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Research Article

RISK ANALYSIS IN DISTRIBUTION OF PETROLEUM PRODUCTS IN SOUTHWEST, NIGERIA

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ABSTRACT

The study investigates the risks in distribution of petroleum products and effective management of the risks in southwest Nigeria. Forty eight (48) questionnaires were distributed to the staff of NNPC/PPMC depots in Ondo, Ogun and Oyo states. Simple random sampling technique was used to distribute the questionnaires to the respondents. The questionnaires were analyzed using descriptive statistical analyses and the ratings of the risk severity were done using reliability important indices. The risks from vandalization was rated highest when pipelines are used while the risk of accident was rated highest when roads are used for the distribution of petroleum products. Also, administrative control measure was ascertained as the most effective measure of managing risk in the distribution of petroleum products. The study finally suggested that government and stakeholders in the oil industry should revitalize the rail transport for distribution of petroleum products which is less prone to risk.

Keywords: risk analysis; risk management; petroleum products; roads; pipelines.

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1. INTRODUCTION

1.1. Background to the Study

According to Christopher and Adepoju [1] petroleum distribution involves varieties of complex infrastructures and processes whose mainstream begins with the exploration of crude oil and finalizes with the delivery of petroleum products to consumers. The duo reported further that petroleum industry has for several years made a major impact on global, national, and local economies. Hussain [2] identified that highly inflexible logistics network is one of the challenges of petroleum distribution from the production capabilities of crude oil suppliers, long transportation time, to the limitations of modes of transportation. Meanwhile, Enyinda *et al* [3] ascertained that one major problem associated with the petroleum industry is the high level of uncertainty/risk from exploration, production, to tight transportation, and supply/delivery process because this sector is highly automated and optimized, so disruptions can rapidly escalate to an industry- wide or nationwide crisis.

Alaba and Agbalajobi [4] study revealed that the domestic management of petroleum resources is fraught with a number of problems which include occasional product shortages, inefficient product distribution and contending pump price of petrol. Consequently, Omofonmwan and Odia [5] established that these problems are compounded by ethnic and civil disturbances in the Niger-Delta oil producing areas which has led to the destruction and vandalization of oil pipelines, disturbances in the operation of the oil explorations and damage to life and properties. Abdullateef [6] classified the petroleum industry activities into three distinct entities which include the upstream, midstream, and downstream, meanwhile the supply chain begins with the exploration and production of crude which subsequently transported to the refinery where it is refined into different products such as jet fuel, petrol, diesel and petrochemicals [7,8]. The product was later transported through the pipelines to storage terminals for distribution to end users. An oil refinery and depot is considered as an essential part of the downstream sector of the petroleum industry [4]. The importance of refineries and depots in Nigeria cannot be over emphasized. As crude oil gotten from the sub-surface cannot be used in its raw state as fuel, therefore it is processed in the refinery in order to obtain the different Petroleum products. These products gotten from the refinery are

stored in the depot. It was observed that distribution of petroleum is associated with many forms of risk which can arise from various stages in the distribution chain. According to Carpignano *et al* [9] risk can arise from transportation companies and tanker fleet characteristics, delivery patterns plus routes, fuel dispensing methods from tanker fire incidents as a result of mishandling products. Since risk has become an intricate and fundamental element that is encountered in everyday operations by petroleum distributors' organizations, this study evaluates the risk involve in the distribution of petroleum product and how effective the risk are being managed.

1.2 Research Question

The questions used for acquisition of data for this study are:

(i) Which of the following mode of transportation do you use in distribution of petroleum products (DPP)?

(ii) How often the risks occurred in distribution of petroleum products?

(iii) How significant is the risk?

(iv) How do you manage and control the risk during distribution of petroleum products?

(v) Is the control measures effective in minimizing the risk?

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study areas are the NNPC/PPMC depots located across the southwest zone of Nigeria. The locations of the NNPC/PPMC depots in the zone are presented in Table 1 and Figure 1.

Table 1. Description of the study area

S/N	Name of depot	GPS coordinate	Address
1	NNPC Depot, Sagamu	6^0 50' 58"N 3^0 38' 53"E	Mosimi Sagamu, Ogun State
2	NNPC Depot, Ibadan	7^0 26' 25"N 3^0 51' 43"E	Apata Ibadan, Oyo State
3	NNPC Depot, Ore	6^0 44' 41"N 4^0 52' 33"E	Ore, Ondo State

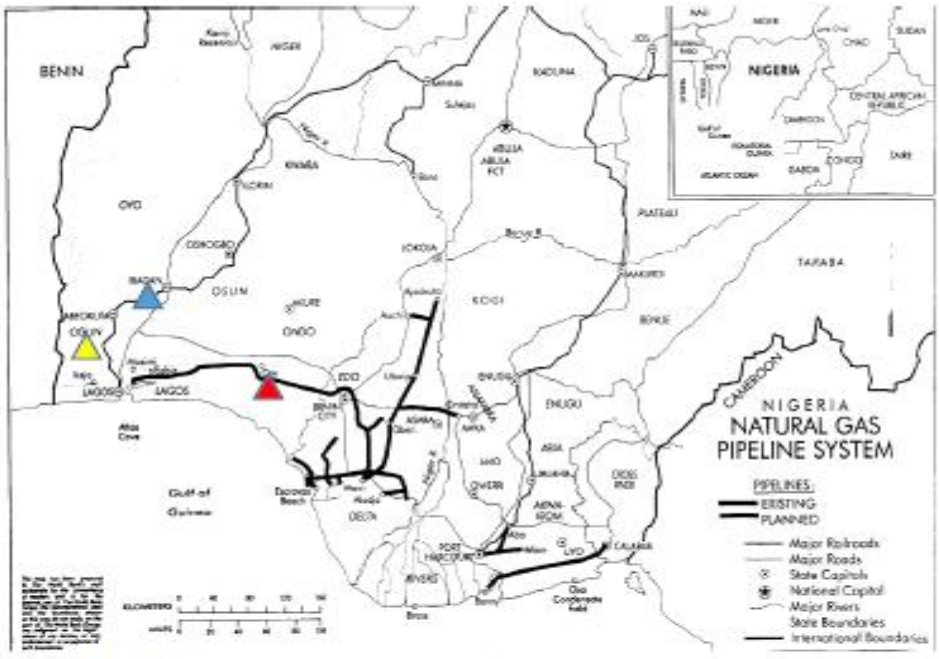

Fig.1. Map of Nigeria showing the Study Area

2.2 Methods of Data Collection

The research design used for this study is surveyed design which was conducted through questionnaire to achieve the objectives of the study. Forty eight (48) questionnaires were distributed to the staff of NNPC/PPMC depots in Ondo, Ogun and Oyo state of which all the questionnaires were returned. Judgment sampling procedure was used in selecting the respondents, while simple random sampling technique was used to distribute the questionnaires to the respondents. Also, personal contact with the sample groups ensure high rate of return of the questionnaire and helped in interpreting the questionnaire to the respondents which minimized the chances of misconception and ambiguity. Furthermore, the discussions with people both within and outside the sample groups provide more light on the authenticity of the responses of the respondents. The analyses of the questionnaire were carried out using descriptive statistical analyses (frequency, percentage, means) while the rating of the risk severity was done using reliability important indices (RII).

3. RESULTS AND DISCUSSION

3.1 Bio Data Analysis and Distribution

Table 2 shows that 17 (74%) of the respondents are male, while 6 (32%) are female. This implies that there were more male in the petroleum industries (depots) than females due to the nature of work in the depots which need more male than females. Also, 35 % of the respondents were within the ages of 26 -35years, 61 % were within the ages of 36 - 45 years and 4.3 % were 46 years and above. Age has many implications on the risk potentials of the transportation sector of the oil industry. Fergusen [10] detected that teenage drivers are inexperienced with immature judgment and have the desire to take risks. 7(31%) were secondary school certificate holder, 15(65%) were university certificate holder, 1(4%) was a Ph.D holder as shown in Table 2. This indicates that risk identification and its occurrence can be easily communicated to workers as a result of the high level of degree of education in today's petroleum industry. The level of the respondents' education greatly influences their attitude and skills in risk identification. Meanwhile, 78 % of the respondents were married, 13 % were not married while 9 % are divorced. The high percentage of married workers would strictly adhere to the rules and regulations in order to avoid any occurrence of hazard due to the negative impact it can have in their immediate family than the single workers. Consequently, 70 % had working experience within 0 - 5years, 17 % had working experience within 6 - 10years and 13 % had working experience of 10 years and above. With the larger percentage of the worker having less experience this would result to the high likelihood occurrence of risk in the depots. The length of service has a close relationship with professional competence, efficiency and risk indicators in the distribution of petroleum product. Finally 6(39.1%) and 14(60.9%) of the petroleum products are transported through pipelines and roads respectively. It implies that pipeline and road were two major routes used to distribute petroleum products in Nigeria since no value given to rail transportation as shown in Table 2.

Table 2. Bio Data Analysis of the Respondents

S/N	Description of Activities	Frequency	Percent
A	SEX		
	Male	30	62.5
	Female	18	37.5
B	AGE		
	26-35years	16	33.3
	36-45year	22	45.8
	46years and above	10	20.7
C	EDUCATIONAL QUALIFICATIONS		
	Secondary	15	31.3
	Graduate	24	50.0
	Ph.D	9	18.7
D	MARITAL STATUS		
	Single	11	22.9
	Married	26	54.2
	Divorced	11	22.9
F	WORKING EXPERIENCE		
	0-5years	24	50.0
	6-10years	12	25.0
	10years above	12	25.0
G	MODE OF DISTRIBUTION OF PETROLEUM PRODUCTS		
	Pipelines	22	45.8
	Road	26	54.2
	Rail	0	0.0

3.2 Risks in Distribution of Petroleum Products (DPP) through Pipelines

The risk response in distribution of petroleum products through pipelines is presented in Table 3 while the sum, mean and relative important indices (RII) of each risk was calculated and presented in Table 4. The risks from vandalization, leakages, and mechanical failure are rated as first, second and third respectively as presented in Table 4. This is as a result of regular reports of vandalization, leakages and mechanical failure in distribution of petroleum products through pipelines. It was also discovered that most of the leakages usually occur as a result of the vandalization of pipelines, corrosion of pipelines and sometimes inadequate maintenance of the pipelines [11]. The aftermath result of this has led to the risk of explosion and loss of life of many people. Also, risks of operational failure were rated as fourth position. It is usually caused by computer failure, power failure and telecommunication failures which most of the time result to the risk of inadequate distribution of petroleum products. Finally, both the risks from poor vessel programming and natural hazard were rated fifth and sixth positions due to their irregular occurrence. Poor vessel programming usually resulted to delay at discharge points and has led to the risk of loss of petroleum products while natural hazard risk usually occurs as a result of coastal flooding or erosion and meteorological problems.

Table 3. Risks in Distribution of Petroleum Product through Pipeline

S/N	Types of Risks	VL	L	M	H	VH
1	Poor vessel programming	9	19	9	6	5
2	Leakage	6	8	15	9	10
3	Natural hazard	16	13	11	8	0
4	Vandalization	5	7	9	11	16
5	Technological/Operational Error	10	16	14	6	2
6	Mechanical Failure	6	9	17	10	6

VL – very low; L – low; M – moderate; H – high and VH – very high

Table 4. Rating of Risk in Distribution of Petroleum Products through Pipelines

Types of Risks	Sum	Mean	RII	Risk Severity
Vandalization	170	3.54	0.708	1st
Leakage	153	3.19	0.637	2nd
Mechanical failure	145	3.02	0.604	3rd
Technological/Operational Error	123	2.56	0.513	4th
Poor vessel programming	118	2.46	0.492	5th
Natural hazard	107	2.23	0.446	6th

3.3 Risks in Distribution of Petroleum Products (DPP) through Roads

The risks in distribution of petroleum products through roads are presented in Table 5 while the sum, mean and relative important indices (RII) of each risk was calculated and presented in Table 6. Table 6 shows that the risks of accident and fire explosion were rated first and second positions in terms of risk severity in distribution of petroleum products. This has resulted in losses of many lives and petroleum products. The risk of mechanical failure and tank leakages were rated third and fourth positions. The risks of mechanical failures were resulted from an operational malfunction of the truck vehicles used for the distribution of petroleum products while the risks from tank leakages were as a result of corrosion of the truck tank used for the distribution of petroleum products. These risks have accounted to a lot of accidents which, accompanied by fire and explosion along the roads. Risk from natural hazard such as bad weather which prevent visibility and flooding of the road which causes damage to the road were rated in fifth position. This risk had responsible for a lot of accidents during the distribution of petroleum products. Finally, risks from theft/robbery and adulteration of petroleum products were rated in sixth and seventh positions respectively as they occasionally happen.

Table 5. Risks in Distribution of Petroleum Product through Pipeline

S/N	Types of Risks	VL	L	M	H	VH
1	Leakage of Tankers	12	15	12	6	3
2	Adulterated Products	24	18	5	1	0
3	Mechanical Failure	3	14	17	9	5
4	Accident	0	4	12	23	9
5	Natural hazard	10	27	8	3	0
6	Fire or Explosion	1	10	8	18	11
7	Theft/Robbery	23	13	7	5	0

VL – very low; L – low; M – moderate; H – high and VH – very high

Table 6. Rating of Risk in Distribution of Petroleum Products through Pipelines

Types of Risks	Sum	Mean	RII	Risk Severity
Accident	181	3.77	0.754	1st
Fire or Explosion	172	3.58	0.716	2nd
Mechanical Failure	143	2.98	0.596	3rd
Leakage of Tankers	117	2.44	0.488	4th
Natural hazard	100	2.08	0.412	5th
Theft/Robbery	90	1.87	0.375	6th
Adulterated Products	79	1.65	0.329	7th

3.4 Risk Management/Control in Distribution of Petroleum Products

Figure 2 demonstrations that administrative measure is the most effective risk control measure in distribution of petroleum products. The administrative measure which includes formulation of rules and regulations that will reduce risk in distribution of petroleum products, monitoring of pipeline against vandalism with security agents and so on were being adopted in reducing risk of vandalization, natural hazards and theft/robbery during the distribution of petroleum products. Also, the elimination control measure of risk was ranked second by removing the risk completely from the source which has helped in reducing risk of accident, adulterated

petroleum products and leakages of petroleum products from tankers. Moreso, isolation control measure of risk was ranked third which involves removing people or workers away from the risk source. This has played a vital role in reducing risk of fire and explosion of petroleum products and leakage of pipelines. Consequently, the redesign risk control measure ranked fourth, which involves changing the working environment or work processes that provide an additional protective barrier between the risk and the employee. This has reduced risk from poor vessel programming of pipeline, technological/operational error and mechanical failure. Finally personal protective equipment (PPE) risk control measure was ranked least which is majorly being used to control risk of natural hazard during the pipeline operations.

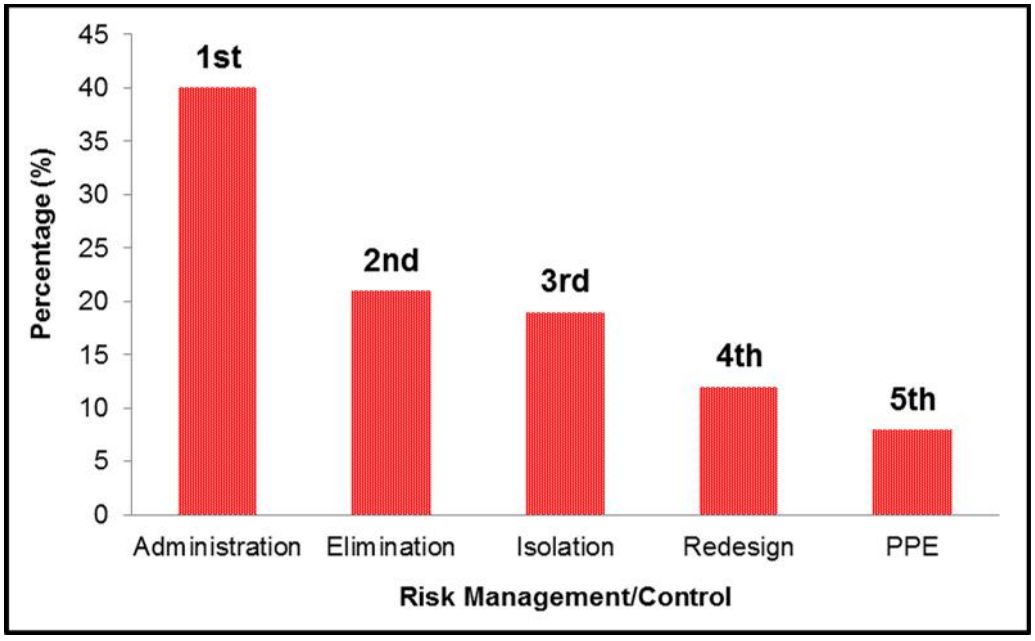

Fig.1. Risk Management in Distribution of Petroleum Products

4. CONCLUSION

The distribution system of petroleum products in the Southwest part of Nigeria through pipelines and roads are associated with a lot of risks such as risks of vandalization, leakages, fire/explosion, mechanical failure and so on. The severity of the risk shows that risks from vandalization were rated highest and risk from natural hazard were rated least when using pipelines while the risk of an accident were rated highest and the risk of adulterated petroleum products was rated least when using road for the distribution of petroleum products. Also,

several management/control measures were adopted in reducing risks of distribution of petroleum products. It was discovered that administrative control measure was ranked as the most effective measures of managing risk during the distribution of petroleum products while use of personal protective equipment was ranked last. The study, thereby makes the following recommendation in order to ensure risk free distribution of petroleum products across the southwestern part of Nigeria.

(i) The management of NNPC/PPMC should empower and equipped the security agents with modern technologies of preventing pipelines from vandalization.

(ii) The management should concentrate more on using pipeline in distribution of petroleum products than road since it's prone to lesser risk than road.

(iii) All the damage pipelines should be repaired with comprehensive maintenance of all other facilities using for the distribution of petroleum products in order to eliminate any form of failures in the system.

(iv) The Government should improve on the condition of road networks in the southwest part of Nigeria in order to reduce accidents and revitalized the rail transport system which is safer for the distribution of petroleum products than roads.

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