardship, inhabitants resorted to oil pipeline vandalism as a means of survival. They also impede oil and gas operations, which diminishes government revenue. Therefore, the purpose of this paper is to conduct an in-depth investigation of the effects of oil pipeline vandalism and to propose a management approach to reduce oil pipeline vandalism impacts on the Nigeria economy especially Niger-Delta region.

2. Conceptual Framework

Conceptual Clarifications of Oil Pipeline Vandalism - Vandalism describes as intentional hostile behaviour directed against environmental substances with the intention of causing damage to the property or as a proactive force that resisted capitalist system exploitation [3]. Vandalism may also be brought on by perceived marginalisation, a condition of denial, exclusion from society resources, and socioeconomic backwardness that leaves a person or a group of individuals with little to no control over their life and resources. This might result in groups forming among the resentful people, tension, and emotional outbursts. As a result, marginalised persons who feel devalued in society, will feel inclined to inflict harm to either public or private property. Additionally, disadvantaged communities believe that social practices and policies favour them less when it comes to access to chances for job, leisure, housing, education, and health care. The link between marginalisation and vandalism is strong, and it can lead to societal norms and values breaking down or possibly disappearing altogether. They concluded that youth vandalism is more noticeable in marginalised regions after comparing an examination of marginalised and non-marginalized areas [4]. This shows that those who are marginalised suffer more from social issues, thus the government must consider their condition before encouraging social unrest.

3. The historical Discovery of Oil and the Nigeria Economy

In Nigeria, and particularly in the Niger Delta Region, there is a significant issue with the local environment, as seen in Figure 1. The extraction and processing of crude oil has significantly contaminated the air, water, and land. Accidental oil spills, which seem to happen rather regularly, have interfered with fishing activity. The extensive harm from oil drilling and spills has also influenced

farming activity. The region's woods and freshwaters, which are tainted by crude oil waste



Figure 1. Map of Nigeria and Niger Delta Region [5]

thrown into them and the regular spills, have suffered harm in addition to farmlands [5]. For instance, the Isoko Land narrative is a tale of dissatisfaction. In Isoko (Uzere), oil was discovered in 1956, and commercial drilling there started in 1958. The total capacity of the Uzere oil well was roughly 120,000 barrels per day (6pd). Despite this contribution, Isoko land as part of the Niger Delta Region has experienced destruction for over the years as seen in Figure 2.



Figure 2. Polluted Areas [5]

Due to an oil release, a historical lake in the region known as Eni that formerly produced fish for the locals' diet and served as a source of revenue is now lifeless. Weeds have grown on farmlands and taken the place of food crops. The Ijaw community of Otugwe IK in the state of Bayelsa recounts yet another instance of environmental exploitation.

A 16-inch underground shell pipeline ruptured in June 1998, releasing around 800,000 barrels of oil into the vicinity. The leakage has contaminated the water supply, fishing ponds, and raffia palms, which have been the community's major source of revenue. The residents of the town have been forced to drink contaminated water for more than a year since there is no other option. In spite of the fact that many individuals contracted illnesses that may have been fatal because of the leak, Shell would not be held accountable. Instead, it has claimed that sabotage

was to blame for the leak and has declined to provide any kind of restitution. The principal supply of drinking water, fishing, and the downstream canal system for Eyama-Elleme in Ogoni country has been poisoned [6]. The late 1960s construction of a shell pipeline in the village is to blame for the area's poisoned waters as seen in Figure 3.



Figure 3. Oil Poisoned Waters [6]

The spillage resulted in a fire explosion that left a huge region covered in a several feet thick, rock-hard crust of burnt oil. Shell refused to accept responsibility for the incident, which allowed crude oil to run into the neighbouring stream and groundwater without being contained. It has been ineffective to drill wells to provide water, as some privately drilled wells had to be abandoned due to the presence of extremely high levels of contamination. In November 1998, a fire tragedy brought on by a pipeline break in the Nigerian National Petroleum Corporation (NNDC) engulfed nearly the whole Jesse village in the state of Edo, killing dozens of people and injuring hundreds more.

The Nigerian government, which controls a majority of the company, refuses to accept responsibility for the pipeline spill. A claim of sabotage and threats to arrest persons (even among the victims) thought to be the saboteurs was the people's experience [7]. As a result, victims of the inferno did not receive the necessary recompense or relief.

The Niger Delta's residents' primary work activity is fishing. The occupation of pipeline vandalism is a further facet of economic activity in the Niger Delta. The tactics used by vandals vary and encompass almost every piece of basic equipment required for damaging oil pipelines and fishing techniques. They have resources and mechanised fishing techniques, yet pipeline vandalism in the Niger Delta as a result of poverty evokes memories of colonialism and imperialism. The group that engages in fishing and oil pipeline vandalism is quite aware about the methods used to destroy the pipeline, the number of pipes that can be taped, and the amount of fish that can be stored each day. Just an explanation of the issue of poverty and how it affects communities in the Niger Delta.

4. Nigeria's Geographic Distribution of Pipelines

Agriculture used to be Nigeria's main source of income for a long time, and naturally, the majority of farm products are shipped by road or rail. The pipeline transport system was created as a result of the discovery of the natural resource crude oil, which gave rise to additional reasons to plan for the transportation of crude oils. Gases, liquids, or semi-liquid products like crude oil are transported throughout the nation via pipeline transport systems through tunnels or tubes [8].

A pipeline is a highly specialised kind of transportation that encompasses all aspects of a transportation system, including the physical layout, travel direction, and, of course, the destination [8]. This pipeline transport system's network spans the whole nation's territory, allowing for the movement of crude oil from the refinery to the point where it will be utilised as a raw material or exported to other nations [8]. Due to the valuable natural resources it delivers, pipelines are buried roughly 1 to 1.5 metres below the surface to prevent interaction with other uses of the land or potential harm. Because the pipeline system is effectively regulated and covered, underground, human pests are motivated to vandalise the pipes in order to spread the natural resources. The pipeline network system for the Nigerian National Petroleum Corporation (NNPC) included networks of pipes that are connected to 21 white product depots and tanks around the country [9]. Most pipeline transport systems get their names from a particular project; examples are Escravos-Lagos Pipeline System (ELP), Offshore Gas Gathering System (OGGS), and Trans-Nigeria Pipeline. To maintain a consistent supply of crude oil to all required locations across the nation, more pipelines are being built every day [8]. In Nigeria, there are around 5001 kilometers of pipelines. Figure 4 shows a visual depiction of the pipeline network in Nigeria. This comprises 4,315 kilometers of pipelines carrying various goods and 666 kilometers of pipes carrying crude oil.

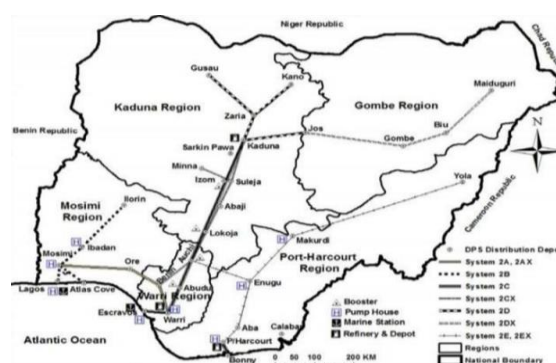


Figure 4. Pipeline Network in Nigeria [8]

The 22 oil storage facilities, the four refineries (in Port Harcourt I and II, Kaduna, and Warri), the offshore terminals (in Bonny and Escravos), and the jetties (in Atlas Cove, Calabar, Okirika, and Warri) are all connected by these pipelines, which run the length of the nation [9]. This 719-kilometer-long network of oil pipes is used to move crude oil to the refineries at Port-Harcourt (I and II), Warri, and Kaduna. Multi-product pipelines are used to transfer refined goods from refineries and import receiving jetties to oil storage depots all around the nation.

5. Pipeline Failures in Nigeria

Failure of a pipeline does not always indicate that the professionals, company, or material used was of inferior quality or unskilled. The pipeline's failure might have been brought on by a number of additional factors, including soil movements, environmental overuse, coating disintegration, outside damage, and third-party harm [10]. The root reasons of pipeline failures include environmental failure, material properties, and stress. There will always be property damage, environmental impact, including injuries or even fatalities, loss of life, and product leakage whenever a pipeline malfunctions. The same substance may contaminate water bodies, making it more harmful for aquatic life, other wildlife, and potential uses to which the water body may be applied. The same scenario may result in financial loss due to the depletion of natural gas and oil because of pipeline collapse. The economic and human cost because of severe pipeline events during a 20-year period (from 1996 to 2015) was estimated by a statistical study conducted in the United States to be \$7 billion, with 324 fatalities and 1,333 injuries, respectively [11]. With the present pipeline infrastructure in operation, the Nigerian petroleum sector confronts a number of difficulties. The Niger Delta area suffers the most because of these difficulties since some of them involve instances of vandalism and violence. Furthermore, vandalism seems to be re-emerging in these areas despite the fact that militant actions have been severely restricted since the amnesty programme was implemented in 2009 [11]. In the previous ten years, 16,083 pipeline fractures and leaks have been documented, with 398 of those complaints being the consequence of ruptures. The vandals' actions, which had a serious impact on Nigeria's economy and environment and ultimately resulted in the loss of lives and property, are what led to the remaining cases that were documented [12]. The key categories depicted in Figure 5 classify the failure types that may most likely result from the previously mentioned circumstances.

In addition to the four elements, Figure 5 demonstrates very clearly that a premeditated act by a person or group of people is always intended to

cause a significant amount of loss since it is typically well planned or organised.

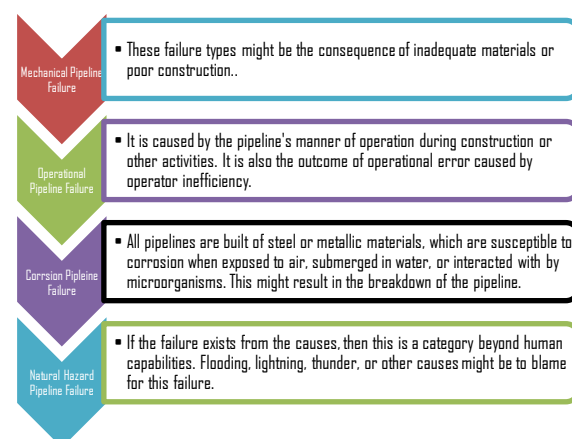


Figure 5. Pipeline Failure Classification in Nigeria [12]

Additionally, the breakdown of each of the aforementioned failures is as follows: Mechanical – 25%, Operational – 7%, Corrosion – 30%, Natural Hazard – 4%, Third Party – 33%, and Others – 1%. The oil pipelines that have been vandalised are the third party.

6. Pipeline Vandalization in The Nigeria Niger Delta

Pipeline vandalism is a significant problem that has led to explosions at the location where people in oil communities congregate to remove gasoline from damaged pipelines. The Historical Factors that cause vandalism might be linked to the overall sense of resentment that exists among the populace because the area has generated enormous amounts of money since 1956. Nigeria, for instance, does not profit from the Niger Delta while being the world's seventh-largest petroleum exporter and the fifth-largest supplier of crude oil to the United States [13]. As a result of the region's underdevelopment, poverty, environmental destruction, and inadequate infrastructure, the residents of this region view oil more as a curse than a blessing. Furthermore, Figure 6 shows that the three primary causes of pipeline vandalism in Nigeria are corrosion (50%) and sabotage (29%) as well as oil production activities (21%) and sabotage. Corrosion is one of the primary causes of pipeline vandalism, according to the report. The next step is vandalism (sabotage), which is driven on by unemployment and poverty. This explains why the economic motivation has made it impossible for the practise of bursting pipelines to decrease while the number of participants continues to rise.

Furthermore, figures given by the special committees on petroleum distribution reveal an

alarming rise over the previous years. The pipeline

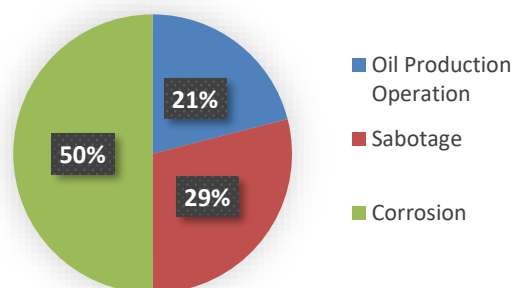


Figure 6. Major Causes of Pipeline in Nigeria [14]

and product marketing organisation noted cases of rupture and vandalism throughout the year in Nigeria, particularly in the Niger Delta area. Death toll reaches pipeline victim at Adeje, close to Warri, Delta state, and further victims were found in surrounding bushes after being engulfed by the blaze. The 12-inch pipeline carrying fuel from Warri to the country's north was purportedly vandalised while the inhabitants were scooping petroleum out of it [14]. Vandals returned to the ruptured pipeline of the Nigerian National Petroleum Corporation (NNPC) at the Warri fire catastrophe, which claimed many lives, scooping fuel that caused a fire to break out as though they were intended to exterminate every person in the surrounding communities. Anyone detected sabotaging oil pipelines would be arrested on the spot, according to a presidential directive. Because of the alarming magnitude of the damage to our pipeline, which is without a doubt our biggest issue, the NNPC was compelled to dispatch police and notify the president. As a result of these illicit or unlawful operations such as black market or illegal bunkering as seen in Figure 7, revenue has been lost to the economy and people have died. For instance, repairing each broken pipe costs the NNPC between N1.2 million and N1.6 million.



Figure 7. Black Market Activities [14]

In addition, the ongoing oil pipeline vandalism in the Niger-Delta is costing the Nigerian Federal

Government revenue [13]. This reduction in revenue has a detrimental effect on the economy and the host communities' capacity to deploy capital. Over the years, the government has struggled to address this issue since the economy of Nigeria suffers damages proportional to the number of million barrels of oil that are vandalised. There is growing disagreement about who is to blame for the enormous oil and gas spill between host communities and oil and gas companies in the region. For instance, the oil spillage incidents in the Nigerian Niger Delta are shown in Figure 8, where oil pipeline vandalism causes 80% more spills than operational errors of oil and gas companies. This demonstrates that oil pipeline vandalism is the primary cause of most oil spills.

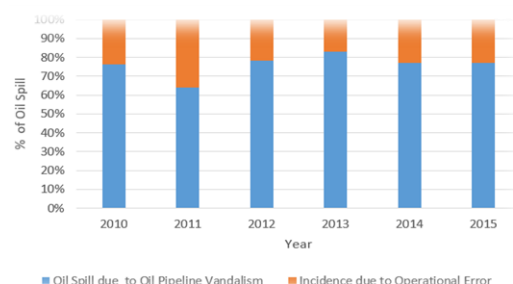


Figure 8. Causes of Oil Spill Incidences in Nigeria Niger Delta [17]

The frequent incidents of oil pipeline vandalism in the Niger Delta have led many people to wonder if the pipeline network is actually functioning. As an illustration, the Federal Government established 3.5 metres of right of way (ROW) on either side of the pipeline, and such pipeline are buried extremely deeply to prevent accidents, incidents, and vandalism. Despite all of the efforts and precautions, the integrity and safety of the pipeline had been compromised since it had been vandalised while being used for either commercial or personal purposes [14]. Figure 9 depicts the frequency and contributing factors of oil spillages between 2014 and 2019. Compared to the other three, it appears

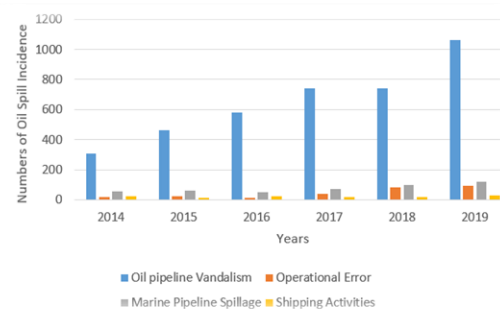


Figure 9. Oil Spillage Incidence Data (2014-2019) [17]

that oil spills caused by oil pipeline vandalism had the biggest volume. This proves conclusively that the bulk of oil spills in the oil-producing region are caused by oil pipeline vandalism.

7. Manifestation of Vandalisation in Nigeria

The pipes were built in the Niger Delta to transport oil to Kaduna in the far north of Nigeria, which is where the risks of the oil and gas pipelines in the Niger Delta lie. Since then, pipelines that crisscross the whole region have confined the Niger Delta. There are several pipes that are outdated and in need of maintenance [15]. Militants who act out of self-interest and disregard any potential environmental destruction have also trashed them. In Nigeria, the following are the main causes of the increasing rate of pipeline vandalism:

- i. The widespread occurrence of poverty and unemployment.
- ii. The advent of bandits who incite vandalism.
- iii. A defective security equipment.
- iv. MNOCs' and the federal government's official negligence.
- v. The framework's weakness.

Explosions at oil pipelines seldom kill vandals. Instead, when a pipeline breaks, those who are poorest are the ones that travel to retrieve petroleum that has spilled. The poorest people in Nigeria live in the highest area, which is where the pipelines are, making them particularly vulnerable to pipeline explosions. Additionally, they are the group in the area with the highest percentage of displaced people. Actually, in official analyses of pipeline explosions caused by vandalism, this fundamental socioeconomic reality is frequently overlooked. The manifestation was discussed in terms of its effects on public health and opposition to the community in Nigeria achieving the millennium development objective [16]. They contend that mechanical failure, operational mistake, interference coming from external parties, and sabotage can all result in oil spills, as seen in Figure 6. Despite efforts to control it, oil pollution is one issue for which no effective and long-lasting solution has yet been found anywhere, including Nigeria. The militant groups urge local communities to combat the issue because pipeline vandalism must be stopped in order to rebuild the nation's severely damaged economy. The extent to which this group will damage oil pipelines and promote criminal activity and bloodshed is unknown. The social interest, which was previously used to challenge the coercive actions of the MNOCs and the federal government, was subordinated to the

commercial interest. After the tragedy caused by vandalism in Nigeria, particularly in the Niger Delta Region, the confluence of economic and social factors led to the displacement of a large demographic. The manifestations of oil pipeline vandalism in the Nigeria Niger Delta have resulted to massive losses of lives of the citizens through oil pipeline explosion and fire outbreak from the siphoning of pipeline.

Table 1. Pipeline Vandalism Explosion Death tolls in the Niger-Delta (2010-2015) Adapted from [15]

S/No	Date	Location	State	Death Loss
1	May, 2010	Sapele	Delta	33
2	July, 2010	Jesse	Delta	250
3	July, 2012	Okogbe	Rivers	200
4	October, 2012	Aba	Abia	15
5	April, 2013	Edo	Edo	36
6	June, 2013	Atlas Cove	Lagos	28
7	June, 2015	Onitsha	Anambra	69
8	Dec, 2015	Nnewi	Anambra	100
	Total			731

The Table 1 shows that there were 731 deaths in the Niger Delta between 2010 and 2015. Due to the oil pipeline explosions and fire outbreaks caused by pipeline vandalism, clearly demonstrating the severe harm that pipeline vandalism has caused.

8. The Consequence of Oil Vandalisation in Nigeria

The water is severely contaminated by personal sewage, industrial effluents, waste, etc. The prevalence of water-borne diseases including typhoid, cholera, bacillary, dysentery, river blindness, and guinea worm infection is primarily attributable to water pollution in the area. Offshore oil drilling has contributed to water pollution in the area, including the extinction of aquatic flora and animals and the contamination of water bodies [18]. Alarmingly, the Niger Delta's waterways have become contaminated by the discharge of crude oil or petroleum products. Furthermore, Poor farming practises in the Niger Delta have deteriorated the soil due to the over-exploitation of the oil. Urban waste is carelessly disposed of and industrial waste from oil exploration is dumped. The Niger Delta's terrain has undergone changes due to pollution driven on by oil spillage from petroleum extraction, which are detrimental to living organisms [16]. A spill of this magnitude damages human wealth as well as crops, farms, plants, and wildlife. This includes waste management, urbanisation, unsustainable domestic practises, unsustainable agricultural practises such as fish farming, malnutrition and disease, freshwater

shortages, habitation and ecological system loss, and insecurity. It also encompasses pollution driven on by industry, oil, and gas, as well as freshwater pollution, air pollution, chemical pollution, soil pollution, and degradation of the land. Because of this vandalism-related pollution, rare species extinction, the depletion of wildlife, fisheries, and biological diversity, hunger, rural and urban poverty fuelled by food shortages, insecurity, and genetic loss, as well as floods, coastal erosion, sedimentation, and circumstances leading to land subsidence, are all possible outcomes [14]. The Conflicts within communities have been triggered by issues with population health, noise pollution, local environmental issues, and a lack of community engagement. The host communities and operational companies are having problems. Inadequate environmental laws and regulations, food contamination, and threatened and endangered biodiversity are the consequences of this. These significant social, environmental, and geopolitical issues are rated. The consequences of Niger Delta environmental issues, including as poverty, food security, fisheries, and hydro biological ecosystems, go beyond local significance and national relevance to fulfil internal criteria. A primary emphasis of development and agricultural economics, as well as the preservation of bio-diversity in marine/coastal environments, is that it directs incidence to the human and industrial aspects of sustainable development [17].

In addition, oil pipeline vandalism has several reasons, including unemployment, which drives some people to engage in illegal activity such as oil pipeline vandalism in order to survive financially. Most of the unemployed people who committed these vandalisms are highly educated and have technological knowledge, but because they are unemployed, they have chosen to engage in other illegal acts in order to exist [9] as seen in Figure. 10.



Figure 10. Merged of Militancy for survival [6]

Moreover, the Niger-Delta region's persistent pipeline vandalism is a result of the antagonistic relationship between the local communities and the multinational oil industry present there. There was

mutual trust when the oil industry first began operating in the Niger Delta's host communities, but at the time, the industry was unable to fulfil its duties (poor infrastructure, high unemployment, and extreme poverty) to those areas [13]. The oil and gas companies have an unfriendly relationship with host communities as a result of this lack of expectations. Therefore, the purpose of this paper is to make possible recommendations on how to manage the various impacts of oil pipeline vandalism on the host communities of the oil-producing region of the Nigeria Niger Delta.

9. Methods

The paper intended to model the implications of oil pipeline vandalism on the Nigeria economy using Niger Delta Region as a case reference. The study adopts the Systems Thinking Methodology (STM) proposed by Forrester [19] and Olaniyi [20]. The mono method is adopted in this study due to the complexity of the phenomena, which examines the various situation of oil pipeline vandalism caused by the host communities in Niger Delta regions where oil was first found. The exploratory methods will be use to provide a thorough understanding of the problem as it associate with the oil spillage and gas flaring from the oil and gas operations. In this study, a holistic approach as systems thinking (ST) used to capture the various interconnections of dynamic systems within complex situations.

To understand how different variables interact, ST aim to map out their multiple points of interconnectivity of phenomena. ST is a qualitative approach that makes use of the individual's mental model to capture various interactive behaviour while looking at a complex problem. In order to inductively develop the CLD (casual loop diagram) of the systems interactions, data will be collected from journal articles, online archives, reference books on issues related to oil and gas activities, and host communities of the oil-producing region in Nigeria. Casual Loop Diagram is a Systems tool used to illustrate a feedback loop in an explicit diagram (As shown in Figure 11). This illustrates how several behaviours, such as underdevelopment, a shortage of food, environmental degradation, inadequate infrastructure, and others, contribute to the causes of oil pipeline vandalism in Nigeria. A closed system with several variables and causation is called a loop.

The causal loop diagram provides a high-level approach of conceptualising models based on their feedback loop structure of presentation of expression of the causation relationships between different variables. A feedback loop, which can be either balancing (negative) or reinforcing (positive), is the fundamental building component of all systems [19]. It is design that the loops are reinforcing if it has an even number of positive (-) and balancing if it has an

odd number of negative (-). There are six steps of STM as indicate in Figure 11 adopted by [19] to provide a clear understanding of a system structure are problem definition, system structure conceptualization, mode formulation, model stimulation, policy analysis and model results and finally, policy formulation and implementation.

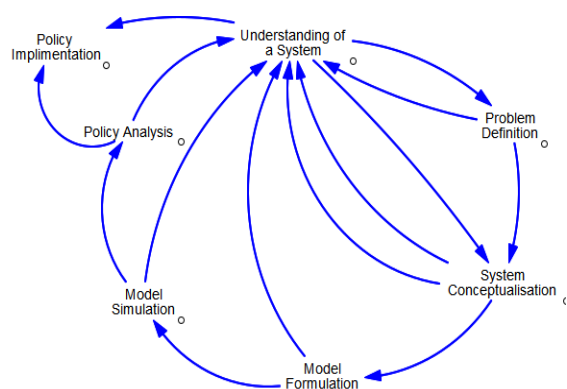


Figure 11. The Phases of Systems Thinking and System Dynamics [20]

Using the STELLA STM software to analyse the dataset, a model was developed to illustrate the various implications of how the host communities and the oil and gas industries contributed to oil pipeline vandalism in Nigeria Niger Delta. The Utilising of the ST approach as a framework is justified by the fact that it captures the system from a holistic point of view as opposed to the more conventional static point of view.

10. Discussions And Analysis Of Issues of Oil Pipeline Vandalism in Nigeria Niger Delta

The casual Loop diagram (CLD) above shows a high-level map of the subsystems that will be discussed, including oil and gas operations (B1) and oil pipeline vandalism (R3). The aim of this paper is to develop an analytical model for understanding the various impacts of oil pipeline vandalism induced by oil and gas activities in Nigeria, particularly in the Niger Delta Region. The interpretation of the oil and gas loop (B1) explains how oil and gas operations have the potential to contribute to oil pipeline vandalism through overexploitation, accidental discharge, operational error, noncompliance, inadequate machinery usage, etc., all of which have a negative impact on the environment and cause conflicts. However, the oil and gas activities have assisted the government meet its revenue expectations by generating economic development for the Nigerian economy. Figure 12 illustrates the connection between B1 showing that when oil and gas operations increase, government expectations

rise as well, which causes an increase in over-exploitation of natural resources in an effort to boost revenues.

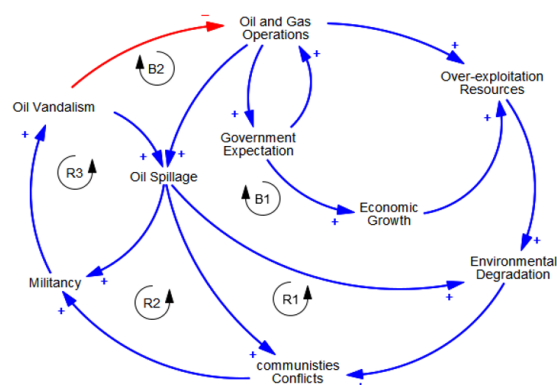


Figure 12. High Level Map of Causal Loop Diagram of Oil Pipeline Vandalism in Nigeria Niger Delta

An increase in overexploitation will cause environmental degradation, which will exacerbate socioeconomic issues such as poverty, unemployment, health problems, and a lack of infrastructure. This will also cause grievance militant groups to emerge, which will lead to an increase in oil pipeline vandalism and a decrease in oil and gas activities. The interpretation of the oil pipeline vandalism Loop (R3) also explains why the host communities are involved in oil pipeline vandalism because of the significant underdevelopment in the oil-producing region, including the absence of good roads, hospitals, ongoing relocation, etc. Figure 12 illustrates the feedback loop between community disputes and oil pipeline vandalism, showing how an increase in oil spillage will result in more oil pipeline vandalism, which will further cause severe environmental damage and community conflicts.

Due to the ongoing environmental degradation, uncontrolled oil and gas extraction and high government expectations may accelerate the rate at which militancy emerges, leading to a rise in legal activities including oil bunkering and pipeline vandalism. Deeper understanding is required to fully appreciate the dynamism and complexity that these interactions create. Despite the fact that the modules for oil and gas operations and oil pipeline vandalism are separate sub-systems. It is clear that the oil and gas industry as well as the federal government must address the unintended consequences of militancy, spillages, over-exploitation, health issues, and host community conflicts in order to reduce oil pipeline vandalism and conflicts. This is because oil and gas activities are the root cause of oil pipeline vandalism (an unlawful act). Evidence suggests that vandals continue to carry out their actions with little resistance despite the involvement of security organisation's such as the Nigeria Security and Civil

Defense Corps (NSDC), the special military, the joint task force (JTF), and the police. The pipeline vandalism hinders the operations of Nigerian oil and gas companies, resulting in low production capacity and, as a result, a drop in revenue generation. This leads to a budget deficit, which has a detrimental impact on the economy of the nation. The consequences of the government's emphasis on maximising the exploitation of natural resources for rapid economic growth, with little regard for resource conservation and sustainability, as well as the ongoing lack of adequate maintenance of pipes, mechanical breakdowns, and operational error, were also acknowledged to be contributing factors to the Nigerian oil and gas pipeline disaster. These complications, which are also depicted in Figure 12, need to be addressed.

11. Recommendation

The recommendations made to assist the stakeholders in preventing losses due to oil pipeline vandalism in Nigeria based on the study discussed. Given that the environmental consequences of these catastrophes are quite severe, it recommends that all impacted areas immediately clean up any oil spills. Additionally, improvements in the delivery of adequate infrastructure, including as a road network, hospitals, electricity, and portable water supplies, as well as a decrease in land degradation, will put a stop to militancy and maintain long-lasting peace in the region with less compensation. Additionally, proper administration and transparency for the training of military members should be encouraged. Possibly, if the relevant stakeholders, including the government, consider the recommendations of this research study and execute with the utmost sincerity, there would be a large decrease in the costs associated with maintaining crude oil pipelines. Furthermore, regarding the awareness level, more effort is required to promote engagement, and the citizens' awareness level together with the increasing responsibility of the stakeholders would help the problem's agility and effectiveness. Improved local accountability working with stakeholders' collaboration will pave the road for system excellence in the early stages. Building a community in Nigeria that is capable of surviving a pipeline accident must be the main objective. This paper also calls for a better tracking system, public-private participation in pipeline monitoring, rigorous enforcement of right policies and other standards, and raising awareness of the disastrous consequences of pipeline accidents, that go undetected. Additionally, researchers recommend Nigeria and other developing nations to enhance their insurance policies and post-disaster recovery procedures.

Finally, a comprehensive public education effort should be launched in these regions to educate residents of the implications of pipeline vandalism. It

is an unlawful conduct, and the extent of the devastation to both human health and the environment surpasses any potential financial rewards. Additionally, efforts made to offer the youth's employment opportunities, infrastructure amenities including vocational training institutes, and the essential economic empowerment resources for self-actualization should be strongly encouraged.

12. Contributions to Knowledge

The paper extends three additional insight to the body of knowledge. Primarily, the paper contributed to understanding the implications of oil pipeline vandalism on commercial activities in Nigeria. The study also identifies specific to Nigerian circumstances including militancy, underdevelopment, poverty, environmental degradation, inadequate infrastructure, and vandalism as the main issues influencing the country's economy. The finding provides decision-makers and planners knowledge on the occurrence, environmental consequences, and hazard of oil pipeline vandalism in Nigeria, as well as rehabilitation and maintenance to mitigate it.

13. Conclusion

African countries are developing quickly economically, especially in the oil and gas sector, but this prosperity has come at a price to the environment and society. These effects have now been more apparently felt compared to Nigeria's oil- and gas-producing regions, where years of neglect and poor management have led to pipeline tragedies. According to the study's findings, pipeline accidents are primarily caused by vandalism, which is concluded to be the major contributing factor. Additionally, the absence of regional security to maintain surveillance on the pipes was shown to be a role in many pipeline explosions since the majority of pipelines are not adequately guarded, making them prone to pipeline vandalism. The Nigerian pipeline tragedy was also seen to be influenced by poor maintenance of the pipes, joints, and valves, mechanical failure, and operational error. According to the analysis, the militant groups are engaging in severe economic sabotage, and if left unchecked, their actions would continue to have a disastrous impact on the nation's economy. The activities of the vandals undoubtedly lead to instability, enormous losses in oil revenue, a decline in the production of power, widespread damage to pipeline infrastructure, and environmental pollution, all of which have a detrimental effect on investment possibilities and company profitability. The impact of vandalism on company operations is that it causes a shortage of fuel, which leads to an increase in the price of fuel on the black market. It also creates an unstable

business environment and frequent power outages, which halt many business operations and slow down the country's economic development, which has an impact on the citizens of Nigeria's standard of living.

The unlawful activity of pipeline vandalism has hindered the delivery of oil and gas products, which has strained relationships between host communities and the oil and gas companies. The environment in the oil-producing region has been impacted by this. This study calls for a thorough study of the consequences of pipeline vandalism in order to make recommendations on how to address the various effects of pipeline vandalism on the host communities in the oil-producing region of the Nigerian Niger Delta.

14. Future Work

It is crucial to be aware of the limitations of this study, which will have an impact on any further research. This includes a dearth of information (only secondary sources were used) and certain under examined perspectives, such as the viewpoint of indigenous people. The study's conclusions suggest tackling the issue of oil pipeline vandalism from all perspectives is relevant.

15. References

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