Effectiveness of Unmanned Aeriel Vehicle on Pipeline Surveillance in Nigeria: A Preliminary Survey

ABSTRACT

This study examines the usefulness of Unmanned Aeriel Vehicle (UAV) on pipeline surveillancein Nigeria over the traditional metho. The purpose of this study is to investigate whether there is an effective role occasioned with the use of UAV against traditional method of pipeline surveillance. The population of this study is 4648, from which the sample size of 369 was selected at random. Questionnaireswere the major instrument used in data collection. Simple percentages were used in analyzing the data collected from the questionnaire.Hypothesis were formulated, statistics was applied to test the hypothesis. Results show that are challenges occasioned by the use the traditional pipeline surveillance method; thatthere is a relationship between asset safety and employee's safety by the deployment of a UAV against the traditional method; that the deployment of a UAV optimize profitability and reduce loss occasioned with the use of traditional surveillance method, and that UAVpreferred for pipeline surveillance compared to traditional surveillance method. The study recommended that oil and gas companies should as a matter of urgency embrace the deployment of UAV on pipeline safety to promote sustainability, efficient service delivery, real time imagery and more. The given solution is effective, cost-efficient and very reliable as it promotes health, safety and environmental best practice all over developed countries of the world.

Keywords: Pipeline, surveillance, Unmanned Aeriel Vehicle

Introduction

The safest means to transport hydrocarbon or natural gas is via pipeline, to meet the global demand, and the uncommon growth of daily volume in oil and gas delivery. In Nigeria, pipelines, including various sizes, length and thickness of pipes, compressors, different pumps flow and deport distribution stations with Unmanned Aeriel Vehiclesafety station incorporated are in remote and urban environment which are exceedingly difficult to monitor and secure such as rigg on high or depth water, remote areas prone to community vices, bunkering, oil theft, tragedy of the common. Willful and planned attacks or damage to these assets, equipment failure, high cost of maintenance and repairs, incidences and accidents, can lead to enormous environmental effects resulting to the loss of biodiversity, ecological imbalance, climate change, loss of lives and properties, loss of revenue, company reputation, affecting the oil and gas international market, etc[1,2]. During the 1990s and 2000s, frequent accidents took place in Nigeria, where vandalized and exploited pipelines exploded causing thousands of deaths and fatalities.

The sustainability of oil and gas installations pipelines, distribution station, booster pumps etc. are of high importance to foster effective delivery, and the main idea or rationale for the oil and gas pipeline safety, security is for safety priority. There has been a call internationally to improve the safety and legislation on pipeline safety, safety and surveillance on all oil/gas installations carrying hydrocarbon such as the EMMC 2014 and PHSA 2015. As reported by the Nigerian National Petroleum Corporation (NNPC), the pipeline transverse from Atlas Cove marked as system 2B pipeline laying from Lagos to Ilorin, IlorintoMosimi, Mosimi to

Ibadan and Ibadan to Ore, experienced 774, 181, 4221 and 122 break points respectively within 3 months in 2012, which has resulted to youth restiveness, loss of lives, fire outbreak and the destruction of houses [3]. The Nigerian Federal Government established legislature to curb the menace of oil theft, sabotage, Pipeline Right of Way (PROW), through the Federal Protection Agency Act of 1990; National Oil Spillage Detection and Response Agency Act 2006; and agencies such as the National Emergency Management Agency, the Nigerian Security and Civil Defense Corp, soldiers and community safety guards which workto effectively bring to a stop this ugly business trend.

Using Unmanned Aerial Vehicles (UAVs) to monitor pipeline as an alternative surveillance technology in Nigeriashould be considered or advocated. The strategy to monitor pipeline with UAVas against the traditional surveillance technologies in Nigeria has risen fears and doubts in the mind of the proponents, stakeholders, communities and sundry – on how effective this can be. Traditional pipelines safety has never had fruition due to the increase in oil and gas pipeline vandalism, leaks, thefts sabotage etc.[4].Currently, most of the pipeline safety is still working on the use of conventional methods. Mainly, through foot patrols by soldiers and community vigilante and aerial surveillance using helicopters or light aircraft[5].Additionally, the cost of using Human Patrol Surveillance (HPS) is extremely high. More so, the main disadvantages of HPS are the potential of late correspondence failure to report on time for effective response to advert oil spill, sabotage or vandalism resulting to environmental damage and proponent's financial loss with high cost of remediation[6,7].

The 20th century has witnessed enormous progress in high-resolution spectral remote sensing and imagery processing technology in the search for effective safety of pipeline system using remote sensing techniques and imagery-oriented software. Though satellite is not enough in the safety of oil and gas pipeline due to the configuration of the spatial and temporal data and imagery resolutions. UAVs provides an alternative safety surveillance technology that can provide real-time data, that enables leak detection and timely intervention [6, 8-10]. Unmanned Aerial Systems (UAS) solution provide effective mission flexibility and relative with high spatial resolution.Nigeria with over five thousand pipeline network system plying along rivers, underground laying, villages, urban settlers, earth ground movement and effect, wear and tear of the equipment, leaks and equipment failure justify the need for pipeline safety with UAVstowards an alternative surveillance technology in Nigeria.

This study explores the potentials of using UAV platforms to add to the safety of pipelines as an alternative surveillance technology in Nigeria.

2.0 Materials and Methods

2.1 Study Area

Nigeria is a West African Country. It is the most populous back nation in the world with a population of 203,452,505. Nigeria is a sub-Saharan African's largest economy that relies on oil and gas as its main source of foreign exchange earnings and government revenue. It has a total area of 923,768sq km, land mass of 910,786ks km and water is 13,000sq km.

The country pipeline asset crisscrosses the six geopolitical zones of the country. There are five main pipeline regions. The first is from Port Harcourt to Yola. The second region is the Mosimi pipeline region comprises of Ore-Atlas cove – Lagos – Mosimi – Ibadan to Illorin. Thirdly the Warri region comprises of Warri – Abubu – Benin – Auchi, the Gombe region spreading from Jos – Gombe – Biu – Maiduguri. The Kaduna region with the crude line route from Warri – Lokoja – Abaji – Suleja – Izom – Minna – Sarkin Pawa – Kaduna – enroute –

Kano and to Gusau. These pipelines are incorporated with DPS (Depot Petroleum Storage tanks), system 2A, 2AX, system 2B, system 2C, system 2CX, system 2D, System 2DX, system 2E, 2EX enroute based on its pipeline products.The pipeline are arranged in such a way that the project deliverables, the refineries, deports, boosters, pump house were considered and integrated.

The Nigeria National Petroleum Corporation is the custodian of Nigeria's oil and gas installation including its over 5,005km pipelines use for delivery pipeline products- kerosene, naphtha, PMS, gasoline and more. Nigeria's downstream oil industries has a total of four refineries. Lagos import storage facilities are located at Apapa, Ijora, Onne, Okirika, Port Harcourt, Calabar and others. The pipeline product market company has 23 depots and 7 pump in the marine based station.

.2 Population of the Study

The population of the study is 4648 which comprises workers in the pipeline, product, storage and delivery companies in Nigeria.

2.3 Sample Size and Sampling

According to Yamani (1964), the following formula was used to determine the sample size.

$$n = \frac{N}{1 + Ne\text{^}2}$$

Where, n = sample size

N = Population

e = Degree of tolerance error (5%)

1 = Constant

The researcher used a combination of cluster sampling and deliberate sampling methods to select the 369 participants in the study. The cluster sampling method was used in picking organization across the breath and width of Nigeria.

2.4 Research Instrument

The research instrumentused in this study was the questionnaire. The questionnaire was phrased with possible continuum based on five-Likert-style scale. The following ratings were adopted in this research to facilitate the analysis: strongly agree-5, agree-4, undecided-3, disagree-2, strongly disagree-1. The questionnaire contained questions on the effect of UAV (UAVs) on the safety of pipeline as an alternative surveillance technology in Nigeria**.**

2.5 Validity of Research Instruments

The research instrumentwas subjected to critical validation by the project supervisor. The corrections made by the supervisor were carefully incorporated by the researcher in order for the instrument to be valid.

2.6 Reliability of the instrument

The instruments for this research was subjected to R-test. The instrument was given to selected people for comments and the process was repeated after one week interval to

determine if their initial response would conform to their later comments. All variable are reliable since their Cronbach's alpha is greater than 0.5. The closeness of this value to 1 indicates that the instrument is very reliable.

2.7 Method of data collection

The questionnaire which was the instrument for data collection was administered to the respondents by the researcher personally. The questionnaire were collected back from the respondents immediately after completion in order to avoid mutilation and to record high response rate from the respondents.

2.8 Method of data analysis

The retrieved copies of questionnaire were analyzed using simple percentage and frequency count with the aid of the software SPSS version 20. Chi-square (x^2) statistics was used to test the hypothesis of the study.

3.0 Results

Table 1: Is there any challenges occasioned by the use the traditional pipeline surveillance method?

Alternative response	Frequency	Percentage (%)
Strongly Agree	190	60.70
Agree	59	18.84
Strong Disagree	40	12.78
Disagreed	24	7.67
Total	313	100

Table 1 shows thatmajority of respondents agrees that there are challenges occasioned on the use of traditional surveillance systems in the operation which is about 79.87% while a few staff 20.13% seams not to acknowledge the challenges facing the company on the traditional surveillance system. So therefore, the use of traditional surveillance technology has affected the safety of the organization asset.

Table 2: There is a relationship between asset safety and employee's safety by the deployment of UAV against the traditional method

Alternative response	Frequency	Percentage
Strongly Agree	180	57.51%
Agree	70	22.36%
Strongly Disagree	33	10.54%
Disagree	30	7.37%

Total	313	100%

Table 2 shows that majority of the respondents agrees that there is a relationship between asset safety and employee safety by the deployment of a UAV against the traditional method.

Table 3: Will the deployment of a UAV optimize profitability and reduce loss occasioned with the use of traditional surveillance method?

Alternative response	**Frequency**	**Percentage**
Strongly Agree	193	61.66%
Agree	75	23.96%
Strongly Disagree	37	11.82%
Disagree	8	2.56%
Total	313	100%

Table 3 indicates that 193 of the respondents representing 61.66% welcomes the idea of a UAV in place of the traditional method because lives and properties will be saved.

Table 4: Are UAVpreferred for pipeline surveillance compared to traditional surveillance method?

Alternative response	**Frequency**	**Percentage**
Strongly Agree	195	62.30%
Agree	70	22.36%
Strongly Disagree	43	13.74%
Disagree	5	1.60%
Total	313	100%

From the Table 4, 195 of the staff representing 62.30% of the response strongly agreed that UAV is preferred over the traditional monitoring system while a total of 43 of the staff strongly disagree and 5 of the staff disagree with the implementation of a UAV.

4.0 Discussion

This study examines the usefulness of Unmanned Aeriel Vehicle (UAV) for pipeline surveillance in Nigeria over the traditional method. In the present study, preponderance of the respondents assertedthat there are challenges occasioned by the use the traditional pipeline surveillance method.Traditional pipeline surveillance methods have long been used to monitor and maintain the integrity of pipelines. However, these methods come with several

challenges, in that they have limited coverage, they are time and cost-intensive, they rely heavily on human observers, there is the problem of inability to monitor in real-time and poor data integration as well as analysis, and some cases, traditional surveillance methods may lead to an environmental impact due to potential leaks or delays in detecting pipeline breaches [7,11,12]. These challenges can impede effective surveillance and pose risks to the safety of the pipelines and the environment.

Addressing these challenges necessitates the adoption of advanced technologies and innovative solutions in pipeline surveillance globally. Theuse of UAVs(drones), aerial surveys, satellite imageryand advanced analytics, ensure continuous monitoring, timely detection of anomalies, and effective maintenance strategies. By embracing modern surveillance techniques, owners of pipelines in Nigeria can enhance safety of their infrastructure, minimize environmental pollution, and minimize their loses occasioned by vandalism.

Majority of the respondents averred thatthere is a relationship between asset safety and employee's safety by the deployment of a UAV against the traditional method. Traditional pipeline surveillance methods often involve human inspectors physically being present in hazardous or difficult-to-reach locations. By deploying UAVs, employees are not exposed to potentially dangerous environments, reducing the risk of accidents, injuries, and exposure to harmful substances.Operators can monitor pipelines remotely using UAVs, eliminating the need for employees to travel long distances or be present on-site for routine surveillance tasks. Enhanced asset monitoring and timely detection of potential threats help protect the integrity of pipelines, while reducing the risks and exposure faced by employees during manual inspections. Ultimately, this contributes to a safer working environment and ensures the longevity and sustainability of pipeline infrastructure.
Majority of the respondents averred that the deployment of a UAV optimize profitability and reduce loss occasioned with the use of traditional surveillance method. According toAllen J, Walsh [13] the deployment of unmanned aerial vehicles (UAVs), in pipeline surveillance brings significant advantages in that it optimizes profitability and reduce loss when compared to traditional methods. UAVs can cover larger areas in a shorter time frame compared to manual inspections. This eliminates the need for a large workforce and associated labor costs involved in traditional surveillance methods.By using UAVs, the need for manual inspections is diminished, reducing travel costs, equipment expenses, and related downtime.UAVs provide real-time monitoring of pipelines, enabling operators to detect abnormalities, leaks, or breaches promptly, which could help to minimize the potential damage and associated costs; minimize unplanned outages and emergency repair costs, and ensures continuous operation, to optimize profitability.By effectively analyzing large datasets generated by UAV, the oil and gas companies can make data-driven decisions that lead to improved efficiency and cost savings.

Majority of the respondents averred that UAVpreferred for pipeline surveillance compared to traditional surveillance method.The preference for UAVs over traditional surveillance methods for pipeline surveillance stems from their efficiency, cost-effectiveness, enhanced safety, increased coverage and accessibility, real-time monitoring capabilities, data-driven decision-making, and environmental benefits[6,14,15]. These advantages make UAVs the preferred choice for pipeline operators seeking to optimize operations, minimize costs, and ensure safer and more efficient surveillance practices.

Conclusion

The study has established that there are challenges occasioned by the use the traditional pipeline surveillance method; thatthere is a relationship between asset safety and employee's safety by the deployment of a UAV against the traditional method; that the deployment of a UAV optimize profitability and reduce loss occasioned with the use of traditional surveillance method, and that UAVpreferred for pipeline surveillance compared to traditional surveillance method.Oil and gas companies would benefit from the deployment of UAV on pipeline safety.

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