DATA NOTE

**Data Note: COVID-19, social distancing, and pipeline vandalism in Nigeria [version 2; peer review: 2 not approved]**

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Abstract

We present a dataset of the monthly cases of pipeline vandalism in Nigeria from January 2015 to January 2021. Data used in this study were collated from the Monthly Financial and Operations Reports (MFOR) of the Nigeria National Petroleum Corporation (NNPC). Each MFOR provides cases of pipeline vandalism during a 12-month span from five key locations; Mosimi, Kaduna, Port Harcourt, Warri, and Gombe. Recorded incidences of pipeline vandalism from these locations were summed and assembled into five groups; namely: historical data, prior-COVID-19, COVID-19 lockdown, and post-COVID-19 lockdown. The data were grouped based on dates. These dates were January 2015 to July 2019, August 2019 to January 2020, February 2020 to July 2020, and August 2020 to January 2021 respectively. The historical data were further sub-divided into four sub-groups based on the deployment (May 2016) of sophisticated weapons, satellite imagery, and geographical information system into the security apparatus to checkmate pipeline vandalism. The four sub-groups are sub-group A (one-year before deployment), sub-group B (the year of deployment), sub-group C (one-year after deployment), and sub-group D (two-years after deployment). The dates span for each sub-group is May 2015-April 2016, May 2016-April 2017, May 2017-April 2018, and May 2018-April 2019 respectively. After the deployment of GIS devices in May 2016, the accumulated national number of pipeline vandalism cases declined from 400 cases in January 2016 to 293 in February 2016, and 259 cases in March 2016 as opposed to 60, 49, and 94 cases in the same months in 2017; but over the years, 2017 to 2021 these methods have proved less effective, and cases of pipeline vandalism have risen once more. Similar changes in the number of cases and patterns were observed during the COVID-19 movement restrictions. From the dataset, it can be seen that COVID-19 influenced incidences of pipeline vandalism.

Keywords

COVID-19, pipeline vandalism, restriction on movement, NNPC pipelines, pipes
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Introduction

Product theft and vandalism of national pipelines are recurring challenges faced by the Nigeria National Petroleum Corporation (NNPC).\(^1\) Oil spillage is associated with oil pipeline destruction. The destruction of pipelines leads to several environmental problems; fresh and seawater pollution, air pollution, chemical pollution, soil and land pollution.\(^1\) It also makes most agricultural practices unsustainable with an associated decline in fish population in polluted waters, biodiversity depletion,\(^3\) loss of habitat, and loss of ecological and security systems.\(^3\)–\(^5\)

Despite the punishment of 21 years to life imprisonment for pipeline vandalism\(^6\) [Section 2 of the Petroleum Production and Distribution (Anti-Sabotage) Act Cap], the practice continues. There are three main aspects of vandalism; that must be acknowledged and addressed if any meaningful sustainable gain against pipeline vandalism can be achieved. One, Nigeria is losing over 300,000 barrels per day (BPD) as a result of crude oil pipeline vandalism.\(^7\) Where do these crudes go? Two, there are billions of dollars in losses to the national revenue, environmental degradation, and in some cases loss of human lives.\(^8\),\(^9\) Where is this money? Thirdly, Pipeline vandalism because of the nature of the criminality, occurs at remote locations.\(^10\)–\(^12\) Which “class” of Nigerians are involved in this act? What is the role of accessibility in pipeline vandalism?

In the global fight against the COVID-19, several liberties, such as our freedom of movement, and association were suspended. The pandemics offer a unique opportunity to study the effect of movement restriction on pipeline vandalism. A relationship between access to pipelines and physical vandalism (which involves the destruction of pipes materially) is assumed. This type of destruction is not remote; it implies “accessibility”. Accessibility by its very nature involves two principal factors; access to the pipeline physically and opportunity. These two aspects of the equation were removed during the lockdown.

“Access” involves proximity to pipelines with ample time to destroy or compromised its structures. Legally, at this point, the miscreant is termed a Vandal.

“Opportunity”, on the other hand, entails a longer time duration to enable the fluid to be scooped/removed and carted away by the (Vandals, now termed) thieves. This project aims to provide information on the role of movement in pipeline vandalism. Verification of this, during “peacetime” is somewhat limited in a democracy. The constitution and economic considerations would not permit such complete, absolute prohibition on movement and assembly.

The pipelines pass through vast expanses of land. From mangrove swamps, tropical rain forest, Savanah, and arid deserts. To effectively, physically lock down all routes and passes would be practically impossible during peacetime. However, during the pandemic, much of the considerations (economically, politically, and constitutionally) were removed therefore, the condition (for vandalism) theoretically should be diminished. This project aims to address this hypothesis and assumptions using statistical methods.

In this light, the COVID-19 pandemic and consequent lockdown could be seen as an experiment. The study would therefore reveal the role “opportunity” and “access to pipeline” play in vandalism collectively. The Researchers could test if a relationship exists between observed variables and their underlying latent constructs. To accomplish this, the researchers use empirical research, to postulate the relationship pattern and test it statistically.
Why is it relevant?
This paper examines the nexus between oil pipeline vandalism and public accessibility in Nigeria.

Given the adverse impact of pipeline vandalism as exemplified in loss of life, economic losses, environmental degradation, and pipeline explosions, the paper submits that an evaluation of the impact of anti-pandemic restrictions on the phenomenon is very relevant as pipeline vandalism poses a danger for economic wellbeing and national security. Thus, a study of the effects of anti-pandemic restrictions on pipeline vandalism is relevant.

During the COVID-19 pandemic, movements were restricted in a manner unparalleled in modern living memory. It is desirable to determine if a significant difference exists in the incidence of pipeline vandalism of Nigerian oil pipelines during the COVID-19 pandemic. This dataset provides that information.

Findings from this research would enable a greater understanding of the diverse players involved in these practices. A greater understanding of the nature of the vice would be achieved. This could lead to better decisions to checkmate the vice of pipeline vandalism.

Methodology
The method
Several methods exist to determine the significance and relationship between groups of data; for example, t-test, ANOVA, etc. In recent times, some scholars have challenged the use of a threshold to declare the statistical significance of the p-value.13–17 Two main arguments exist. One; research data contain more meaning than is summarized in a P-value and its statistical significance. Two, the concepts are frequently misunderstood and consequently inappropriately interpreted. The abolishment of p-values has been echoed in some articles; an example is Ref. 18.

Traditionally, Researchers examine differences between groups using t-test, ANOVA.17,19-21 In this study the one-way ANOVA was used; and, percentage differences were added as quantifiers. A one-way ANOVA is a statistical test used to determine whether or not there is a significant difference between the means of three or more independent groups.

![Figure 1. Normality check on subgroups.](image-url) Normality checks were conducted on the underlying data sets that formed each group and subgroup A-D to determine whether the sample data have been drawn from a normally distributed population (within some tolerance). When sample data are representative; the conclusions drawn from such data are often valid.22 (The Assumption(s) of Normality, http://www2.psychology.uiowa.edu/faculty/mordkoff/GradStats/part%201/I.07%20normal.pdf, Copyright © 2000, 2011, 2016, J. Toby Mordkoff).
The assumptions in the one-way ANOVA are:

a. Normality (That each sample is taken from a normally distributed population.)

b. Sample independence (That each sample has been drawn independently of the other samples.)

c. Variance Equality. Homoscedasticity of the dependent variable.

The verification of the assumptions used in the ANOVA analysis

Normality - This can check visually or, by the histogram. Normality checks were carried out on all subgroups datasets (Figure 1), prior-COVID, COVID and post-COVID datasets (Figure 2) and on historical datset (Figure 3). Before data can be analysed statistically, it must be shown to be “normally distributed”. “Normal” data are data that are drawn from a population that has a normal distribution. For the subgroups these are:

Normality check on the group data:

Figure 2. Normality check on group data. The data sets in the groups- pre-COVID, COVID and post-COVID, are 6 months before, during and after the COVID lockdown. While the historical data ranged from May 2015-February 2019. These data were also subjected to normality check. A histogram is an estimate of the probability distribution of a continuous variable. The graphs (Figures 1, 2 and 3) approximate the characteristics bell-shape curve²³ (Lund Research Ltd. Descriptive and Inferential Statistics. Available http://www.statistics.lard.com).
Variance

This can be checked with a boxplot. For the subgroups these are:

Figure 3. Normality check on “historical data” used in the analysis.

Figure 4. Variance check on sub groups.

The check on the group data:

Figure 5. Variance check on groups.
Independence

There is no formal test to verify that the observations in each group are independent.

The data

The study uses easily accessible and verifiable data. Primary data was collected by the Researchers from first-hand sources. All data used in this study reside in public domains. This is in line with the Authors’ aim to allow ease to the methods, materials, and protocols. It also allows replication. Primary data of the number of cases of pipeline vandalism each month from January 2015 to January 2021 were collected and grouped based on date. The names of each group are self-explanatory. The groups are:

1. Historical data – 1 January 2015 to 31 July 2019.
2. Prior COVID-19 data – 1 August 2019 to 31 January 2020.
3. COVID-19 data – 1 February 2020 to 31 July 2020.
4. Post COVID-19 data – 1 August 2020 to 31 January 2021.

Under the land use decree, the oil wealth of the country (Nigeria) resides with the Federal Government. All aspect is controlled by the Nigeria National Petroleum Cooperation (NNPC) or its subsidiaries. Incidences of vandalism of pipeline are ascribed in the Monthly Financial and Operations Reports (MFOR) of the Nigeria National Petroleum Corporation (NNPC). Thus, the integrity and veracity of data used cannot be in doubt. These monthly reports are available for free download by the public from the NNPC website link (NNPC; https://www.nnpcgroup.com). This information can be accessed by clicking “NNPC Business” and selecting “Business Information”, then “Monthly Performance Data” on their website (https://www.nnpcgroup.com) or through (https://www.nnpcgroup.com/NNPC-Business/Business-Information/Pages/Monthly-Performance-Data.aspx). The underlying data is available for free download by the public, thus; reproducibility of the dataset is facilitated. The information abstracted from the NNPC MFOR was the number of cases of pipeline vandalism per month, the month of vandalism, and the year of vandalism.

| S/N | Group               | Time                        | Duration/comment                                                                 |
|-----|---------------------|-----------------------------|---------------------------------------------------------------------------------|
| 1   | Historical data     | 1 January 2015 to 31 July 2019 | Further subdivided into 4 subgroups, each of 12 months duration                 |
|     |                     |                             | • Sub-group A                                                                    |
|     |                     |                             | • Sub-group B                                                                    |
|     |                     |                             | • Sub-group C                                                                    |
|     |                     |                             | • And, sub-group D                                                               |
|     |                     |                             | Analysis of subgroups shall reveal the effect of the use of GIS on pipeline vandalism |
Furthermore, we obtained information and dates of major National and International events that may be additional external stimuli in this analysis. This information was collected from national and regional newspapers and web-based publications, and web pages.

These are:

- May 2016, incorporation and deployment of sophisticated weapons, use of satellite images and geographical information system (GIS) into the security apparatus to ensure vandalism is contained, the setting up of a pipeline security force to stamp out the menace, and the formation of the Trans-National Organized Crime (TNOC) with regional allies to fight against the proliferation of Small Arms and Light Weapons. This was a welcome development as the area under physical patrol was massive.

- The onset of COVID-19 in December 2019 and the declaration of COVID-19, on 30th January 2020, as a Public Health Emergency of International Concern by WHO (World Health Organization), and the upgrade to a pandemic by the 11 March 2020

- In Nigeria, the pre-lockdown commenced from 28 February – 29 March 2020; 31 days duration. The lockdown was 35 days; from 30 March to 3 May 2020. And an ‘easing up’ of 73 days, 5 May – 15 July 2020.

**Classifications in group 1, “Historical Data”**

“Historical data” span from January 2015 to July 2019, these data represent pipeline vandalism data before the advent of COVID-19 and its restrictions. These data were collected before the outbreak. Consequently, it could be assumed that COVID-19 did not influence the incidences of pipeline vandalism during this time. These data can therefore be used as a “baseline”; a such of “norm”. For in-depth study, this group (spanning approximately 4 years was further divided into subgroups of a year durations each).

The sub-groups are:

- Sub-group A (one-year before deployment) - May 2015-April 2016
- Sub-group B (the year of deployment) - May 2016-April 2017
- Sub-group C (one-year after deployment) - May 2017-April 2018
- And, sub-group D (two years after deployment) - May 2018-April 2019.

An analysis of the sub-groups would reveal if the use of GIS had any impact on cases of pipeline vandalism.

**Classifications in “groups 2-4”**

Data from groups 2-4 were arbitrarily set within a duration of 6-months each. Pipeline vandalism during the time frames could be imparted by COVID-19. A comparative analysis of data six months before lockdown (group 2, Table 1) and six months after lockdown (group 4, Table 1) would reveal if COVID-19 had any impact on cases of pipeline vandalism.

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**Table 1. Continued**

| S/N | Group                  | Time                        | Duration/comment                                                                 |
|-----|------------------------|-----------------------------|----------------------------------------------------------------------------------|
| 2   | prior-COVID-19         | 1 August 2019 to 31 January 2020 | 6 months; Comparative analysis of S/N (2) and (4) determines the effect of the lockdown implementation on pipeline vandalism. |
| 3   | COVID-19 lockdown      | 1 February 2020 to 31 July 2020 | 6 months; The slope of S/N(3) is indicative of the rate of effectiveness of the lockdown. |
| 4   | post-COVID-19 lockdown | 1 August 2020 to 31 January 2021 | 6 months;                                                                 |

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To minimize/remove seasonal variations due to the weather (wet and dry season) data were compared only with data from the corresponding seasonal frame. This is logical, in temperate zones, data of pipeline vandalism in the summer should be compared against summer data; winter against winter in the colder zones; similarly data of pipeline vandalism in the rainy season should be compared only against data of pipeline vandalism in another rainy season in the tropic.

**Software used in the data analysis**
For ease of accessibility, the software used for analysis was the MS office Excel 2013 with the Analysis ToolPak add-in.

**Reproducibility and replication of results**
The reproducibility of data determines if similar results or conclusions could be attained by a different research team, using the same methods. The results in this study, are not artifacts of the unique setup, therefore any researcher using any statistical tool should lead to the same/similar results.

Replication, on the other hand, refers to the repetition of a research study, usually with different situations and different subjects. This determines if the basic findings of the original study can be applied to other participants and circumstances. It can be considered as a “re-run” study; aimed to confirm results. The severe acute respiratory syndrome (novel coronavirus COVID-19 or SARA-CoV-2) and its associated lockdown offered a unique opportunity that may not be replicable on the same scale.

In all statistical analyses in this project, an alpha = 0.05 as the significance threshold was set. In line with best practice for transparency in data analysis, our research hypotheses were clearly articulated; and null and alternative hypotheses were established. This means that the null hypothesis would be rejected if the p-value is less than or equal to 0.05 and the alternative hypothesis would be accepted.

**The programmed MS Excel spreadsheet**
The programmed MS Excel spreadsheet was used in the calculation of the time series analysis using a moving average.

The programmed Excel spreadsheet consist of rows and column. Each column was given a unique identifier ranging from 1 to 10 (Figure 7) and a column heading which is the formula used for the calculation in the column (Figure 7).

The third and fourth columns are the date and cases of pipeline vandalism for the period. The fifth column is the moving average. In the excel spreadsheet, the moving average, MA was calculated by:

The moving average, \( MA = \text{AVERAGE}(D_t : D_{t+1}) \)

Where \( D_t \) = is the cases of pipeline vandalism at time, \( t \)

And

\( D_{t+1} \) = is the cases of pipeline vandalism at time, \( t+1 \)

In columns 6-9 the seasonal and irregularity components are handled and the data deseasonalized.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|----|
| t | pattern | time (date) | \( Y_t \) | baseline | seasonal moving average, MA(2) | and irregular components | \( St \) | deseasonalize | \( St \times T_t \) |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

**Figure 7. The parts of the programmed MS Excel spreadsheet.**
Analysis of the groups (1 August 2019 to 31 January 2021)
For the group data, the total incidences during the time frame covered by the group, average, and standard deviation were established. The grouped data were subjected to an ANOVA analysis, A null and alternative hypothesis were set as followed:

- **Null hypothesis**: There is no significant difference between the mean case of pipeline vandalism incidences prior, during, and post COVID lockdown.

- **Alternative hypothesis**: There is a significant difference between the mean case of pipeline vandalism incidences prior, during, and post COVID-19.

Analysis of the sub-groups (May 2015-April 2019)
For the sub-groups, the total cases in each subgroup, the mean, and the standard deviation were calculated. A null and an alternative hypothesis were set.

- **Null hypothesis**: There is no significant difference between the mean case of pipeline vandalism incidences prior, during, and post the deployment.

- **Alternative hypothesis**: There is a significant difference between the mean case of pipeline vandalism incidences prior, during, and post-deployment.

The sub-grouped data were also subjected to an ANOVA analysis, and a time series analysis (after the data were smoothened by moving average).

**Dataset validation**
**Allowances made to control bias or unwanted sources of variability**

**Seasonal confounds**

There are two principal seasons, the wet rainy season and the hot dry season in Nigeria. Pipeline vandalism takes place in remote locations near isolated, rural roads and footpaths; not readily accessible during adverse weather conditions. We, therefore, assume that the rainfall affects the number of cases of pipeline vandalism. However, rainfall patterns are fairly predictable and torrential rainfall occurs in the mid of the rainy seasons. Seasonal confounds were eliminated by comparing data for the same months in each group. This implies that the rainfall season data (in one group or year) were compared only with the rainfall season data (in another group or year); with similar arguments for the dry season data.

**Data points in each group or sub-group**

For all analyses, the number of data points was of uniform length to reduce any possible bias due to unparalleled data points.

In each group (prior, during, and post COVID-19 lockdown groups) the number of data points was six. In the four sub-groups of the historical data (i.e., sub-group “A”, sub-group “B”, sub-group “C”, and sub-group “D”) each sub-group had 12 data points.

The data was assembled over an even interval and ordered chronologically with equal time-frequency.

**Exclusion of data**

All cases/incidences of vandalism of pipelines that fall before or after the time frame under review (1 January 2015 to 31 January 2021) as ascribed in the MFOR were removed from the analysis.

**Other assumptions made**

The destruction of these pipelines has been a scourge on the national petroleum industry in Nigeria since time immemorial, two groups of people disrupt pipelines in Nigeria. One; the activists, radicals, and militants, to make political statements, and two, the thieves. Thieves, solely for monetary consideration via illegal possession of the fluids therein.
The former, make political statements before any attempted disruptions, often to inform the government and allow negotiation for the fulfillment of their demands; the latter does not. During the lockdown, no activists, radicals, or militants made any political statement; so, we can assume they also heeded the order to “isolate and social distance”. We, therefore, attributed all pipeline vandalism during the COVID-19 lockdown period to thieves.

**Results**

The number of cases of vandalism of pipeline ascribed in the Monthly Financial and Operations Reports (MFOR) of the Nigeria National Petroleum Corporation (NNPC), for the years under study is shown on Table 2.

| S/N | Month and year | ∑ Monthly total |
|-----|----------------|----------------|
| 1.  | YEAR: 1        | January-2015   | 288 |
| 2.  | February-2015  |               | 198 |
| 3.  | March-2015     |               | 145 |
| 4.  | April-2015     |               | 231 |
| 5.  | May-2015       |               | 250 |
| 6.  | June-2015      |               | 287 |
| 7.  | July-2015      |               | 218 |
| 8.  | August-2015    |               | 250 |
| 9.  | September-2015 |               | 236 |
| 10. | October-2015   |               | 275 |
| 11. | November-2015  |               | 204 |
| 12. | December-2015  |               | 275 |
| 13. | YEAR: 2        | January-2016   | 400 |
| 14. | February-2016  |               | 293 |
| 15. | March-2016     |               | 259 |
| 16. | April-2016     |               | 214 |
| 17. | May-2016       |               | 260 |
| 18. | June-2016      |               | 261 |
| 19. | July-2016      |               | 311 |
| 20. | August-2016    |               | 221 |
| 21. | September-2016 |               | 179 |
| 22. | October-2016   |               | 101 |
| 23. | November-2016  |               | 43  |
| 24. | December-2016  |               | 18  |
| 25. | YEAR: 3        | January-2017   | 60  |
| 26. | February-2017  |               | 49  |
| 27. | March-2017     |               | 94  |
| 28. | April-2017     |               | 82  |
| 29. | May-2017       |               | 55  |
| 30. | June-2017      |               | 86  |
| 31. | July-2017      |               | 116 |
| 32. | August-2017    |               | 70  |
| 33. | September-2017 |               | 70  |
| 34. | October-2017   |               | 126 |
| 35. | November-2017  |               | 136 |
| 36. | December-2017  |               | 176 |
Table 2. Continued

| S/N | Month and year | Σ Monthly total |
|-----|----------------|-----------------|
| 37. | Year: 4 January-2018 | 216 |
| 38. | February-2018 | 148 |
| 39. | March-2018 | 224 |
| 40. | April-2018 | 116 |
| 41. | May-2018 | 82 |
| 42. | June-2018 | 174 |
| 43. | July-2018 | 204 |
| 44. | August-2018 | 86 |
| 45. | September-2018 | 125 |
| 46. | October-2018 | 219 |
| 47. | November-2018 | 197 |
| 48. | December-2018 | 264 |
| 49. | Year: 5 January-2019 | 230 |
| 50. | February-2019 | 137 |
| 51. | March-2019 | 111 |
| 52. | April-2019 | 125 |
| 53. | May-2019 | 60 |
| 54. | June-2019 | 106 |
| 55. | July-2019 | 228 |
| 56. | August-2019 | 158 |
| 57. | September-2019 | 186 |
| 58. | October-2019 | 35 |
| 59. | November-2019 | 68 |
| 60. | December-2019 | 40 |
| 61. | Year: 6 January-2020 | 60 |
| 62. | February-2020 | 32 |
| 63. | March-2020 | 19 |
| 64. | April-2020 | 65 |
| 65. | May-2020 | 37 |
| 66. | June-2020 | 33 |
| 67. | July-2020 | 36 |
| 68. | August-2020 | 37 |
| 69. | September-2020 | 31 |
| 70. | October-2020 | 23 |
| 71. | November-2020 | 35 |
| 72. | December-2020 | 43 |
| 73. | Year: 7 January-2021 | 27 |

Data courtesy from the NNPC group [https://www.nnpcgroup.com](https://www.nnpcgroup.com).

Other information considered in the interpretation of the data plot of monthly cases of pipeline vandalism vs. time in month/year (Figure 8) include:

i. The date of deployment (May 2016) of sophisticated weapons, satellite imagery, and geographical information system into the security apparatus to checkmate pipeline vandalism. Before the deployment,
the pipeline security method involved the active patrol in pipeline installation by security agents using patrol vehicles. Another method adopted by past administration was the involvement of local militia leaders in delicate but dangerous and remote locations. After the deployment a combination of the active patrol of pipeline installation by security agents and GIS are used; in addition to a reversal of the policy on the use of local militia.  

ii. The date of declaration of public health emergency of international concern.

iii. The date of the upgrade of the COVID-19 to “pandemic status.”

iv. And the dates of the COVID-19 lockdown narratives in Nigeria.

The May 2016 event (from a cursory glance of Figure 8) had a great impact on cases of pipeline vandalism.

**Analysis of groups and sub-groups**

A comparative analysis of data six months before lockdown (group 2, Table 1) and six months after lockdown (group 4, Table 1) would reveal if COVID-19 had any impact on cases of pipeline vandalism.

Figure 11 compares the cases of pipeline vandalism 6 months after the deployment of GIS and other security apparatus and in the months of lockdown. The total lockdown was observed to yield better results. It was observed that a blanket
Figure 10. Pipeline vandalism analysis by groups.

Figure 11. The effect of improvement of security apparatus and lockdown on cases of pipeline vandalism.

Figure 12. The effect of lockdown implementation on cases of pipeline vandalism.
### Table 3. Statistical analysis of groups and sub-groups.

#### ANOVA: Single factor for groups

| Groups                        | Count | Sum   | Average | Variance |
|------------------------------|-------|-------|---------|----------|
| Prior-COVID -19 (August 2019-January 2020) | 6     | 547   | 91.1667 | 4148.167 |
| COVID (February 2020-July 2020)       | 6     | 222   | 37      | 230      |
| Post- COVID (August 2020-January 2021) | 6     | 196   | 32.6667 | 51.8667  |

#### ANOVA

| Source of Variation | SS         | df | MS       | F        | P-value | F crit |
|---------------------|------------|----|----------|----------|---------|--------|
| Between Groups      | 12750.11111| 2  | 6375.056 | 4.317161 | 0.033045 | 3.68232|
| Within Groups       | 22150.16667| 15 | 1476.678 |          |         |        |
| Total               | 34900.27778| 17 |          |          |         |        |

**SUMMARY**

| TOTAL cases | 547   | 222   | 196   |
| Mean case   | 91.2  | 37.0  | 32.7  |
| Standard deviation | 64.41 | 15.17 | 7.20  |

#### ANOVA: Single factor for sub-groups

| Groups    | Count | Sum     | Average | Variance |
|-----------|-------|---------|---------|----------|
| sub-group A | 12    | 3136    | 261.3333333 | 2796.787879 |
| sub-group B | 12    | 1679    | 139.9166667 | 10212.62879  |
| sub-group C | 12    | 1539    | 128.25   | 3076.386364  |
| sub-group D | 12    | 1954    | 162.8333333 | 3594.69697    |

#### ANOVA

| Source of Variation | SS         | df | MS       | F        | P-value | F crit |
|---------------------|------------|----|----------|----------|---------|--------|
| Between Groups      | 132038.1667| 3  | 44012.72222 | 8.945447976 | 9.67E-05 | 2.816466 |
| Within Groups       | 216485.5   | 44 | 4920.125  |          |         |        |
| Total               | 348523.6667| 47 |          |          |         |        |

**SUMMARY**

| TOTAL cases | 3136 | 1679 | 1954 |
| Mean (monthly) case | 261.3333333 | 139.9167 | 162.8333 |
| Standard deviation | 52.8846658 | 101.0576 | 59.95579 |
restriction lowered the cases of vandalism the most; to an all-time low of 19 cases in March 2020 after a start of 32 cases in February 2020 it was observed that cases started to rise (Figure 11), although it never reach pre-lockdown levels. The blanket restriction on movement was most effective (Table 3).

Lag analysis
A “lag” is a fixed amount of time. In the lag analysis in this paper, two key observations (number of cases of vandalism) are plotted lagged. These are the time periods after the implementation of the GIS into the security apparatus to checkmate pipeline vandalism before changes could be observed. The six-month lag may be the “learning/training and implementation phase” after the media announcements and deployment.

Notice the declining incidences of pipeline vandalism from August after the installation in May with an all-time low in December (Figure 9). It was noted that after the periods of renovations of the methodologies used to checkmate the activities of vandals.

The uncompromising movement restrictions also favored a reduction in cases of pipeline vandalism, as a similar shift was observed in the groups’ data. These data span from six months before lockdown, the COVID-19 pandemics lockdown group and six months after. The lockdown period and the periods immediately after, presented the fewest cases of pipeline vandalism (Figure 10).

As observed from Figures 11 and 12, short term benefits were observed. The restriction of movement led to a reduction of pipeline vandalism when the number of cases of vandalism for any month are compared. However by December, initial ripples were observed.

The implementation of a different security protocol in May 2016 was found to be followed by a reduction in cases of pipeline vandalism. The restriction during the pandemic was found to be followed by a reduction in cases of pipeline vandalism. These methods could be said to be also effective.

Rate of effectiveness
From a security viewpoint, it was therefore desirous to determine if greater success would be attributed to either the use of GIS or blanket restriction. This would enable the design of a more winning approach to vandalism. For this, the cases of pipeline vandalism 6 months after the incorporation and implementation of the GIS systems and the 6 months of total and comprehensive lockdown were compared (Table 4).

To determine this, the rate of effectiveness was considered. This may be defined as:

\[
\text{Rate of effectiveness, } R_e = \frac{(B - A)}{t}
\]

Where:

Rate of effectiveness = \(R_e\)

Number of cases at start of observation period = \(A\)

Number of cases at end of observation period = \(B\)

Time duration of observation period = \(t\)
Table 5. Time series analysis subgroup A.

| t  | Pattern | Time       | Yt       | Yt Baseline | St It                  | Yt/St | Trend component @ time t |
|----|---------|------------|----------|-------------|------------------------|-------|--------------------------|
| 1  | 1       | May 2015   | 2.5      |             |                        | 0.9725186 | 2.57064491 | 2.4 |
| 2  | 2       | June 2015  | 2.87     |             | 2.685                  | 1.068901304 | 1.00995175 | 2.51572008 | 2.5 |
| 3  | 1       | July 2015  | 2.18     |             | 2.525                  | 0.863366337 | 0.9725186 | 2.241602362 | 2.5 |
| 4  | 2       | August 2015| 2.25     |             | 2.215                  | 1.015801354 | 1.00995175 | 2.227829204 | 2.5 |
| 5  | 1       | September 2015| 2.36    |             | 2.305                  | 1.023861171 | 0.9725186 | 2.426688795 | 2.5 |
| 6  | 2       | October 2015| 2.75    |             | 2.555                  | 1.076320939 | 1.00995175 | 2.72290236 | 2.6 |
| 7  | 1       | November 2015| 2.04   |             | 2.395                  | 0.85177453  | 0.9725186 | 2.097646247 | 2.6 |
| 8  | 2       | December 2015| 2.75   |             | 2.395                  | 1.14822547  | 1.00995175 | 2.72290236 | 2.6 |
| 9  | 1       | January 2016 | 4      |             | 3.375                  | 1.185185185 | 0.9725186 | 4.113031857 | 2.7 |
| 10 | 2       | February 2016| 2.93    |             | 3.465                  | 0.845598846 | 1.00995175 | 2.901128696 | 2.8 |
| 11 | 1       | March 2016  | 2.59     |             | 2.76                   | 0.938405797 | 0.9725186 | 2.663188127 | 2.7 |
| 12 | 2       | April 2016  | 2.14     |             | 2.365                  | 0.904862579 | 1.00995175 | 2.118913109 | 2.8 |
| t  | Time          | Pattern | Cases of pipeline vandalism (within year of deployment) | Moving average, MA(2) | Seasonal and irregular components | Desseasonalize Tt | St  |
|----|--------------|---------|------------------------------------------------------|------------------------|-----------------------------------|-------------------|-----|
| 1  | May 2016     | 2       | 26.65                                                | 0.77571062             | 3.351765381                      | 276.123447        | 2   |
| 2  | June 2016    | 2.6     | 26.05                                                | 0.50441166             | 2.746709018                      | 251.500717        | 2.6 |
| 3  | July 2016    | 3.11    | 28.66                                                | 1.08769022             | 2.280719188                      | 223.8702807       | 3.11|
| 4  | August 2016  | 2.21    | 2.66                                                 | 0.830827068            | 2.849000573                      | 201.253446        | 2.21|
| 5  | September 2016 | 1.79  | 0.895                                                | 0.50441166             | 1.833333333                      | 181.6298166       | 1.79|
| 6  | October 2016 | 1.01    | 1.4                                                  | 0.721428571            | 1.06978022                       | 158.0061845       | 1.01|
| 7  | November 2016 | 1.043  | 0.72                                                 | 0.597222222            | 0.77570162                       | 134.1602525       | 1.043|
| 8  | December 2016 | 0.18   | 0.305                                                | 0.50441166             | 0.180385538                      | 110.7582044       | 0.18|
| 9  | January 2017 | 0.06    | 0.39                                                 | 0.590163934            | 0.77570162                       | 105.6594744       | 0.06|
| 10 | February 2017 | 0.49   | 0.545                                                | 0.590163934            | 0.77570162                       | 95.315608         | 0.49|
| 11 | March 2017   | 0.94    | 0.715                                                | 0.590163934            | 0.77570162                       | 59.9880249        | 0.94|
| 12 | April 2017   | 0.82    | 0.88                                                 | 0.590163934            | 0.77570162                       | 37.9315299        | 0.82|
Table 7. Time series analysis subgroup C.

| t  | Pattern | Time          | Yt                      | Baseline          | St | Trend component @ time t |
|----|---------|---------------|-------------------------|-------------------|----|-------------------------|
| 1  | 1       | May 2017      | 5.5                     |                   |    |                         |
| 2  | 2       | June 2017     | 8.6                     | 7.05              | 1.219858156 | 6.772518154 | 7.483994404 | 9.3       |
| 3  | 1       | July 2017     | 11.6                    | 10.1              | 1.148514851 | 10.55884569 | 8.561910326 | 9.4       |
| 4  | 2       | August 2017   | 7                       | 9.3               | 0.752688172 | 7.140421753 | 9.639826247 | 9.5       |
| 5  | 1       | September 2017| 7                       |                   |    |                         |
| 6  | 2       | October 2017  | 12.6                    | 9.8               | 1.285714286 | 12.85275916 | 11.79565809 | 11.6      |
| 7  | 1       | November 2017 | 13.6                    | 13.1              | 1.038167939 | 12.37933633 | 12.87357401 | 14.1      |
| 8  | 2       | December 2017 | 17.6                    | 15.6              | 1.128205128 | 17.95306041 | 13.95148993 | 13.7      |
| 9  | 1       | January 2018  | 21.6                    | 19.6              | 1.102040816 | 19.66129887 | 15.02940585 | 16.5      |
| 10 | 2       | February 2018 | 14.8                    | 18.2              | 0.813186813 | 15.09689171 | 16.10732177 | 15.8      |
| 11 | 1       | March 2018    | 22.4                    | 18.6              | 1.204301075 | 20.38949513 | 17.18523769 | 18.9      |
| 12 | 2       | April 2018    | 11.6                    | 17                | 0.682352941 | 11.83269891 | 18.26315361 | 17.9      |
Table 8. Time series analysis subgroup D.

| t | Pattern | Time            | Cases of pipeline vandalism (2 years after deployment) $\times 10^2$ | Moving average, MA(2) | Seasonal and irregular components | St     | Deseasonalize | Tt     | St*Tt   |
|---|---------|-----------------|-------------------------------------------------|----------------------|-----------------------------------|--------|---------------|--------|--------|
| 1 | 1       | May 2018        | 0.82                                            |                      | 0.76227095                        | 1.075732985 | 145.0591046 | 110.5743 |
| 2 | 2       | June 2018       | 1.74                                            | 1.28                 | 1.14617666                        | 1.518090589 | 147.7548965 | 169.3532 |
| 3 | 3       | July 2018       | 2.04                                            | 1.89                 | 1.08577925                        | 1.87883494  | 150.4506885 | 163.3562 |
| 4 | 1       | August 2018     | 0.86                                            | 1.45                 | 0.593103448                       | 0.76227095 | 1.128207764 | 153.1464805 | 116.7391 |
| 5 | 2       | September 2018  | 1.25                                            | 1.055                | 1.184834123                       | 1.14617666 | 1.090582319 | 155.8422724 | 178.6228 |
| 6 | 3       | October 2018    | 2.19                                            | 1.72                 | 1.273255814                       | 1.08577925 | 2.016984568 | 158.5380644 | 172.1373 |
| 7 | 1       | November 2018   | 1.97                                            | 2.08                 | 0.947115385                       | 0.76227095 | 2.584382902 | 161.2338563 | 122.9039 |
| 8 | 2       | December 2018   | 2.64                                            | 2.305                | 1.145336226                       | 1.14617666 | 2.303309858 | 163.9296483 | 187.8923 |
| 9 | 3       | January 2019    | 2.3                                             | 2.47                 | 0.931174089                       | 1.08577925 | 2.118294295 | 166.6254403 | 180.9184 |
| 10| 1       | February 2019   | 1.37                                            | 1.835                | 0.746594005                       | 0.76227095 | 1.797261206 | 169.3212322 | 129.0687 |
| 11| 2       | March 2019      | 1.11                                            | 1.24                 | 0.89516129                        | 1.14617666 | 0.9684371   | 172.0170242 | 197.1619 |
| 12| 3       | April 2019      | 1.25                                            | 1.18                 | 1.059322034                       | 1.08577925 | 1.1512469   | 174.7128161 | 189.6996 |
Figure 13. Time series analysis subgroup A.

Figure 14. Time series analysis subgroup B.
Figure 15. Time series analysis subgroup C.

Figure 16. Time series analysis subgroup D.
Time series analysis
A time series analysis of the data was undertaken to determine the effect of time vandalism on pipeline and allow forecasting using a moving average (MA) model.

In time series analysis a sequence of data points recorded over an interval of time and collected at consistent intervals over the set period of time at consistent intervals is analysed. the data points are not intermittently or randomly selected. The time series analysis of subgroups A, B, C and D are shown in Tables 5, 6, 7, and 8 respectively. In Figures 13, 14, 15, and 16 dataset from each subgroups and generated moving average models are plotted. This shows the degree of fitness of the moving average models in each incidence.

Data availability
Underlying data
Harvard Dataverse. Effects of COVID-19 on pipeline vandalism in Nigeria, West Africa. DOI: https://doi.org/10.7910/DVN/8X5KKB.30

This project contains the following underlying data:

Dataset Data for Effects of COVID-19 on pipeline vandalism ingested files:

- Original data.tab. (Contains the unfiltered data from the NNPC reports, with cases of pipeline vandalism tabulated by month and year.).
- ANOVA-Historical subgroups.tab. (Two sheets. One; (MasterDataSheet) contains the original data divided into the groups and a second (Historical sub-groups) preliminary analysis on the sub-groups).
- ANOVA-COVID-19 groups.tab. (ANOVA analysis of COVID-19 group (prior, during, and post COVID-19 lockdown groups)).
- Graph-subgrpB-and-6-months lockdown.tab. (Comparative analysis of key periods – 1 February-30 July 2017 and 1 February-30 July 2020).
- Time series analysis -COVID-19 groups.tab. (Time series analysis of COVID-19 group (prior, during, and post COVID-19 lockdown groups) smoothening with moving average).
- Time-series analysis-Historical subgroups.tab. (Time series analysis of historical subgroups with smoothening by moving average).

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

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Open Peer Review

Current Peer Review Status: ✖ ✖

Version 1

Reviewer Report 11 January 2022

https://doi.org/10.5256/f1000research.57792.r115417

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Nima Khakzad
School of Occupational and Public Health, Ryerson University, Toronto, Ontario, Canada

The authors have assessed the influence of satellite/GIS equipment and the COVID-19 lockdown on the number of pipeline vandalism events in Nigeria. In general, the employed technique is oversimplified, and the research outcomes are too obvious to warrant a novel/innovative study. From a methodological perspective, regarding the deployment of satellite/GIS equipment and restriction of social activities due to the COVID-19 lockdown as two independent variables and the number of pipeline vandalism events as the only dependent variable, the authors should have employed a multi-variable correlation analysis rather than two separate single-variable correlation analysis, at least from the onset of the lockdown onwards.

Furthermore, the results of the study are too obvious to justify the necessity of the research. That the deployment of monitoring measures and the COVID-19 lockdown have had a negative impact on the number of the vandalism events was predictable even with a glimpse on the raw data in Figure 1.

Below are some more comments:

- In the abstract, the data is said to have been assessed in 5 groups, but only 4 groups have been named. Please correct this.

- Under “other assumptions made”, 2 groups of people are said to be involved in pipeline vandalism, but three groups are named. Please correct this.

- In the abstract, it should be pointed out, as one of the main outcomes of the study, why the number of pipeline vandalisms rose again in 2017 despite all the security and satellite measures.

- Use of acronyms/abbreviations in the Keywords is not recommended. (NNPC in this case). Besides, the keywords “pipeline” and ‘pipes” are too close to be considered two different keywords.
The vertical lines marked on Figure 1 need to be in different colors with a legend provided to decode the colors. In the current form, except the first line which denotes the deployment of satellite/GIS equipment, the other lines are not clear to mark which significant event/date.

**Is the rationale for creating the dataset(s) clearly described?**
Yes

**Are the protocols appropriate and is the work technically sound?**
No

**Are sufficient details of methods and materials provided to allow replication by others?**
Yes

**Are the datasets clearly presented in a useable and accessible format?**
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Safety Engineering; Cascading effects

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 28 July 2021

https://doi.org/10.5256/f1000research.57792.r89908

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Alessandro Rovetta
1 Redeev SRL, Naples, Italy
2 Research and Disclosure Division, Mensana srls, Brescia, Italy

**General comments:**

This paper investigates the impact of anti-COVID-19 restrictive measures on the vandalism pipeline by analyzing the time series of the incidence of the phenomenon from January 2015 to January 2021. To do this, an ANOVA is adopted after the data has been processed via a moving average. The authors conclude that COVID-19 influenced the incidences of pipeline vandalism. However, at present, there are numerous critical issues to be addressed before proceeding with indexing.
Major comments:

1) Section: Introduction. This section needs some additions to represent a complete background and contextualize the paper in the current scenario. Specifically, I suggest briefly discussing:

1.1. The incidence of pipeline vandalism in Nigeria and the related problems and damage (providing appropriate references)

1.2. The usefulness of this study (i.e., what kind of information can this type of analysis return regarding pipeline vandalism? Why is it relevant to evaluate the impact of anti-pandemic restrictions on the phenomenon?)

1.3. The significance of the paper for future research (i.e., how can this data note help government authorities deal with pipeline vandalism?)

2) Section: Methods.

2.1. “These monthly reports are available for free download by the public from the NNPC website link (NNPC; https://www.nnpcgroup.com)” To facilitate reproducibility, I kindly ask the authors to provide a more precise URL or path description to derive this dataset. Thank you.

2.2. “The data were grouped into four groups, namely: [...]” I strongly suggest motivating those subdivisions in detail. In particular, based on what criteria and purpose were these groups formed?

2.3. “May 2016, incorporation and deployment of sophisticated weapons, use of satellite images and geographical information system (GIS) into the security apparatus to ensure vandalism is contained, the setting up of a pipeline security force to stamp out the menace, and the formation of the Trans-National Organized Crime (TNOC) with regional allies to fight against the proliferation of Small Arms and Light Weapons. 4” Reference 4 refers to a web page called “Oil and Gas 360.” Therefore, I kindly ask if it is possible to provide a more specific URL or refer to an academic source.

2.4. “In Nigeria, the pre-lockdown commenced from 28th February – 29th March, 2020, and was 31 days in duration. The lockdown, in total 35 days; was from 30th March to 3rd May, 2020, and easing up’ of 73 days, 5th May – 15th July, 2020.” This information needs a reference.

2.5. “The May 2016 event (from a cursory glance of Figure 1) had a great impact on cases of pipeline vandalism.” Figure 1 shows that the decreasing trend has occurred since July 2016. Therefore, it is necessary to argue the causal nature of the association made and discuss the presence of a time-series lag.

2.6. “In all statistical analysis in this project, an alpha = 0.05 as the significance threshold was set, and a null and an alternative hypothesis were established. This means that the null hypothesis would be rejected if the p-value is less than or equal to 0.05 and the alternative hypothesis would be accepted.” Using a simple threshold for significance analysis is misleading (Amrhein et al. (2017)1, Greenland et al. (2016)2). P-values should be used - at best - as a graded measure of the strength of evidence against the null hypothesis. Therefore it is necessary to report the P-values in full (if this is not
possible, it is advisable to provide an additional file). Furthermore, P-values are unsuitable for measuring the intensity of a phenomenon (e.g., very weak but statistically significant phenomena can occur (Schober et al. (2018))). Therefore I suggest introducing quantifiers into the analysis (e.g., percentage differences).

2.7. “The sub-grouped data were also subjected to an ANOVA, and a time series analysis (after the data were smoothened by moving average).” ANOVA analysis requires the verification of a certain number of assumptions, as explained here. Therefore, how the latter has been verified must be described in detail. Moreover, it is necessary to specify the type of ANOVA adopted. Finally, the amplitude of the moving average must be specified.

2.8. A time-series analysis requires the verification of the absence/presence of previous trends. Therefore, I suggest adding this essential control.

2.9. “Pipeline vandalism takes place in remote locations on isolated, rural roads and footpaths; not readily accessible during adverse weather conditions.” Since this sentence justifies a fundamental assumption, I suggest motivating it with a source.

Minor comments:

m1) Section: Method. “The onset of COVID-19 in December 2019 and the declaration of COVID-19, on 30th January 2020, as a Public Health Emergency of International Concern by WHO (World Health Organization), and the upgrade to a pandemic by the 11th of March 2020.” This sentence needs a reference. I can suggest this one here.

m2) Section: Method. “During the lockdown, no activists, radicals, and militants made any political statement; f...” It would be appropriate to justify this sentence with a source.

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2. Greenland S, Senn SJ, Rothman KJ, Carlin JB, et al.: Statistical tests, P values, confidence intervals, and power: a guide to misinterpretations. Eur J Epidemiol. 31 (4): 337-50 PubMed Abstract | Publisher Full Text
3. Schober P, Boer C, Schwarte LA: Correlation Coefficients: Appropriate Use and Interpretation. Anesth Analg. 126 (5): 1763-1768 PubMed Abstract | Publisher Full Text

Is the rationale for creating the dataset(s) clearly described?
Partly

Are the protocols appropriate and is the work technically sound?
Partly

Are sufficient details of methods and materials provided to allow replication by others?
No

Are the datasets clearly presented in a useable and accessible format?
Partly

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Infodemiology, Infoveillance, Public Health, Statistics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

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### Comments on this article

#### Version 1

**Author Response 24 Aug 2021**

**N Onwuachi-Iheagwara**, Delta state university, Oleh, Nigeria

- **Section: Introduction.** This section needs some additions to represent a complete background and contextualize the paper in the current scenario. Specifically, I suggest briefly discussing: 1.1. *The incidence of pipeline vandalism in Nigeria and the related problems and damage (providing appropriate references)*
- **Response:** Oil spillage is associated with oil pipeline destruction. The destruction of pipelines leads to several environmental problems; this includes fresh and seawater pollution, air pollution, chemical pollution, soil and land pollution [1]. This also makes most agricultural practice unsustainable with an associated decline in fish farming in populated waters, biodiversity depletion [3], loss of habitat and loss of ecological and security systems [2,3,4].

**References:**

1. Mmeje, David Uchechukwu, Bello Ayuba, U.D. Mohammed. Investigation of Pipeline Vandalism and Its Implications on Business Activities in Nigeria. Journal of Resources Development and Management, 2017 Vol.38, pp.69-81. ISSN 2422-8397 [www.iiste.org](http://www.iiste.org)
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4. E. Ugwuanyi, “Steaming Vandalism Theft in Downstream Sector” in A.C. Okoli and S. Orinya, “Oil Pipeline Vandalism and Nigeria's National Security” (2013) Global Journal of Human Social Science

- **1.2. The usefulness of this study (i.e., what kind of information can this type of analysis return regarding pipeline vandalism? Why is it relevant to evaluate the impact of anti-pandemic**
restrictions on the phenomenon?

- **Response:** Despite the 21 years to life imprisonment for pipeline vandalism [1; Section 2 of the Petroleum Production and Distribution (Anti-Sabotage) Act Cap]; statistics have shown three main aspects of the vandalism; that must be addressed if any meaningful sustainable gain against pipeline vandalism can be addressed. One, Nigeria is losing well over 300,000 barrels per day (BPD) as a result of crude oil pipeline vandalism; [2]. Two, this translates into billions of dollars in losses [3, 4]. Where is this money? Which “class” of Nigerians are involved in this act? Also, pipeline vandalism occurs at remote locations because of the nature of the criminality [5]. In the global fight against the COVID-19, several of our liberties were suspended. This includes the freedom of movement and association. The pandemics, therefore, offer a unique opportunity to study the effect of movement restriction on pipeline vandalism. It is logical to assume a relationship between access to pipelines and physical vandalism (which involves the destruction of pipes materially). This type of destruction is not remote; it implies access. Access to the pipeline and the opportunity; are two aspects of the equation that were removed during the lockdown.

“Access” involves proximity to the pipeline during which time these structures are destroyed or compromised to gain the fluid within. Legally, at this point, the miscreant is termed a vandal. “Opportunity”, on the other hand, entails a longer time duration to enable the fluid to be scooped/removed and carted away by the (Vandals, now termed ) thieves. Verification of this model, during “peacetime” is somewhat limited in a democracy. The constitution and economic considerations would not permit. The pipeline passes through a large expanse of land and to effectively lock down the route and passes would be practically impossible. However, during the pandemic, many of these considerations (economically, politically, and constitutionally) were removed, therefore the condition (for vandalism) theoretically diminished. In this light, the pandemic and consequent lockdown could be seen as an experiment. Therefore, the study would reveal the roles “opportunity” and “access to pipeline” play in vandalism. The Researchers could test if a relationship exists between observed variables and their underlying latent constructs.

To accomplish this, the researchers use empirical research, to postulate the relationship pattern and test it statistically. Why is it relevant? This paper examines the nexus between oil pipeline vandalism and public accessibility in Nigeria.

Given the adverse impact of pipeline vandalism as exemplified in loss of life, economic losses, environmental degradation, and pipeline explosions, the paper submits that an evaluation of the impact of anti-pandemic restrictions on the phenomenon is very relevant as pipeline vandalism poses a danger for economic wellbeing and national security.

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1. Edward Ohwofasa Okumagba. Oil and Gas Pipeline "Vandalism" in Nigeria: Analysing Alternative Options beyond the Traditional Legal Approach. International Energy Law Review. 2019 issue 7 p183-190. https://www.researchgate.net/publication/342184010
2. Okoli, A.C. The political ecology of the Niger Delta crisis and the prospects of lasting peace in the post amnesty period “Global Journal of Human Social Science, 2013, 13 (3:1.0), pp.38-46.
3. Michael Eboh 2021. “Cost of pipeline vandalization, oil theft hit N159bn in 1 year”. Vanguard. August 1, 2021. https://www.vanguardngr.com/2020/10/cost-of-pipeline-vandalisation-oil-theft-hit-n159bn-in-1-year/
4. O. O Udofia; O. F Joel. Pipeline Vandalism in Nigeria: Recommended Best Practice of Checking the Menace. Paper presented at the Nigeria Annual International Conference and Exhibition, Lagos, Nigeria, August 2012. Paper Number: SPE-162980-MS, https://doi.org/10.2118/162980-MS, Published: August 06, 2012

5. Ahmed Tukur Umar & Moh’d Shahwahid Hajj Othman | Miao Wang (Reviewing Editor) (2017) Causes and consequences of crude oil pipeline vandalism in the Niger Delta region of Nigeria: A confirmatory factor analysis approach, Cogent Economics & Finance, 5:1, DOI: 10.1080/23322039.2017.1353199

• 1.3. The significance of the paper for future research (i.e., how can this data note help government authorities deal with pipeline vandalism?)
  • **Response:** The government would be better informed and thus, can make better decisions to checkmate this vice.

• **Section:** Methods 2.1. “These monthly reports are available for free download by the public from the NNPC website link (NNPC; https://www.nnpcgroup.com)” To facilitate reproducibility, I kindly ask the authors to provide a more precise URL or path description to derive this dataset. Thank you.
  • **Response:** Under the land use decree, the oil wealth of the country (Nigeria) resides with the federal government. Most aspect is controlled by the Nigeria National Petroleum Cooperation (NNPC) or its subsidiaries. The NNPC publishes the “NNPC Monthly Financial Operations Report” which can be accessed by clicking “NNPC Business” and selecting “Business Information”, then “Monthly Performance Data” on their website (https://www.nnpcgroup.com) or through (https://www.nnpcgroup.com/NNPC-Business/Business-Information/Pages/Monthly-Performance-Data.aspx)

• 2.2. “The data were grouped into four groups, namely: [...]” I strongly suggest motivating those subdivisions in detail. In particular, based on what criteria and purpose were these groups formed?
  • **Response:** The data used were from January 2015 to January 2021. The names of each group are self-explanatory; namely: Historical data, Prior-covid-19, Covid-19 lockdown, And post-COVID-19 lockdown. The data were grouped based on dates. “Historic data” span from January 2015 to July 2019, these data represent pipeline vandalism data completely without COVID-19 influences. These data were collected before the outbreak, thus as there was no “knowledge” of COVID-19 during the time represented by this group, it could be assumed that COVID-19 did not influence the data collected on pipeline vandalism during this time. These data can therefore be used as a “baseline”; such as “norm”. Groups 2-4 were arbitrarily set within a duration of 6-months. Pipeline vandalism during the time frame represented by groups 2-4 could be imparted by COVID-19: These groups can therefore be compared with “historical data” of the same time in the past from the historical data group, (group1) to determine if COVID-19 had in any way influenced the outcome (the
number of pipeline vandalism during the stated time). To minimize/remove seasonal variation due to the weather (wet and dry season) data were compared only with data from the corresponding seasonal frame. This is logic, data of pipeline vandalism in the summer should be compared against summer data; winter against winter in the colder zones; similarly, data of pipeline vandalism in the rainy season against data of pipeline vandalism in another rainy season in the tropic. Group 1, January 2015 to July 2019, represents a “norm”. However, on closer inspection of figure 1, an alteration would be observed about June 2016, this would imply an event occurred which altered the normal sequence. For this reason, literature and newspapers were consulted to determine which event occurred about that time that led to such a drastic change in the norm. The implementation of a different security protocol was found to have occurred in May 2016. Thus, the historical data were further sub-grouped into sub-groups A, B, C, and D, representing 1-year before deployment, the year of deployment, 1-year after deployment, and 2-years after deployment, respectively.

For an in-depth explanation, kindly view the Dataverse, Data for Effects of COVID-19 on pipeline vandalism in Nigeria, West Africa, (https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/8X5KKB) published in Dataverse for COVID-19, social distancing, and pipeline vandalism in Nigeria (https://dataverse.harvard.edu/dataverse/Nneka).

2.3. “May 2016, incorporation and deployment of sophisticated weapons, use of satellite images and geographical information system (GIS) into the security apparatus to ensure vandalism is contained, the setting up of a pipeline security force to stamp out the menace, and the formation of the Trans-National Organized Crime (TNOC) with regional allies to fight against the proliferation of Small Arms and Light Weapons. 4”. Reference 4 refers to a web page called “Oil and Gas 360.” Therefore, I kindly ask if it is possible to provide a more specific URL or refer to an academic source.

Response: It is not an academic paper; it is an EVENT reported in the news; hence a newspaper is an appropriate source for this information. The reference is: Levinus Nwabughigu, C. (2016, May 28). Buhari’s milestones in one year – Presidency. Vanguard: https://www.vanguardngr.com/2016/05/buharis-milestones-in-one-year-presidency/

2.4. “In Nigeria, the pre-lockdown commenced from 28th February – 29th March 2020, and was 31 days in duration. The lockdown, in total 35 days; was from 30th March to 3rd May 2020, and easing up of 73 days, 5th May – 15th July 2020.” This information needs a reference.

Response: Ibrahim RL, Ajide KB, Olatunde Julius O. Easing of lockdown measures in Nigeria: Implications for the healthcare system. Health Policy Technol. 2020;9(4):399-404. doi:10.1016/j.hlpt.2020.09.004 and Dan-Nwafor, Chioma et al. “Nigeria’s public health response to the COVID-19 pandemic: January to May 2020.” Journal of global health vol. 10,2 (2020): 020399. doi:10.7189/jogh.10.020399

2.5. “The May 2016 event (from a cursory glance of Figure 1) had a great impact on cases of pipeline vandalism.” Figure 1 shows that the decreasing trend has occurred since July 2016. Therefore, it is necessary to argue the causal nature of the association made and discuss the presence of a time-series lag.

Response: A “lag” is a fixed amount of time. A lag plot is a special case of x, y plot; wherein a
set of observations is plotted lagged against a second set of observations. It is our view that adequate information on the number of cases of pipeline vandalism by time (month/year) is conveyed by figure 1. The possible causal nature/association of other events with cases of vandalism are shown in the graph. Yes, it can be argued that an association exists between the decreasing trend after the deployment and the deployment.

• 2.6. “In all statistical analysis in this project, an alpha = 0.05 as the significance threshold was set, and a null and an alternative hypothesis were established. This means that the null hypothesis would be rejected if the p-value is less than or equal to 0.05 and the alternative hypothesis would be accepted.” Using a simple threshold for significance analysis is misleading (Amrhein et al. (20171), Greenland et al. (20162)). P-values should be used - at best - as a graded measure of the strength of evidence against the null hypothesis. Therefore it is necessary to report the P-values in full (if this is not possible, it is advisable to provide an additional file). Furthermore, P-values are unsuitable for measuring the intensity of a phenomenon (e.g., very weak but statistically significant phenomena can occur (Schober et al. (20183))). Therefore I suggest introducing quantifiers into the analysis (e.g., percentage differences).

• Response: In recent times, some scholars have challenged the use of a threshold to declare the statistical significance of the p-value, [1]. Two main arguments are, one; research data contain more meaning than is summarized in a P-value and its statistical significance, and two; the concepts are frequently misunderstood and consequently inappropriately interpreted. The abolishment of p-values has been echoed in such an article as “Should statistical significance be retired? ” [DOI: 10.1007/s00393-020-00835-x, download at https://pubmed.ncbi.nlm.nih.gov/32621162/] . We, however, do not wish to be drawn into that argument. In line with best practice for transparency in data analysis, our research hypotheses were clearly articulated; they are; namely: Null hypothesis: There is no significant difference between the mean case of pipeline vandalism incidences prior, during, and post COVID-19 lockdown. Alternative hypothesis: There is a significant difference between the mean cases of pipeline vandalism incidences prior, during, and post COVID-19. Traditionally, researchers examine such differences between groups using t-test, Anova [2,3,4]. We used ANOVA; however, in the second version, percentage differences shall be added as quantifiers into the analysis. References:

1. Andrade, Chittaranjan. “The P-Value and Statistical Significance: Misunderstandings, Explanations, Challenges, and Alternatives.” Indian journal of psychological medicine vol. 41,3 (2019): 210-215. doi:10.4103/IIJPSYM.IJPSYM_193_19. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6532382/
2. http://mason.gmu.edu/~afinn/html/teaching/courses/f03_comm250/fbk_chapters/13.pdf
3. https://www.sciencedirect.com/science/article/pii/S1877042813029686/pdf?md5=2ee7f259710d2a331ed20-s2.0-S1877042813029686-main.pdf
4. https://www.arcjournals.org/pdfs/ijsimr/v3-i12/10.pdf

• 2.7. “The sub-grouped data were also subjected to an ANOVA, and a time series analysis (after the data were smoothened by moving average).” ANOVA analysis requires the verification of a certain
number of assumptions, as explained here. Therefore, how the latter has been verified must be described in detail. Moreover, it is necessary to specify the type of ANOVA adopted. Finally, the amplitude of the moving average must be specified.

- **Response:** The assumptions in ANOVA are concerned with the population distribution. These three assumptions are:

1. Homoscedasticity of the dependent variable (equality of variances among group
2. Dependent variable is normally distributed within each group
3. Each observation in the sample is independent of all others

The type of ANOVA: In this investigation, one-way ANOVA was used. A one-way ANOVA is a statistical test used to determine whether or not there is a significant difference between the means of three or more independent groups.
The assumptions in the one-way ANOVA are:

1. Normality: that each sample is taken from a normally distributed population.
2. Sample independence: that each sample has been drawn independently of the other samples.
3. Variance Equality: that the variance of data in the different groups should be the same.

The verification of the assumptions used in the ANOVA analysis. Normality can check visually or, by a histogram. Variance can be checked with a boxplot. For the third assumption, there is no formal test to verify that the observations in each group are independent. Finally, the amplitude of the moving average must be specified. The amplitude of the moving average shall be elaborated in the second version of the article

- **2.8. A time-series analysis requires the verification of the absence/presence of previous trends. Therefore, I suggest adding this essential control.**
- **Response:** This shall be added in the second version of our paper. Thank you for your observation.

- **2.9. “Pipeline vandalism takes place in remote locations on isolated, rural roads and footpaths; not readily accessible during adverse weather conditions.” Since this sentence justifies a fundamental assumption, I suggest motivating it with a source.**
- **Response:** Olu-Adeyemi (2020). The Political Ecology of Oil Pipeline Vandalism in Nigeria Lanre. International Journal of Research and Innovation in Social Science (IJRiSS) |Volume IV, Issue V, May 2020|ISSN 2454-6186 and Okoli, Al Chukwuma (2019). Oil Pipeline vandalism In the Niger Delta. Accord: Conflict Trendsop. Cit: https://www.accord.org.za/conflict-trends/oil-pipeline-vandalism-in-the-niger-delta/

- **Minor comments: m1) Section: Method. “The onset of COVID-19 in December 2019 and the declaration of COVID-19, on 30th January 2020, as a Public Health Emergency of International**
Concern by WHO (World Health Organization), and the upgrade to a pandemic by the 11th of March 2020.” This sentence needs a reference. I can suggest this one here. Sohrabi C, Alsafi Z, O'Neill N, et al. World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19) [published correction appears in Int J Surg. 2020 May;77:217]. Int J Surg. 2020;76:71-76. doi:10.1016/j.ijsu.2020.02.034 and Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. Acta Biomed. 2020 Mar 19;91(1):157-160. doi: 10.23750/abm.v91i1.9397. PMID: 32191675; PMCID: PMC7569573.

• **Response:** Thank you, we will include it.

• m2) Section: Method. “During the lockdown, no activists, radicals, and militants made any political statement; [...]” It would be appropriate to justify this sentence with a source.

• **Response:** As noted in response to your question in 2.3 above. Everything is not an academic paper. When activists, militants strike a pipeline installation it is reported in the News. This implies an absence of reports in the absence of a strike.

Overall, thank you for your observations.

**Competing Interests:** There are no competing interests to declare.

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