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Oil and Gas Distribution Control Force: Technology Operations and Management

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Abstract:

Oil and gas distribution in Nigeria relies on transportation. It has cause a certain degree of environmental impacts. Natural gas and oil can be used actively as a supplementary energy all over the world, is a certain trend in the future . The concepts of safety, risk and environmental management are currently receiving considerable attention in the global petroleum industry, due to operational accidents, incidents with devastating consequences to living organisms e.g. Human,plant and animals safety and environment. The effect of vandalization of pipeline and its effects on ecological system, loss of revenue, damage to the land and Agricultural problem, impacts of oil spills along the coast, oil spillage is categorized in four groups, minor, medium, major and disaster. Oil pipeline act 1956, Amended Act1965. The 2010, Deepwater Horizon accident involving BP in the Gulf of Mexico . The industry have been supplying the energy demands of mankind. The challenge face by the petroleum industry is striking a balance between the critical need for supply energy with safe and sustainable operations. Nigerian economy heavily dependence on the petroleumindustry. The industry accounts for over 95% of export earning and over 90% of government revenue. The poor safety and environmental management within the industry has been attributed to poor technical infrastructures accidents and vandalism. The federal Environmental Protection Agency(FEPA) which was recently made part of the ministry of the environmental is legally vested with the responsibility of protecting and sustaining the Nigerian environment through formulation and implementation of regulatory frameworks. The concepts of safety, risk and environmental management are currently receiving considerable attention in the global petroleum industry due to the potential of operational accidents / incidents with devastating consequences to human safety and the environment . The challenge faced by global petroleum industry is striking a balance between the critical need for distribution, supply of energy with safe and sustainable operation. The research uses both primary and secondary data, using interview in qualitative research. The research use appropriate statistical techniques, descriptive statistics for summarizing or describing numerical data like tables and calculating the percentage to describe characteristic of a sample distribution and interdiction of oil and gas distribution The risk management should consist of collection of technical and social tactics, to leverages on potential solutions that partnership with all stakeholders, local communities, to recognize the benefit of the pipeline and be involved in local surveillance.

Keyword: **Oil products, distribution, looses, stakeholders, impact control and management**.

INTRODUCTION

The global classification of oil and gas industry operations consist of two streams of operations , upstream and downstream, the upstream operations includes; exploration;evaluationandappraisals;development; production and transportation of crude oil and untreated gas (Charles 1999). The downstream operations are crude oil refining, transportation, distribution and product retailing. All of these activities can potentially cause harm to human safety and the environment. Research attention tends to focus more on accidents emanating from the upstream petroleum industry operations in Nigeria (Zabbwey 2009 ; Kadafa et al. 2012) and focusses more on environmental pollution occurring during exploration and production of oil and accidental or deliberate crude spillage. This is due to subsector and involvement of big multinational companies. Safety and risk management research within the downstream context has often been neglected and till date, no satisfactory, generally accepted risk management framework has been developed for measuring assessing interpreting and mitigating safety and environmental risks from accidents in the operation within the downstream sector of the Nigeria oil and gas industry. Oil and gas distribution include transportation of crude oil from the production sites to refineries as well as transportation and distribution of the products to the customers. Oil tankers serve the majority of the international trade of crude oil and oil products

while pipeline are mostly used for domestic transportation. Rail and trucks are also used for shore- distance distribution, Larger tankers usually carry crude oil while smaller tankers carry refined petroleum products. Oil tankers are mainly equipped with diesel propulsion. As for pipeline transportation, crude oil is usually piped to refineries and oil products to large customers and distributors. The energy required for pipeline transportation depends on volumes, pipeline diameter and oil quality. Oil can be stored in land tankers and on- board oil tankers for either energy security and profit purposes, or based on shore-term variations of the oil price.When accidents occur within downstream operations, they lead to major economic losses and serious safety and environmental consequences.

Theorganization of petroleum exporting countries (OPEC) resolutions (1960 and 1971) ushered a significant change in the ownership structure of the entire petroleum industry in Nigeria. In 1971, the government established the Nigerian National oil corporation (NNPC) now Nigerian National Petroleum corporation (NNPC) by decree No. 33, currently there are 4 refineries in the country, one each in Kaduna, Warri and Two in Port Harcourt with a nameplate capacity of 438,750 billion b/per day. The refineries routinely perform below their capacities due to poor management and maintenance policies.The Nigerian government is a key participant (both regulation and commercial operations) in downstream operations including petroleum product transportation and distribution (Akinlo 2012). The downstream operation activities are characterized by :- (a) complete and exclusive domination of the supply chain structure of the downstream sector by government via the NNPC through ownership of all the existing refineries, distribution pipelines, depots and oil import jetties. There are 6 major marketers (Oando Nig. Plc., Mobil oil Nig. Plc., Total Nig. Plc,. Forte oil Nig. Plc. MRS Nig. Plc., and Conoil Plc., in Nigeria control a 25.47% share of the fuels retail market, over 3800 independent marketers control 51% of the fuels retail market, while the NNPC controls 23.43% of the retail market.

Scarcity of petroleum products leads to long queues at service stations all over the country. This has fueled poor safety practices and high level of environmental pollution as people take extreme measure, including illegal activities to supply or obtain products. Quantity (volume) and distance are key elements to determine the most suitable and profitable transportation technology for natural gas. For large volumes pipeline transport is profitable for shore to medium distances and liquefied natural gas several competing technologies including electricity production and compressed natural gas suitable for small volumes. The LNG technology includes natural gas liquefaction, shipping by fleets and regasification of natural gas at the receiving terminals, which is then delivered onshore by pipeline and distribution network. Oil and gas distribution in Nigeria mainly relies on pipeline and its effects on ecological system loss of revenue

, damage to the land and agricultural, problem impacts of oil spills along the Nigerian coast.

Risk management Frame work.

The absence of a risk management framework within the Nigerian downstream petroleum operations has contribution to deficiency in guidelines for setting and achieving safety and environmental management goals that should incorporate a balance of technical information and stakeholder input. The challenges faced in Nigeria in the quest to harmonize the conflict between safety and the environment with petroleum operations through the concept of sustainable development Emeseh 2006). Especially in pursuit of modern management, this is one of the reasons, the downstreamoperations are characterized by poor safety and environmental standards, e.g. Refinery under performance results in fuel scarcity in Nigeria. (Bazilian and Onyeji 2012) , fuel scarcity contributes topetroleum elevated accident risks in the country owing to such factors as the prevalence of adulterated petroleum products in the " Black- Market " during periods of scarcity, sabotage and siphoning of products from NNPC facilities for sales in black market, illegal refining, unsafe storage and transportation of petroleum products by consumers and importation of substandard refined products into the nation. Potential development and Barriers: Oil and gas are dominant components of the present energy system and are expected to remain so for decades. The future development t of oil and gas distribution depend on oil and gas market expansion, energy security and international trade issues, It expansion is only considered for energy security purposes, e.g. Emerging economies such as China and India are quickly expanding their oil and gas infrastructure to meet their growth energy. The impact of future climate policies and the recent focus on reducing green house gas (GHG) emission. Pipeline and Truck systems are the main mode of petroleum product transportation and distribution due to lack of efficient and collapse of rail and inland waterway, transportation infrastructure. Globallyand in Nigeria many pipeline system transmission carrying liquid petroleum products are not on secureindustrial sites but are routed across the land:- remote locations, busy city or network of highways. The hindering

potential for the third party to interfere with the integrity of the pipeline is available in man.In advanced nations pipeline infrastructure presents are most effective, safe, and environmentally over long distances this is not the case in Nigeria. Pipeline vandalism has been likedto catastrophic disasters, this give reasons for high road haulage operations for petroleum distribution products.

About 95 % of total petroleum product volume transported by road is done using truck tankers of about 33,000liter capacity. More than 5500 tankers are involved in the daily product cargo haulageand1500 trailers in dry cargo haulage on poorly maintained Nigerian roads (FRSC 2011). The rampant occurrence of accidents, vandalism and related fire disasters are products of transportation and distribution through pipeline and road –trucking characteristic.

The capacity of oil pipelines varies widely:- The Norwegian Nor pipe export pipeline has capacity of 9000,000 barrels per day (*b/d) while the Novorossiysk pipeline has a capacity of 100,000 b/d. The oil flow with typical speed of 1 to 6 m/s is ensured by pump station located along the pipeline. Many of the current onshore pipeline are made of (70 grade steel) material and work at an operating pressure under 75bar. Using higher grade streel (X80 and X100) enable higher operating pressures and the transportation of higher volumes of gas with reduced pumping energy.

SAMPLE OF VANDALIZATION / ACCIDENT PETROLEUM PIPELINE

The safety and environmental impact of pipeline and road- truck operations are critical concern,therefore require the attention are critical concern therefore require the attention of risk professionals. Injuries , contamination of the environment and loss of investment all depend on the controls of physical processes , the lack of control within these operations increases safety and environmental vulnerability. The is need to define novel means of mitigating the risk associated with these operation by balancing technical processes with human involvement for a holistic management of risk.

MATERIAL AND METHODS:-

TECHNICAL AND HUMAN INVOLUMENT IN RISK MANAGEMENT:-

The improved technical and human involvement in risk management is especially important for the Nigerian context due to the operational usage and characteristics of stake holders and legislations within the downstream sector:- many safety and environmental regulatory failures in Nigeria are largely attributed to weakness and looseness of the legislation and the related government unwillingness to the enforce laws, deferring priority within the tiers of government. The absence of technical / technology knowhow skilled manpower and law literacy rate. The stakeholders face with the enormous complexity of these limitations and the critical task of ensuring that petroleum supply chain operations remain functional for optimization of supply of the products.

In American pipeline routes:- The oil pipelines are the most efficient method of transporting oil. There pipeline routes bare very intricate and widespread . The pipelines are designed to take oil all over the country that they inhibit. America is the best example of these pipeline routes because America has the longest cumulative mileage of pipeline in the world. The routes that these pipeline travel are able to be extremely direct because the quickest way from one point to another is by traveling in a straight line. Pipelines do not disrupt their surroundings allowing them to be built in the most direct routes possible. The fact that oil travels quickly through the pipelines and their ability to directly provide consumer areas with the needed amount is making pipeline more and more popular in the United State.

Pipeline Risk Management Operations

The risk associated with the pipeline and operation risk mitigation strategies, the realities of managing problems , safety and security. Some elements of existing research have pointed out the safety and environmental problems associated to distribution, operation of pipeline and the activities of saboteurs in Nigeria, (Anifowose et al 2012, and Omodanisi et al 2014), a quantitative analysis of the spatiotemporal pattern of pipeline

interdiction was defined as the deliberate or intentional act of destruction on a system such as trans port pipeline (Anifowose et la 2012) was performed to understand the shareholder, claim and actions with the complex web of causes of interdiction of petroleum distribution in Nigeria. From an environmental management view, (Omodanisi et al 2014) combined data from digital and social surveys laboratory readings and spatial information in a geographical information system to investigate the effect of pipeline explosion which happened in December 2006 at a rural community in Lagos, Nigeria. It was recorded that inadequate security or poor monitoring of the pipeline and sabotage from certain "greedy " people as the causes of pipelineexplosion. This raised the significant questions about the efficiency of the current pipeline protection system , and law enforcement in Nigeria. It also raised questions regarding the lack of framework for risk reduction and disaster management. The above research are instrumental in shaping the contextual understanding of risk factors that may be encountered while assessing the pipeline , the likely contribution that risk management offers in managing these issues has not been explored, Using the technical capabilities that pipeline risk assessment models such as (De Stefani et al 2009) to generate risk mitigation options. These are damaging the environment and even cause human losses. These accidents are damaging the reputation of companies which usually have to do deal with extra costs of oil recovery and compensations. Sometimes terrorists could target pipeline. In these occasion safety problems are caused by criminal activity of some group of people and not by random failures. Offshore and onshore pipelines are sometimes hazardous. The fact that humanity has encountered many problems caused either by failure of the equipment or by criminal and in some cases by political Activity. In some cases , the potential victims are also the people working in these facilities, the surrounding area and the company exploiting the entire facility There is a significant difference between supply fuels to a specific area and to the entire country, in terms of relying on the pipeline. The pipeline has the property of

constant flow which means that consumers are depending on this kindof energy supply, in contrast with tankers kind of flexibility relate to product delivering.The damages, explosions, sabotages or even closed values after the decision of operators of the pipelines reflect to the energy reliability of dependent consumers. Safety issues associated with these means of transport are very important for owners, contactors, transporters, stakeholders and obviously the environment. The legislation and standards governing the transportation of oil and gas products has evolved in a similar way to other areas of the oil and gas industry and most importantly, lessons have been learnt from unfortunate accidents / disasters. Pipelines through which about 40% of worlds oil flows are less vulnerable, they are the most efficient method to transport oil, and refined products. A simple explosive device would puncture the line and make it useless. They are very long pipes and as a result, this make it difficult to protect. This makes pipeline potential targets for terrorists.

New Model Risk Management Framework for Downstream Product Distribution.

To develop a risk management framework for the oil downstream product distribution, it needs acomplete integration of regulatory requirement and stakeholders interest, which may form part of the National Policy proposition for the distribution operation system. This are :-

a. The existing oil risk assessment methods and technics :- pipeline accident is defined by Roed –Larsen , et al (2004) as unplanned pipeline failure event which occur suddenly and causes injury, Fatality or loss leading to decrease in material value and environmental quality, and increase in liability, Citro and Gagliardi, (2012). Hazards from oil operations are due to the possibility of loss of containment (LOC) with risks of fire and explosion in addition to environmental damage. Pipeline risk should be fully assessed in order to develop appropriate mitigation measure. To develop mitigation measures involve understanding two elements of safe operation of pipeline

"the risk posed by oil products" and the pipeline failure or accident / incident causal factors.

b. Element of risk Assessment involves:- (i) Analyzing failure likelihood or frequencies and failure consequences quantitatively and qualitatively with charactering risk value by comparing it with established limits to define the acceptability of risk poses by the pipeline. (ii) The need to understand element pipeline failure or accident / incident causal factors as a model . There are variety of different system in used for conducting oil risk assessment . It may combines either qualitative or quantitative approach to develop a suitable operation methodology. The three methodology are:- Point – Scoring (uses qualitative approaches), Ranking and Quantified (uses qualitative approaches). At the point – Scoring System.

   In 2011, Kalatpoor et al, stated in their research that one of the common point scoring methods in pipeline risk assessment in the Kent's method is Relative Risk Rating (RRR) it was used as a final measure for estimating the risk level of the selected pipeline it between two separate lines or within various sections in a line.

   Ken Muhlbaver (2002) defined Related Risk Rating (RRR) as:-

   RRR = (Index Sum) :- (leak impact factor)

   Index Sum = Third Party + corrosion + Design + incorrect operation.

   Leak impact factor = product Hazard (PH x leak Volume (LV) x Dispersion (D) x Receptor (R)

c. Ranking System :- This is quite simple and flexible approach and mostly qualitative in nature. It Identify hazards for pipeline and also rank the probability of failure for each hazard typically as high , medium or low. It also qualitatively ranked the failure from each hazards for the products.

d. Quantified risk assessment:- It uses the process of calculating absolute risk levels based on computation of failure frequencyand consequence. These uses predicated fire models, oil-dispersion models , loss- models and offers consistent risk level comparison for different failure modes and

benefits of risk mitigation via which failure reduction can be quantified, using the information of pipeline geometry and population density of geographic information system (GIS). It found that based on the regulatory acceptable criteria for pipeline risk, individual risk at the minimum proximity of the oil pipeline to occupied buildings is approximately proportional to the square root of the operating pressure of the pipeline, while quantified risk assessment are mostly modelled to suit certain oil pipeline context.

DEVELOPING AN OIL DISTRIBUTION RISK ASSESSMENT MODEL AND USES OFDATA.

The method used for analysis of distribution risk is draws from techniques risk assessment models which combined both quantitative and qualitative approaches to obtain result that overcome limitation in data requirement for risk assessment of transportation of long pipeline distribution. These are as follows:- (i) Collection of data to establish general pipeline distribution methods, which involve document related to the construction, operation, shipment and maintenance of the pipeline operators (PPMC). This made it possible to record operating parameters:- Pipeline diameter, wall thickness, length, design flow rate, steel grade design pressure, depth of cover and catholic corrosion. (2) Condition of Right of way :- Inspection was conducted on a section of the in Mosimi area of Ogun State (pipeline way) for data on the condition of right of way. The chosenarea for Inspection accounts for about 70% of the services gateway for oil product importation. (2B- along the Atlas-CoveMosimi).

Interview with operators, communities and security; The use of cross content thematic analysis method described was to established oil / pipeline accident / incident. The result of the interview was combined with the results from pipeline risk assessment and Right of way (ROW) inspection to establish structured technical understanding of pipeline risks, human technical operations, organizational failure causes, stakeholder interests and the existing emergency system (EES). The out come are:- Failure in pipeline can occur due to a range of potential threats , which

maybe Time-depend ant e. g. i, Failure of a high pressure pipeline can occur as a leak or rupture. ii, Third party interference and incorrect operation, iii, Ground movement and iv, External / internal corrosion and material fatigue or time independent.

Leaks are defined as fluid loss through a stable defect while ruptures are fluid loss through an unstable defect which extends during failures, that the release area is normally equivalent to two open ends. Mahlbauer (2004) stated on accident scenario using empirical formulas to calculate frequencies from historic data and illustrate the result on event tree. Consequence analysis :- involved assessing the effects of accidents in order to determine the severity of pipeline failure; It includes ignition frequencies; fatality; volume –loses; financial loses and

environmental damage.

Risk Estimation: - There are many risk among this are Individual risk (IR) and

Social risk (SR)

which are used to describe risk. (Ma et al 2013) defined IR at a specified location of individual

risk value (X, Y) as: -

$$\mathbf{IR(X, Y) = \Sigma_i \ \Sigma_Q \int_{1-}^{1+} Fi.Pci\,(X, Y)DL.}$$

The subscript **i** donates the accident event, $\mathbf{F_i}$ is the failure frequency per unit length of the

pipeline associated with the accident event **i**, **L** the pipeline length, $\mathbf{P_{ci}}$the probability of casualty

associated with the accident event **i** and **1±** represent the ends of the interacting section of the

pipeline in which an accident pose hazard to the specified location **(X, Y)** as shown in figure below:-

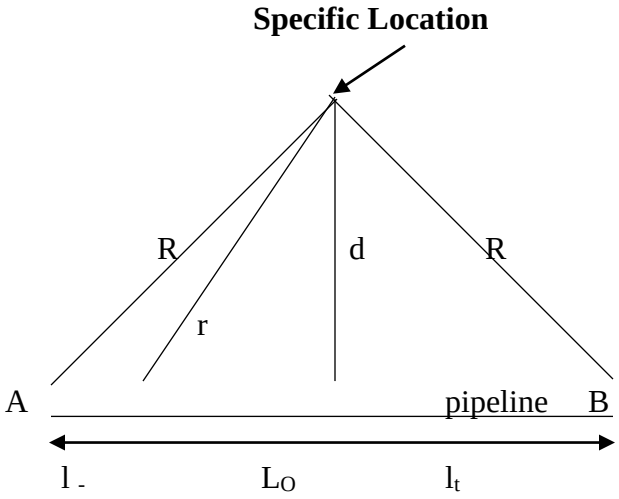


Figure 1. Individual Risk Geometric Model

Interdiction or sabotage of pipeline will usually occur at a point within the interactive risk geometry of the pipeline maybe based on either delay ignition or immediate ignition period, the resultant consequence will vary.

Figure 1 above shows the pipeline within each distribution region, the length of the lines, number of reported failures for periods. As the failure analysis revealed interdiction and sabotage as the major failure incident causal factor, there is need to explore and understand the reason interdiction is recorded as the major causal factor.

Failure Causal Factors: - (a) Failure due to interdiction is defined as the deliberate or intentional act of destruction on a system such as transport pipeline (Church et al, 2004; Anifowose et al 2011). This failure classification is believed to be a combination of failure from third party damage **(FTPD)** Failure of Third Damage and **(FIN)** Failure of Interdiction.

DIFFERENT TECHNIQUE USED BY PIPELINE INTERDCTORS

Interdiction can be an act of sabotage on thepipeline using explosives or other inferno starting

techniques. This is mostly used as a means of protest or registering dissatisfaction with

the operator or the government. Another form of interdiction involves illegal hot tapping into the pipelines to steal products for personal gains. Hot tapping technically refers to authorized installation of connections to pipelines while they remain in service. It is frequently used in pipeline engineering to repair areas that have undergone mechanical damage or corrosion or to add branches for system modifications. It is also referred to as line tapping pressure tapping pressure cutting and side cutting. The most common techniques used is the use of hacksaw or manual drill or sharp ended metal bar to cut or drill orpuncture the line.

This is used by interdictor who will dig the ground cover of the pipelines and a large hole used in containing LOC. They will puncture, cut or drill into the line andallow the product to leak out, then mechanical pump is used to pump the product into trucks other means of transportation. A more sophist card used by organized criminals is a combination of difference mechanical hottapping systems. The figure used by this class of interdictors includes a tapping drilling machine, boring bar branch fitting and valves. The drilling machine used typically consists of a mechanically driven telescoping boring bar that

controls a cutting tools, the cutting tool is used to bore a hole into the pipeline wall in order to centrde a hole saw that cuts out a section of pipeline wall. Connection to the pipe is then made within a fitting ,which can be a simple welded nipple for small connection to a larger pipeline. Suitable valves such as ball or gate valve is then used to control the flow of products into trucks or other means of transportation. This type of interdiction is usually not a one- off attempt to syphoned products. Based on the operator's assertion, the interdictors will steal from the system, close the valves and cover their tracks, and come back to the spot to steal again. The hazard and risks associated with illegal hot tapping are enormous:- (a) Where welds are used for drilling, burn –through can occur when the under melted area beneath the weld pool is not strong enough to contain the internal pressure of the pipe. (b) The risk of ignition from heat (during or cutting) or naked flame in hydrocarbon charged atmosphere. Illegal hot tapping also have vast environmental impacts as interdictor car less about spills and clean-up.

Effect of Age of Pipeline on failure frequency.

Pipeline systems are classified into two according to the year of installation. To determine the effect ofaging on failure frequency, relevant failure frequencies associatedwith their age classification was extracted. It was noticed that there was a noticeable difference between failures from interdiction andsabotage across the two age categories, that the high valve of interdiction frequency is influenced by an outlier.The reason for this high hit rate may be due to the explanation offered above. As expected, failure due to rupture increased with pipeline age. This suggests that stringent integrity based inspection and maintenance schedule needs to be put in place if the pipeline category is to continue running as it has outlived its designed lifespan of 25 years.

RESULTS AND DISCUSSION:-

Result of Finding:-

It consists of determination of the consequences of particular physical effects in hazard zones and the impact on receptors (human and environment). A hazard zone is the region in which physical effects of the hazard exceeds critical threshold values and induces negative (Dziubinski et , al 2006). The results intensity depend on many factors including , ignition frequency, the proximity of receptors (human and environment elements) the properties and volume of released substance, process conditions and the way of release. As a result of deliberate arson after scooping fuel, unintentional fire as a result of illegal hot tapping or bomb attack. Most of the sources of fire from mechanical faults are not clearly reported, an incident was attributed to sudden rupture. Another sparks from electric overhead cables, bush burning for hunting purpose and construction activities were mostly the source of fire from third party damage.

Precarious conditions are also generated from these latent condition such that small active failure results in high accident due to inappropriate response and spill clean –up strategies. A likely link between peoples safety behavior and their quest to fulfil the five basic needs :- Safety, Social, Physiological, esteem and self – actualization as suggested by Maslow's theory (King, 2009). These needs can

create internal pressures that can influence a person's behavior. The need for attaining human physiological needs required for survival such as food, and shelter may influence people living in poverty prone communities to engage in pipeline sabotage. (ii) The lack of interface with host communities suggests that individuals lack knowledge on the risk and hazards associated with the pipeline , which results in unbalance risk perception. (iii) The host communities feel that their safetyis compromised by the presence of the pipeline asset and this hierarchical need must to be addressed by the PPMC which must encourage the development and education on safety and risk, without action, any satisfactory organizational approach to people's management or safety management is notpossible. (iv) Risk knowledge alone will not be the ultimate solution because when people perceive that their safety is compromised by the risk at hand, risk communication will not be possible until the need is satisfied (Branstrom, 2010).

The Different Factors Impact And Justification Finding

From our finding there has been a decrease of 65% in Nigeria , from year 2012, Pipeline generally have a better safety record , (injuries, death , fines / explosions) than other modes of transportation. A general view of how the system works is when an emerging threat for safety of these pipelines appears that they pass through specific areas where there are political instability or high poverty percentage. These always causes distribution interruption and environmental impacts, e.g. like the Abule – Egba pipeline in Lagos State, Nigeria on 26 /12 /2006, with hundreds of casualties. Wasinmi in Ogun State and the recent current one in Abule – Ado in Ojo area of Lagos. There are not many measures that could be taken in order to avoid similar situations because of the huge area that needs to be covered for the pipeline protection. A low cost solution could be the placing of security cameras, An Helicopter monitoring guard around the critical locations to act as a deterrent. The introduction of valves at certain spacing which will limit the amount of oil that is discharge out when an explosion happens

to the environment and minimized damages to environmental system.

Table 1. Monthly Petroleum Products Distribution ('000 liters), 2005

Products	January	February	March	April	May	June	July	August	September	October	November	December	Total
PMS	1,248,258.82	1,235,276.19	1,337,359.76	1,343,467.76	1,331,002.38	1,363,705.14	1,350,716.24	1,268,772.29	1,223,985.19	1,420,682.02	1,266,753.50	1,504,462.06	15,894,471.33
ATK	56,810.74	32,807.37	35,893.58	32,224.44	31,638.82	31,067.36	31,856.09	45,297.67	34,349.26	36,128.41	26,563.70	32,807.88	427,445.31
HHK	216,521.66	232,002.78	214,392.85	233,346.86	224,417.92	170,517.55	187,245.52	238,548.04	220,314.66	272,360.99	198,385.56	255,565.10	2,663,619.49
AGO	216,639.88	210,044.,28	225,992.70	257,483.39	245,033.91	202,338.67	264,590.17	234,810.29	233,507.55	278,594.98	224,785.12	234,935.85	2,830,756.79
TOTAL	1,736,231.10	1,710,130.62	1,813,638.88	1,866,622.45	1,832,093.03	1,767,628.72	1,834,408.02	1,787,428.29	1,714,156.66	2,007,766.39	1,916,407.87	2,027,800.89	21,816,292.92

Table 1 showing Monthly Petroleum Products Transportation 2015

Technically, safety issues related to the transportation of oil and gas should be taken care of during the design and installation stage by recommended code and standard like ASME, API, DNV and ISO. Although they all have different safety factor with DNV codes been the most stringent. The code and standards usually address arising from occasional load, operational load, Thermal expansion load e.t.c. and road / railway crossing . The safety issues that arise during transportation and distribution

of oil and gas are mainly due to human factors, which could be negligence of maintenance, personnel, terrorist attack, activities of non engineering professional around an oil and gas facility. Not all the pipeline are completely burred to the ground and the buried ones are near residential buildings that on several occasions leaks and cause contamination to drinking water is the nearby water wells, this claim a number of life.

Table 2. 10 – Year Average Daily Petroleum Products Distribution ('000 liters)

Year / Product	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PMS	22,758.56	24,273.43	23,551.05	17,406.90	17,406.90	15,584.79	13,746.67	43,546.50	47,709.80	48,711.91
HHK	2,538.06	1,466.02	2,534.04	1,987.17	1,831.64	2,407.69	1,728.65	7,297.59	7,901.70	5,724.94
AGO	4,519.86	3,857.43	3,857.43	3,273.91	2,409.23	2,679.16	1,854.05	8,619.63	7,755.50	8,903.19

Sources:- NNPC 2015 Annual Statically Bulletin. www.nnpcgroup.com

The oil and gas is in the presence of the highly volatile organic material. Some proportion of oil and gas will inevitably volatilize into the atmosphere to cause destruction and pollution to the environment . If a large number of evaporation happen, it will make the air flammable, which is easy to cause explosion. Therefore it is necessary to reduce the dump stations. There are three main causes of corrosion in pipeline:- (a) The pipeline's environment, because the pipeline are buried in the soil for a long time, the soil resistivity, moisture content, PH, and sulfide could be the reasons, choosing appropriate anti-corrosion materials and conducting a comprehensive test are vital . (b) Anti-corrosion measures, increasing the corrosion protective layers and cathode protection are two common methods. (c) Stress levels has been proved that when the material level of stress beyond its limits, the stress, the material will rupture. (d) Inappropriate production operation is

another reason of corrosion. Normally hydrocarbons will be dewatered to be a certain level before transportation, but if the operation is incorrect, which makes water transported with hydrocarbons in pipeline this could cause corrosion. (e) Effective protection for pipeline and oil tank is essential, especially for onshore pipeline. (f) In some region, oil theft action happens frequently, which has huge impact for pipeline safety,

Therefore building pipeline walking regulation is vital for operators. In view of the flammability oil and gas storage sites should be selected on the down wind direction in the high population density region, Oil tank construction should consider the impact of earthquake.

Table 3.Petroleum Products Distribution by NNPC Retail Ltd. ('000 liters) 2015. (per month)

Products	January	February	March	April	May	June	July	August	September	October	November	December	Total
PMS	140,331.77	132,980.52	143,703.40	119,277.96	93,162.42	122,455.63	120,838.99	138,390.51	101,021.00	141,111.49	164,044.46	149,640.03	1,567568.17
HHK	11,128.53	14,350.42	10,304.17	2,377.61	5,734.33	4,599.86	942.79	12,540.41	8,248.43	248.22	4,314.53	183.90	74,983.20
AGO	5,078.91	5,553.76	6,281.03	5,026.78	4,385.41	1,884.46	2,564.74	2,292.09	1,830.74	2,748.14	2,278.15	1,767.03	41,691.25
TOTAL	150,539.20	152,384.70	160,288.60	126,682.35	103,882.16	128,939.95	124,346.52	153,223.01	11,110.17	144,107.85	170,637.15	151,590.97	1,684,232.63

Table 3 showing NNPC Retail in month for 12 months of 2015.

Having established how various faults within the complex socio- technical system of oil distribution / transportation operation interact and results in pipeline failure, the reasons why such failure usually record high consequences can further be explored. Review of regulatory framework to show the mandatory responsibility vested on the Nigerian government to protect it citizens

and the environment from all oil and gas transportation activities / operations.

The legal power given to DPR and NOSDRA should form the backbone of their regulatory operations. The empirical evidence revealed that key limiting factors responsible for their inability to attain this mandate is the current misalignment of the country oil company. (NNPC - PPMC) as an integral part of the federal Ministry of petroleum resources with DPR (the Regulator). The parties involved need to consider the negative safety and environmental impact of the current system, change their commitment levels and build appropriate systems that will clearly define risk management responsibilities and accountabilities in both technical and administrative operation of the pipeline integrity and safety management systems.

There are still issues regarding poor funding and the effectiveness of national regulatory coverage, by collaborating with states, local government authorities. The authorities can also be involved in regulating third party activities such as construction and farming along the pipeline right of way (ROW). The logistical operation can be provided by the PPMC in a collaborative manner and under the supervision of DPR. This will allow DPR to focus on regulating more on technical aspect of the pipeline such as the requirements for in line with inspection and monitoring of corrosion defects which will solve the issue related to resource availability.

Table 4 Domestic Refining fuel and Loss statistic

Product	K R P C		P H R C		WRPC		TOTAL	
	Quantity (mt)	% Wt. of Production	Quantity (mt)	% Wt. of Production	Quantity (mt)	% Wt. of Production	Quantity (mt)	% Wt. of Production
GAS	2,383	4.00	10,430	3.03	3,252	1.29	16,065	1.49
LPG	4,838	8.12	1,500	-	538	0.12	6,876	0.64
AGO	2,542	2.03	9,680	9.72	1,717	0.98	13,939	1.29
Coke Burnt	327	-	5670	1.33	1.853	0.12	7,850	0.73
R/Fuel	75,284	146.04	64,446	32.55	27,621	7.10	167,35	15.49

							1	
Gas/LPS Flared	2,987	5.05	10,481	5.18	1,196	0.69	14,664	3.32
Losses	1,396	2.53	29,304	12.37	5,189	2.37	35,889	3.32
R/Fuel & Loss	79,667	153.62	104,231	50.09	34,006	10.17	217,904	20.17

Sources:- NNPC '2015' Annual Statistical Bulletin. www.nnpcgroup.com

Table 5, 4 YEAR PIPELINE CRUDE OIL LOSS 2012 - 2015

Crude Type	2012		2013		2014		2015	
	Quantity (bbl)	Value (₦ million)	Quantity (bbl)	Value (₦ million)	Quantity (bbl)	Value (₦ million)	Quantity (bbl)	Value (₦ million)
Boning Light	908,730	15,660.02	865,482	14,598.08	17,964	204.37	-	-
Escraves Light	2,058,184	35,468.40	1,408,081.	23,750.10	586.776	8,635.67	290,006	2987.39
URALS	-	-	25,706	433.58	-	-	-	-
Ughelli Blend	852,078	14,683.74	12,490	210.67	341,566	5,026.87	-	-
Seplat	-	-	-	-	62,499	919.80	-	-
Total	13,818,992	65,812.16	2,311,759	38,992.43	1,008,805	14,846.71	290,06	2,987.39

Table 5 shows the Oil loss in 4 years 2012 - 2015

Community Engagement

The research on the interdiction on the pipeline revealed how the pipeline industry is affected by socio-political and socio – economic issues . This issues should be an integral part of oil distribution risk management strategies. Detailed of environmental and social impact assessment should be conducted across the operation network, and should have been carried out before the ROW construction of the pipeline . The socio – environmental problems associated with oil distribution/ pipeline failure are obvious concerns to potential spills on land and pipeline rivers crossing locations . Other issue such as atmospheric pollution from incidents of fire effects on soil fertility and crop yield,odor,

noise, waste and economic activitiesshould be addressed.

Table 6, 10 - Year of Fire Outbreak Incidences 2006 - 2015

AREA	NUMBER OF CASES									
	23006	2007	2008	2009	2010	2011	2012	2013	2014	2015
P H	30	8	4	-	-	1	1	5	1	3
Warri	1	2	4	-	-	12	6	10	13	5
Mosimi	-	4	6	-	-	7	16	3	12	11
Kaduna	8	3	8	4	-	1	10	16	6	6
Gombe	-	1	3	-	-	4	1	-	-	-
TOTAL	39	18	25	5	-	25	34	34	32	25

Table 6 showing number of cases of fire outbreak incidents 2006 - 2015

Table 7 10 Year Pipeline Product Loss

Year	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
Area	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)	P L (‘000 liters)	V L (₦ million)
P H	336.23	21,885	95.62	151.15	12,239	-	-	-	-	-	-	-	5.39	684	223	24446	7.46	958.72	11.57	1528.31
Warri	16.00	1,552	-	-	23.36	1,589	-	-	45.93	2,674.41	14.37	1,434	-	-	16.86	1,785.00	14.29	2,311.75	-	-
Mosimi	183.40	13,709	141.52	10,634	12.88	6.81	160.38	110.38	8.95	3796.70	127.39	9,903	163.22	18958	268.76	31,364.06	332.85	8,279.14	471.24	4975376
Kaduna	-	-	5.10	2.73	5.13	3.5	-	-	3.99	380.00	16.06	1.189	13.06	1842	39.62	5,487.81	1.08	200.39	-	-
Gombe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	535.62	36,646	242.23	17,240	191.62	14,594	110,38	8,198	194.42	6,848.11	157.81	12,526	181.6	21,484	327.48	38,881.38	355.69	44,747.96	482.81	51,282.07

Community management action at this level should be facilitated by providing the legislative support the form of regulations and standards to ensure that community actions are legitimate and also facilitate access to resources to ensure that community actions are legitimate and also facilitate access to resources to fund the additional responsibility vested in them. The community and local authority actions should promote education, public awareness and training at the community level, by focusing on incremental infrastructure up grading as a means of winning over the confidence of the people and motivating the development of group- oriented activities. It is much needed considering the fact that the research find out that some people have little or no understanding of the risks involved in handling oil distribution products.

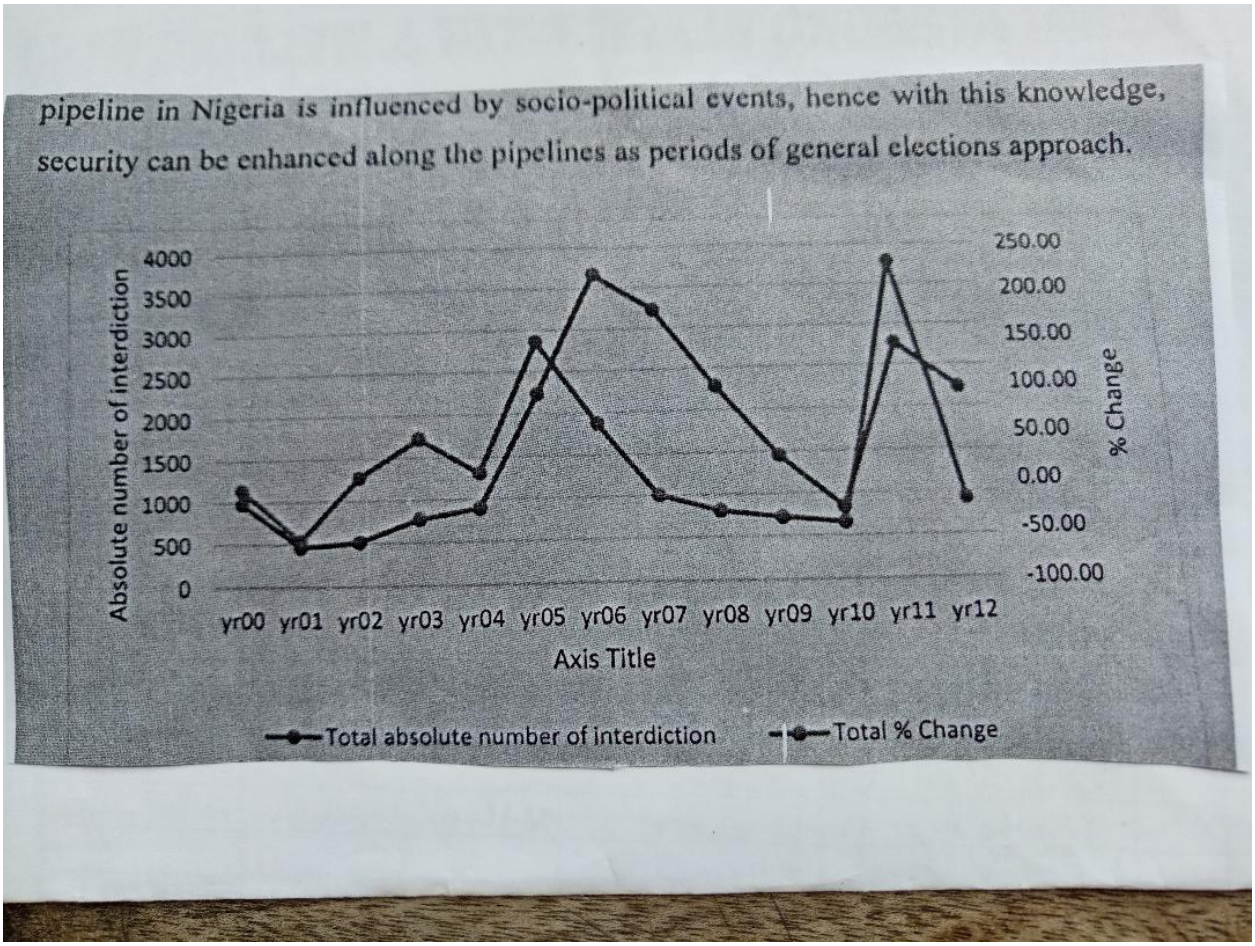
Since it is in their best interest to do so as the problem from the pipeline failure affects their sources of livelihood. This is a reason for increased violence by vandals and thieves is outside their purview by the operation of law. Evidence shows that the widespread cases of vandalism on the pipeline portrays the government's lack of capacity to effect implementation of a strict policing policy. As stakeholders with interest in the safe operation of pipeline, community involvement will prove effective. Further research should explore and integrate the risk management strategies in the study with the security context of the pipeline surroundings, geographical, socio-technical system with rings defined and constructed according to security sensitivity of the pipelines, Rings-of- protection should translate into a number of measures, such that is combines physical security equipment people and procedures in order to offer the best chance of adequate asset protection against theft, sabotage and terrorism

Table 8. 10 Year Pipeline Incidences

Year Area	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015	
	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture	Vandalization	Rapture
Port Harcourt 5 years	2,091	-	1,631	7	557	-	382	-	142	-	336	-	393	-	616	24	269	-	917	4
Warri 5 years	662	-	306	-	745	-	280	-	161	-	548	-	495	-	315	2	378	-	236	18
Mosimi 5 years	480	6	459	20	516	14	605	4	184	7	463	5	479	2	1,078	2	1,071	6	1,114	-
Kaduna 5 years	176	-	126	-	110	19	100	23	240	15	571	14	622	24	634`	33	657	26	445	27
Gombe 5 years	265	3	702	-	357	-	86	-	109	2	850	-	241	-	862	4	1,325	-	71	-
Total	3,674	9	3,224	20	2285	33	1,453	27	836	24	2,768	19	2230	26	3505	65	3700	34	2783	49

Identifying the pipeline host communities as a stakeholder will give the people the needed locus to take action for warding off interdictors and vandals from the pipelines. Royalty payment must be appropriate in addition as a means of Motivation. Interview with community leaders shows that they are ready to participate in the management of the pipeline. Public awareness and risk communication of pipeline operation is vital to the continued safe operation of pipeline, public awareness programmes are required to establish close communication between the operator and the communities, for provision of information with respect to the hazards associated with petroleum products.

The impact of pipeline Interdiction and security effect during general elections. Number of interdictions



Collaboration with local authorities, community leaders to decide on the content and frequencies of risk communication. The need for different audience within the various communities. Communicationshould be flexible, and should neither be treated as a bolt – on extra, nor approached solely in the context of one-way provision of public information. This should aimed at:- (a) Ensuring preservation of Right Of Way (ROW). (b) Building trust and better relationship with the public, communities. (c)Enhancing public safety and security (d) pipeline safety and environmental performance and (e) Ensure emergency response coordination. Risk Communication needs to recognize the inter- Organisational risk , communication within the framework to involve cascading risk management policies and regulatory directives to NNPC - PPMC for community based engagement with people to ensure people participate in their own decision about risk. Both inter and intra – organisation at all level should be in line with the following principles. Effective communication in the framework needs to acknowledge current issues and problems, this should be open in their content and approach, and timely.Using pipeline engineering professional or technology to ensure integrity.

RE COMMENDATIONS AND CONCLUSIONS

Risk management policy directions which are relevant to stakeholders within the developed frame work need to be deploy to ensure effective risk management within the context of pipeline and truck tanker operations.The regulatory and operational interests of stakeholders organisations should also informed the policy recommendations .The frame work should be developed via consistency, transparency and flexibility in communication. However interview with stakeholders revealed that the challenge is not the lack of money but the absence of political will to access and allocate resources effectively and the lack of knowledge of the existence of funds. The involvement of government as both regulator and operator remains a potential area of conflict within the policy

propositions. The petroleum industry should work closely with government agencies, Universities and research centers to combat the menace of oil pipeline vandalization. More funds should be provided by all the stakeholders in the oil and gas industry for further research in the development and transportation / distribution of oil products in the country. The Federal Government , State government, and other non- government agencies should ensure that the social amenities and needed infrastructures are provided for the oil rich communities. Using pipeline engineering technology to enhance integrity, for surveillance methods products such as C C T V , barrier (e.g. Fences) motion detectors etc, should have a role in detecting the activities of interdictors and vandals. The use of Acoustic-leak-detection technology can be used. Another system known as Negative pressure wave have quick response time and accurate leak detection capabilities (in the range of meters) .The Acoustic or sonic methodology is based on identification of hydraulic transients created by a n pipeline wall rapture at the leak onset. Special transducers (sensors) are positioned at both ends of the monitored section to capture the transient signals. The sensors track the dynamic pressure signals and convert them into electrical signal that are read and analyzed by dedicated electronics running sophisticated detection and filtering algorithm for proper leak- pattern recognition. Other systems such as the mass balance, rate of change method, pressure point analysis, pressure deviation etc. can be effective in leak detection. For the purpose of pipeline inspection, online inspections system should be designed and implemented.

CONCLUSION

The risk associated with the downstream petroleum product distribution pipeline has been assessed and some strategies for risk management proposed. The research shows that interdiction and third party interference are major causes of failure to the pipelines, which is over 96% of pipeline failure.The ignition frequencies, fatality and product losses from the Nigerian pipeline are found to be high.The values of individual risk for the pipelines to fall outside tolerable limits. Fatalities from pipelines failure ranges from 0.04 to 0.38 per Km per year, depending on the region of operations in Nigeria. On

averages operators of the pipeline system loses about $100million per year due to these failures. The risk management strategies consist of collection of technical and social tactics which leverages onthe potential solutions that partnership with all stakeholders offers, local communities to determine the issues and problems and gain intelligence. The finding shows that pipeline vandalization and it impact on human environment and investment has being largely affected. The risk associated with the petroleum product distribution pipeline has been assessed and some strategies for risk management proposed. The assessment clearly shows that interdiction and third party interference are the major causes of failure to the pipeline , accounting for 95% of pipeline failure which may be attributed to socio- political events in the country.

The ignition frequencies, fatality and product losses from the Nigerian pipelines are found to be high. This made the values of individual risk for the pipeline to fall outside tolerable limits.

Based on the finding of risk assessment, interview analysis and ROW inspection, an analysis of the complex socio- technical pipeline operating and regulatory systems was conducted and a risk management framework proposed, which focus on interdiction being the predominant pipeline incident / accident causal factor. The risk management strategies consist of a collection of technical and social tactics . This has to leverages on the potential solutions that partnership with all stake-holders offers, particularly local communities to determine the issues and problems and gain "Intelligence " by conducting an ESIA. Framework recommends PPMC to work with local communities to recognize the benefit of the pipelines. Engage the host communities and involve them in local surveillance.

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