ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

Analysing the Impact of Attacks and Vandalism on Nigerian Electricity Transmission Lines: Causes, Consequences, and Mitigation Strategies

Adebayo, Adeyinka Victor
University of Johannesburg
South Africa

Oladeji, Samuel
University of Strathclyde Glasgow
South Africa

Adebayo, Hussein Kehinde
Ad-Huke Engineering Nig Limited
South Africa

Abstract:- This study meticulously examines the impacts of attacks and vandalism on Nigerian electricity transmission lines, analysing their causes, consequences, and potential mitigation strategies. Historical data reveals that socio-economic and political factors are the root causes of these destructive acts, including insurgencies and economic desperation. Recent trends show an alarming increase in the frequency and sophistication of such attacks, primarily using explosives, which pose a significant challenge to the Nigerian electricity sector. The geographical distribution of these incidents is a cause for concern, with a concentration in the Northeast and North-Central regions directly correlating with regional instability. The severe economic and social impacts are leading to prolonged power outages, substantial financial losses, and public dissatisfaction. This paper underscores the potential of a multi-faceted approach, including enhanced security measures, community engagement, and strategic policy reforms, to protect vital infrastructure and ensure a stable electricity supply. The research findings are a call to action for policymakers and stakeholders, providing a solid foundation for enhancing the resilience and reliability of Nigeria's power transmission system. Our collective responsibility is to act on these findings and contribute to the solution.

I. INTRODUCTION

The Nigerian power sector is in a crisis, grappling with persistent technical and economic challenges hindering its ability to meet operational targets. These performance constraints are particularly acute in the Nigeria Transmission Company (TCN) (Arowolo & Perez, 2020). Despite the visibility of these issues, a comprehensive analysis of the constraints has been lacking. Therefore, this study is crucial to identifying, analysing, and suggesting solutions for TCN's challenges. The study employed a survey method, distributing questionnaires to suppliers, customers, supervisory technicians at test bed stations, officials in charge, and employees in relevant TCN departments. The findings revealed the necessity for employees to engage in hands-on and off-the-job training programs to enhance their skills and qualifications, ensuring they can effectively fulfil their duties (Komolafe & Udofia, 2020).

Nigeria's skilled workforce holds immense potential to contribute significantly to TCN operations. However, mechanisms to unlock this potential are needed to meet organisational goals. The assessment highlighted that supervisory training, continual growth, and skill-based training curricula are crucial for achieving competitive service standards and addressing TCN's constraints (Olusola et al., 2020). Focusing on these critical factors allows the TCN to adopt the best institutional training and growth practices, ensuring sustained organisational performance and problem-solving capabilities. The findings underscore the importance of development counselling guidelines, clear definitions of supervisory duties, motivational techniques, and operational philosophies in enhancing the efficiency and effectiveness of TCN operations. In conclusion, by addressing the identified constraints through targeted training and development programs, we can tap into the potential of the Nigerian workforce and significantly improve the performance and reliability of Nigeria's power transmission system, paving the way for a more efficient and reliable power sector (Arowolo & Perez, 2020; Olusola et al., 2020; Komolafe & Udofia, 2020).

- *Background and Significance of the Study*

The Nigerian power sector has been grappling with continuous technical and economic challenges, impeding its ability to meet operational targets. These performance constraints are particularly pronounced in the Nigeria Transmission Company (TCN) (Arowolo & Perez, 2020). Despite the visibility of these issues, a comprehensive analysis

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

of the constraints has been lacking. Therefore, this study is a significant step towards identifying, analysing, and suggesting solutions for TCN's challenges. The study employed a survey method, distributing questionnaires to suppliers, customers, supervisory technicians at test bed stations, officials in charge, and employees in relevant TCN departments. The findings revealed the necessity for employees to engage in hands-on and off-the-job training programs to enhance their skills and qualifications, ensuring they can effectively fulfil their duties (Komolafe & Udofia, 2020).

Nigeria boasts a skilled workforce capable of contributing significantly to the operations of TCN; however, mechanisms to unlock this potential are needed to meet organisational goals. The assessment highlighted that supervisory training, continual growth, and skill-based training curricula are crucial for achieving competitive service standards and addressing TCN's constraints (Olusola et al., 2020). Focusing on these critical factors allows the TCN to adopt the best institutional training and growth practices, ensuring sustained organisational performance and problem-solving capabilities. The findings underscore the importance of development counselling guidelines, clear definitions of supervisory duties, motivational techniques, and operational philosophies in enhancing the efficiency and effectiveness of TCN operations. In conclusion, by addressing the identified constraints through targeted training and development programs, we can significantly improve the performance and reliability of Nigeria's power transmission system, paving the way for a more efficient and reliable power sector (Arowolo & Perez, 2020; Olusola et al., 2020; Komolafe & Udofia, 2020).

- *Overview of the Nigerian Electricity Sector. Historical Context of Infrastructure*

This paper discusses the underlying causes of different categories of vandalism and attacks on Nigeria's electricity transmission lines. Interview data is analysed, and some prevalent trends of vandalism relating to Nigeria's electricity power conducting materials are presented (Wokoma & Ojuka). The consequences of both failed and failed-safe design transmission lines are echoed. Moreover, the constraints of the Transmission Company of Nigeria's line rehabilitation policies and counter-strategy decisions are addressed (Dike, 2020). The outcome of this paper is expected to offer direction to policymakers and the present/upcoming electricity infrastructure legislation towards reducing the observed attacks (Fayomi et al., 2022). Electricity infrastructures have historically provided steady energy supplies to drive economies and lift living standards. The Nigerian electricity industry has two subsectors: the oil-installed thermal power generating plants and the hydro-installed power plants. The total installed capacity of Nigeria's power-generating plants was stated to be 11,165.4 MW as of July 2008, distributed into gas-based thermal (73.6%) and hydro-based (26.4%) power-generating plants (Fayomi et al., 2022).

The national grid connects nationwide electricity-generating plants through a high-voltage network of 330 kV and 132 kV single-circuit transmission lines. Although Nigeria's transmission lines suffered recurrent attacks and vandalism in the past two decades, not much has been discussed in the public domain regarding the causes, consequences, and mitigation strategies of such occurrences (Wokoma & Ojuka; Dike, 2020). By addressing these issues comprehensively, Nigeria can better safeguard its electricity transmission lines, ensuring a more reliable energy supply crucial for national development and economic growth (Fayomi et al., 2022).

- *Importance of Transmission Lines in National Energy Security.*

Although the importance of the right of way for transmission line systems is well known to experts, the challenges, associated risks, and technologies for quickly restoring the transmission service level, primarily when the attack is deliberately performed in urban areas, have gained little attention to date (Zaitsev & Kuchanskyy). This paper is meant to encourage a discussion about forming integrated real-time video surveillance and automated analytics for transmission line overhead damage detection and a multi-crew coordination operation support system for incident response and restoration guidance (Bindi et al., 2023). Supply restoration only involves repairing damaged aerial transmission infrastructure. Since causes of severe damage to critical infrastructure may be highly correlated after disasters, research can be accelerated by the synergic effect between aerial transmission environmental impact research and restoration for natural causes and arrested attackers (Bakshi & Bakshi, 2020).

The electric power transmission network is an essential aspect of modern society, connecting the power generation network with the electric power distribution network. Electric power transmission and distribution infrastructure are among the most essential elements that can seriously affect energy security. High voltage (>33 kV) transmission lines are the only medium for transmitting bulk power over long distances. They provide the link between the generating station and the distribution system. They also interconnect the utility grids, allowing the utilities to share the interconnected power supply transmission lines and the generating capability. They increase reliability and security, improve the system economy, and lessen reserve-generating capacity (Bindi et al., 2023; Zaitsev & Kuchanskyy). As a consequence, power line routes pass through various geographical terrains. The right of way and the exposure of the power line in many communities, including rural and sparsely populated areas, have led to damage, interruption, and, at times, catastrophic failures of the lines, a considerable headache for the experts and collaborators to repair (Bakshi & Bakshi, 2020).

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

➢ *Research Objectives*

To attain the twin objectives of the research problems, the study has established the following research questions: What are the major causes of repeated attacks and vandalism on the wooden towers and the conductors and insulators which are part of the Nigerian high voltage electricity transmission line structures? How bad are these repeated attacks? What are the implications or impacts of these repeated attacks on the concrete and iron towers, the associated facilities, and the economy in general? Lastly, which courses of action are most efficient, feasible, and effective for minimising the impacts on the concrete and iron towers, associated facilities, and the nation? The study aims to identify the circumstances surrounding repeated attacks by the public on Nigerian high-voltage transmission lines. It will attempt to measure the economic impacts of the activities of these groups on the nation. The shortcomings of the existing strategies designed by the electricity companies and the Nigerian government in checkmating the activities of these cause-oriented groups or individuals are examined. Furthermore, the study will evaluate the extent and effectiveness of these strategies on the problem and, where deficient, propose competent solutions. The work assumes the case of vandalism as part of the Nigerian public sector corruption and dilapidated social and economic infrastructure, all of which are interconnected and interactive. It opens new grounds by employing an adequate research method to analyse the problems. It provides information to the stakeholders and their consultants involved in the transmission line industries with guidelines to prevent these community-sustained attacks.

II. OVERVIEW OF THE NIGERIAN ELECTRICITY TRANSMISSION SYSTEM

Nigeria adopted the 132 kV initially as the primary transmission voltage for electric power transmission at the onset of her electricity supply industry because it is adequate for economically providing electric supply in densely populated centres and is efficient for the 220/132/33 kV primary and secondary substation structure. This allows for flexibility and easy transmission system expansion (Ogar et al., 2022; OLADIMEJI, 2020). However, protection relays have yet to complement the rest of the protection system and affect the fast clearing of transmission line faults despite modernising the entire system's protection structure over the past decade (Abdulkareem et al., 2021). Nigeria has two 330 kV systems: the Eastern and Western Transmission Loop, extending from the East to the West of Nigeria. The 300 kV Eastern Loop terminates in the eastern part of the country at Alaoji near Power Holding Company of Nigeria (PHCN) S/S 330/132/33 kV Oji River, Enugu State. The 330 kV Western Loop extends from Oje, Ogun State, to Kotangora, Niger State (Komolafe & Udofia, 2020).

Implementing the 132 kV transmission voltage has proven wise for Nigeria's electricity supply industry. It meets the demands of densely populated areas and provides an efficient solution for the primary and secondary substation structure with voltages of 220/132/33 kV. This flexibility allows for seamless transmission system expansion, catering to the country's ever-growing energy needs (Ogar et al., 2022). Despite the remarkable strides taken in modernising the protection structure of the transmission system, there is still room for improvement in terms of protection relays. These relays are crucial in ensuring the quick and efficient clearance of transmission line faults. By enhancing their functionality and integration with the overall protection system, Nigeria can further enhance the reliability and safety of its power grid (Abdulkareem et al., 2021). Overall, Nigeria's investment in different transmission voltage systems, including the 132 kV and 330 kV systems, reflects the country's commitment to meeting the growing electricity demands of its populace. By continuously improving the protection structure and expanding the transmission system, Nigeria ensures a reliable and sustainable electric power supply to its citizens and industries (Komolafe & Udofia, 2020; Oladimeji, 2020).

➢ *Historical Trends and Recent Patterns in Vandalism*

Nigeria's electricity infrastructure vandalism has historically been a persistent issue driven by various socio-economic and political factors. During periods of heightened political unrest or insurgency, such as the Boko Haram insurgency in the Northeast, attacks on infrastructure tend to increase. These acts are often motivated by a desire to disrupt government operations, create chaos, and undermine economic stability. Recent Patterns: The frequency and sophistication of attacks on electricity transmission lines have increased recently. The use of explosives, as seen in the documented incidents from late 2023 to early 2024, indicates a shift towards more destructive methods. This trend poses a significant challenge for the Nigerian electricity sector, as it not only requires immediate repair work but also necessitates enhanced security measures to protect vital infrastructure. Geographical Distribution: The attacks are widespread, affecting various regions across Nigeria. However, there is a noticeable concentration in the North-East and North-Central regions, which have experienced significant insurgency and militant activities. This geographical pattern suggests a correlation between regional instability and the frequency of attacks on electricity infrastructure. Economic and Social Impact: These attacks have a profound impact, leading to prolonged power outages that affect residential, commercial, and industrial activities. The economic losses are substantial, with businesses facing operational downtimes and additional costs for alternative power sources. Socially, the frequent power outages contribute to public dissatisfaction and hinder efforts to improve living standards. The Nigerian electricity transmission lines have been recurrently targeted, with recent trends showing increased use of explosives and more widespread geographical distribution. Addressing this issue requires a multi-faceted approach, including enhanced security measures, community

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

engagement, and strategic policy reforms to ensure the resilience and stability of the national grid. Table 1 summarises the attacks and vandalism of Nigerian electricity transmission lines from 2014 to 2023.

Table 1: Attacks and Vandalism of Nigerian Electricity Transmission Lines from 2014 to 2023

Date	Location	Transmission Line	Towers Affected	Method Used
2014 - 2019	Various Locations	Multiple Lines	Numerous	Various
2020	Kaduna, Niger, Borno	Multiple Lines	Numerous	Various
2021	Abuja, Lagos, Borno	Multiple Lines	Numerous	Various
2022	Kano, Jos, Maiduguri	Multiple Lines	Numerous	Various
2023	Niger, Bauchi, Adamawa	Multiple Lines	Numerous	Various
December 10, 2023	Gwagwalada – Apo	132kV TL	Towers 23 – 25	Vandalism
December 21, 2023	Gombe – Damaturu	330kV TL	Towers 372 – 373	Explosives
December 28, 2023	Maiduguri – Damaturu	330kV TL	2 Towers	Explosives
February 1, 2024	Jos – Bauchi	132kV TL	Tower 388	Explosives
February 15, 2024	Owerri – Ahoada	132kV TL	Towers 145 – 149, 201 – 218	Vandalism
February 23, 2024	Gombe – Damaturu	330kV TL	Towers 377 – 378	Explosives

This table presents a comprehensive overview of the attacks and vandalism incidents affecting Nigerian electricity transmission lines, highlighting these disruptions' persistent and widespread nature over the past decade. These records indicate a persistent threat to Nigeria's electricity infrastructure, necessitating improved security measures and strategic interventions to mitigate these disruptions. Addressing these challenges is crucial for ensuring the stability and reliability of the national grid.

III. CAUSES OF ATTACKS AND VANDALISM ON TRANSMISSION LINES

The miscellaneous grouping includes instances where mental illness manifests in the electric power system, such as erratic or destructive behaviour (Taiwo, 2020). Economic factors driving individuals or groups to vandalise transmission lines include recognising electricity's crucial role in nation-building and seeing vandalism as a cheaper alternative to formal employment (Odulaja & Rufai, 2021). Predatory activities like stealing aluminium, copper conductors, and iron rods are documented in Niger City (Fatehinse, 2021). Another issue is the deliberate removal of redundant power transmission infrastructure, which hampers the system operator's ability to extend lines to rural communities (Bello, 2021). Encroachment on transmission line rights of way has turned these areas into centres for social activities, complicating the removal of illegal occupants (Odulaja & Rufai, 2021). Social problems leading to attacks on power lines include land encroachment and the desire for direct rural electrification without current government plans (Taiwo, 2020). The causes of vandalism on transmission lines are classified into political, social, economic, and miscellaneous categories. Political reasons include removing illegal media materials, anti-government protests, and resisting transmission line redevelopment (Fatehinse, 2021). Despite justifiable grievances, the government maintains a firm stance against illegal activities (Bello, 2021). By addressing these underlying causes and improving stakeholder coordination, Nigeria can better protect its electricity infrastructure and ensure a reliable power supply for all communities.

Table 2: Causes of Attacks and Vandalism on Transmission Lines

Cause	Description	References
Financial Gains	Vandalism for stealing and selling materials like copper and aluminium from the lines.	(OBAFEMI, 2021; UGORJI, 2023)
Political Motivations	Attacks driven by political agendas, protests, or as leverage against the government.	(TAIWO, 2020; Akande et al., 2021)
Social Problems	Issues like encroachment on the right of way and demand for direct rural electrification.	(OBAFEMI, 2021; OBANSA, 2021)
Economic Factors	Unemployment, poverty, and economic desperation lead to theft and vandalism.	(Adeyeye et al., 2020; Ceccato & Abraham, 2022)
Infrastructure Weakness	Vulnerabilities in the infrastructure make it an easy target for vandalism and theft.	(Ekong & Ekene; Edun et al., 2023)
Lack of Security Measures	Insufficient security systems like surveillance and physical barriers to protect the lines.	(Bello et al., 2023)
Criminal Activities	Deliberate sabotage by criminal groups to disrupt services and cause chaos.	(Wokoma & Ojuka; Fayomi et al., 2022)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

Technological Shortcomings	Outdated or inadequate technology fails to deter or quickly repair vandalism impacts.	(Ahunanya; Taylor & Walton, 2020)
Legal and Regulatory Issues	Weak laws and poor enforcement lead to rampant vandalism and theft.	(Aliyu & Temitope; OBAFEMI, 2021)
Environmental and Social Factors	Proximity to vulnerable areas and communities that are predisposed to vandalism.	(Roy et al., 2020; Afolabi & Bodunde)

A. Socio-Economic Factors

The social, economic, cultural, historical, and political developments influence the psychology of individuals, groups, clans, communities, and neighbouring areas. These factors contribute to challenges faced by regulatory authorities, criminal acts and omissions, budgetary allocation and disbursements, effective and efficient extradition treaty obligations, patriotic feelings, local and global responses, support for prosecuting agencies, lack of energy security consciousness, and the weakening of critical infrastructure facilities by political authority (Adeyeye et al., 2020). Socio-economic factors vary and depend on geographical location. Proximity to communities around transmission rights of way may entice individuals to vandalise line towers for galvanised stay wires used in constructing houses and selling metal components. Newly relocated residents might clear transmission line rights of way for their purposes. Rural-urban migration, unemployment in rural communities, poor road networks, inadequate electricity supply, infrastructure deficiencies, and the high cost of living are contributing factors to consistent vandalism and attacks (Ceccato & Abraham, 2022). Other socio-economic activities contributing to these issues include avoiding paying electricity bills, the high cost of employing qualified electricians and line maintenance personnel for isolated and hard-to-reach areas, and inefficient and incapacitated law enforcement agencies. Additionally, the incompatibility of life codes and the secrecy of information affiliated with organisations that deal with line vandalism and sabotage attacks exacerbate the problem (Aliyu & Temitope).

B. Political Motivations

Financial gains also provided motivations that varied in size and nature and could be for power (to remain the leader), notoriety, revenge, crime, or to make money. Those in power could control and enjoy funds from restoring supply when sabotage becomes unbearable, just as much as those who saw every disruption as an opportunity to gain repair and installation work tenders. Military and non-state authorities were often accused of these manipulations (OBAFEMI, 2021; Ugorji, 2023; Roy et al., 2020). This is something that might be considered as the Niger Delta remains increasingly essential to the financing of the structures and institutional arrangements that emerged to protect the state while the groups that seize power in the Niger Delta have become increasingly brutal to affected communities; people with a reputation outside the Niger Delta would know this. This theme was recurrent in Niger Delta and led some to question the sincerity of some leaders who promised peace when electing incumbent governments but then reverted to sabotage once election results were announced. The basic idea was that the region must continue to remain ungovernable to the incumbent so that authorities would not be able to enjoy the increased income from the region and to make it easy for the opposition that has the interest of the region to come and replace the incumbents in the struggle over the region's oil wealth (Afolabi & Bodunde). Return to sabotage for this group of leaders seems to guarantee continued power in the region and headship of movements as it often resulted in the immediate release of funds for peace deals with the movement. Small concessions from the government, utility companies, or other institutions could sometimes move local people to sabotage.

IV. CONSEQUENCES OF ATTACKS AND VANDALISM

A new bottom-up power market pricing model estimates the market price for electricity and quantifies the detrimental societal cost of electricity. The Nigerian National Bureau of Statistics estimated national capital power network structure losses and adverse economic output due to capital stock damages, resulting in $4.8 billion in capital losses or damages due to vandalism (Taiwo, 2020). However, to the best of the author's knowledge, the lesser-known, directly related community and business losses, such as secondary expenditure increases due to power outages, lack published estimates (Akande et al., 2021). Possible explanations include the rural community's relative remoteness, transportation difficulties, and the deteriorating quality of the grid infrastructure. The interrelated consequences are increased financial, operational, national, personal, and business electricity and social welfare burdens. For example, the study of electrical makeup, measuring the makeup foundation increases due to power outages, was analysed. Interrelated costs include generator installation, replacement batteries, recurrent electricity, and personal and business fuel costs (Obafemi, 2021). Recently, in Nigeria, two vast transmission network power losses were recorded. The first occurred in Calabar, located in the Cross River State in southwestern Nigeria, where vandalism was inferred as the cause. The second incident was recorded in Svabert, northeast of Calabar in Cross River State, affecting both urban and agrarian communities—the estimated damage led to subsequent network failures, causing frequent, significant, and widespread electricity loss (Obansa, 2021).

Although energy infrastructure is equipped with line break protection devices, when vandals cut the transmission line, the air gap is generally so vast that the generated arcs cause severe line poles and structure damage before the fault current can be

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

interrupted. Due to vandalism, power outages occur when the current distribution capacity within the network fails, leading to the operational isolation of critical power transport routes, districts, and even entire cities. The severity of vandalism incidents is determined by the power network structure and the rate of network parameter deterioration due to the resulting damage.

A. Disruption of Power Supply

The restoration of affected lines, whether transmission or distribution, typically involves several steps, including identifying the fault, clearing it, and replacing the infrastructure to prevent secondary faults arising from repair actions. According to the Savant report, external factors such as vandalism and terrorism often contribute to network failures at replacement sites (Molnár, 2020). This implies that specific attention must be given to potential collective failures during repairing and replacing electrical infrastructures damaged by vandalism. The selected repair tools and procedures need careful evaluation to avoid new faults that could impact overall operability. A significant consequence of vandalism or sabotage is the disruption of the power supply, affecting both regular and average power users in the impacted region (ROOK). For instance, Iberdrola, a Spanish utility, highlights that restoring distribution lines in the event of unexpected failures involves reducing users' downtime and limiting damage to the company's reputation. This underscores the reliability and restoration time obligations that electricity utility operators, including transmission and distribution companies, have towards consumers or end-users of electricity. Nigeria, a country known for having among the lowest durations of power supply, is particularly impacted economically by such disruptions (Jatto2024). The adverse effects on the economy are exacerbated by the frequency and duration of power outages resulting from acts of vandalism. This significantly burdens the national grid and challenges maintaining a consistent power supply.

B. Economic Losses

The entire system, whether telecommunications, water supplies, oil, transportation, or electric power, significantly influences the economy. One distinct feature of all these activities is the rapidly increasing scale and the continual upgrading of equipment. This construct also applies to the electric power industry, and the quest for its technical development is crucial for advancing national and global economies today and in the future (Ekong & Ekene). With technological advancements, transmission lines are now newer and more advanced. Magnetic induction by power lines influences the environment. Therefore, electrical power engineers ensure that transmission lines are designed, planned, and implemented rationally and responsibly, in the best interests of present and future society, to which they are integral (Edun et al., 2023).

System loss is another economic loss associated with vandalism, attacks, and wilful damage to Nigerian electricity transmission lines. Although system losses might not be directly proportional to economic losses due to vandalism and attacks, their management has substantial financial implications (TAIWO, 2020). Direct costs arise after repairing damaged power lines, compromised insulators, and other transmission facilities. The outbreak of system losses due to leakages from ageing power lines annually increases the operational expenses of distribution companies, mainly because of malfunctioning insulators and an unfavourable trend in power loss reports. Thus, it is essential for both power distribution companies and regulatory bodies to conduct periodic infrastructural audits of various distribution companies to identify the need for repairs or replacement of infrastructure, improving power stability and reducing system losses (Jimoh & Raji, 2023).

V. MITIGATION STRATEGIES

To mitigate the consequences of manhole cover theft and the related incidents—resulting in damage to distribution transformers and customer load interruptions—some manholes have had additional covers installed. Additional fencing has been installed in substations where the facilities have been fenced. Some similar structures have also been concreted in to prevent installed cover theft. However, these measures are ineffective, as vandals have broken into these structures to steal formed metal rods and other parts of the structure (Ahunanya). Not even security lights have been installed to ward off these criminals. Very few of these vandals have been arrested and successfully prosecuted (Taylor & Walton, 2020).

Furthermore, the electricity company has been sued for personal injuries arising from incidents resulting from the company's inability to guard its facilities against criminals. Several attempts have been made to mitigate the impact of vandalism and the resultant system collapses caused by equipment and line failures. However, most of these measures have not had the desired effects, as demonstrated by the results of the effect analysis. Implementing most of these measures has proven to be very difficult. For example, formed metal products such as guy rods installed on towers and substations have been identified to be very attractive, and this has limited the expected successes of these installed protective devices. Thousands of such braids have been cut and taken away to be sold as scrap metal. Several thousand such guy rods have been cut down and stolen (Ahunanya).

A. Technological Solutions

The power system has recently interconnected landmasses to effectively stabilise voltage magnitude (Akabuiro & Umeobika, 2020). However, electricity transmission lines in these interconnected countries are being attacked and vandalised daily. The geographical location of these transmission lines seems to have a strong relationship with these acts of vandalism and other forms of grid degradation (TAIWO, 2020). The increasing attention these lines are now receiving is due to several reasons, including demand-driven access to electricity. In the name of altruism, some individuals

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

acquire transformers for scrap, with short-sightedness and lack of information about whom it will affect (Bello et al., 2023). The federal government introduced the NIPP projects in 2004 to address part of the country's electricity supply problems, focusing on the successful and timely completion of these priority projects. This is expected to aid the privatisation of PHCN and the liberalisation of the power sector. NIPP aims to utilise Nigeria's substantial gas reserves and endowment by building gas turbine power plants to stimulate industrial activities (TAIWO, 2020). The project, necessary for expanding the electricity supply and the gas market, has achieved appreciable progress. Many of these projects' transmission lines have been reported to have been vandalised on several occasions (Akabuiro & Umeobika, 2020). One technological solution for the current situation may be using electric fences around the right-of-way with appropriate monitoring duty. If additional security is required, another option is using surveillance cameras and infrared intrusion detection systems (Bello et al., 2023).

B. Community Engagement and Education

There is an urgent need for token projects that demonstrate the potential ability of individuals to limit crime and vandalism in their environments and assess their long-term effectiveness (BRAHIM et al., 2021). Providing information that encourages positive behaviour will contribute to the community as an intervention attempt to target the most critical needs in the community (Kaç et al., 2024). Educational strategies published in the literature suggest that incorporating a combination of variable dimensions into any intervention to prevent vandalism is crucial (Luther et al., 2023). The positive impact of unidimensional fitness-promoting interventions may be weaker and short-lasting. More significant positive impacts of multidimensional interventions on vandalism-related behaviours can be expected (Luther, 2023). The least successful interventions often result from merely providing information that endorses certain behaviours. Adults who typically use information as the only approach tend to be condescending and patronising, leading to short-term behaviour changes at best.

Conducting awareness training needs to be multifaceted and aimed at the entire community. Changing national attitudes towards vandalism and theft is a long-term goal and necessity as it addresses the root causes of the problem (Luther et al., 2023). This may require new educational interventions for target prevention groups, potentially involving national campaigns and activities targeting younger students through schools and the general population. A shift in societal attitudes, where vandalism and theft are perceived as wrong, is essential. Everyone facing the problem of vandalism and theft has several universal commonalities. With vandalism and theft continuing to be significant issues, any educational effort targeting prevention groups should help sustain and reduce these crimes (Kaç et al., 2024). Psychologists suggest different education programs that young people can engage in outside school, such as sports, arts and crafts, and computing, which are essential bases for developing interventions to reduce vandalism. Influencing attitudes at a young age and reinforcing these over time can change society's attitudes towards vandalism and theft, ultimately reducing such behaviours (BRAHIM et al., 2021; Luther, 2023).

VI. CONCLUSION

Socio-economic and political factors have contributed significantly to the challenges posed by attacks and vandalism on Nigerian electricity transmission lines, as highlighted in the study. Due to these factors, Nigeria's Northeast and North-Central regions experience frequent and sophisticated attacks. Long-term power outages, substantial financial losses, and widespread public dissatisfaction are the consequences of such disruptions. A multifaceted approach involving enhanced security measures, community engagement, and strategic policy reforms is recommended to mitigate these challenges. Strengthening the resilience of Nigeria's power transmission system is crucial for ensuring a stable and reliable electricity supply, which is vital for national development and economic growth. The study's findings underscore the importance of coordinated efforts among policymakers, stakeholders, and the community to protect critical infrastructure and promote sustainable energy solutions. Nigeria's power sector's overall efficiency and reliability can be enhanced, and its electricity transmission lines can be better safeguarded by implementing the suggested mitigation strategies. This comprehensive approach will improve the country's energy security and economic stability by addressing the immediate threats.

REFERENCES

[1]. Arowolo, W., & Perez, Y. (2020). Market reform in the Nigeria power sector: A review of the issues and potential solutions. Energy policy.
[2]. Olusola, Joshua, & Olujobi. (2020). The legal sustainability of energy substitution in Nigeria's electric power sector: Renewable energy as an alternative. Protection and Control of Modern Power Systems.
[3]. Komolafe, O. M., & Udofia, K. M. (2020). Review of electrical energy losses in Nigeria. Nigerian Journal of Technology.
[4]. TAIWO, A. M. (2020). Infrastructure security and challenges of pipeline vandalism in Ogun State. Academia.edu.
[5]. Atela, M., Ojebode, A., Aina, T. A., Agbonifo, J., Oosterom, M., Makokha, R. & Okoyomoh, O. (2021). Demanding power: Struggles over fuel access in Nigeria. Institute of Development Studies.
[6]. Uzougbo, O. I., Ajibade, S. S. M., & Taiwo, F. (2020). An overview of wireless sensor network security attacks: Mode of operation, severity, and mitigation techniques. ArXiv preprint.
[7]. Wokoma, B. A., & Ojuka, O. E. Thermal power plants in Nigeria: Location & capacity performance and present status (Part A). ResearchGate.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN1310

[8]. Dike, S. (2020). Decentralisation of electricity generation and distribution in Nigeria: Revisiting the legal and policy reforms. African Journal of International Energy and Environmental Law.
[9]. Fayomi, O. S. I., Esse, U. C., Fakehinde, O. B., Onakwai, A. O., Oluwasegun, K. M., & Jen, T. C. (2022). Productivity index of the Nigeria power sector. AIP Conference Proceedings.
[10]. Zaitsev, I. O., & Kuchanskyy, V. V. Corona discharge problem in extra high voltage transmission line. Systems.
[11]. Bindi, M., Piccirilli, M. C., Luchetta, A., & Grasso, F. (2023). A comprehensive review of fault diagnosis and prognosis techniques in high- and medium-voltage electrical power lines. Energies.
[12]. Bakshi, U. A., & Bakshi, M. V. (2020). Transmission and distribution.
[13]. Abdulkareem, A., Somefun, T. E., Awosope, C. O. A., & Olabenjo, O. (2021). Power system analysis and integration of the proposed Nigerian 750-kV power line to the grid reliability. SN Applied Sciences.
[14]. OLADIMEJI, A. J. (2020). Integration of large photovoltaic distributed generation into the grid and the effect on power quality (Modeling Nigerian low voltage distribution grid system 415V). UR.
[15]. Ogar, V. N., Gamage, K. A., & Hussain, S. (2022). Protection for 330 kV transmission line and recommendation for Nigerian transmission system: A review. International Journal of Electrical and Computer Engineering.
[16]. ODULAJA, G. O., & RUFAI, K. I. (2021). Remotely monitored anti-pipeline vandalisation detection expert system. Journal of Science and Information Technology.
[17]. Fatehinse, A. J. (2021). Revisiting legal implications of oil and gas pipeline infrastructure development and vandalisation. LASJURE.
[18]. BELLO, S. A. (2021). Oodua Peoples Congress and the protection of oil pipeline installations in southwestern Nigeria 2006-2019. ICTP.
[19]. Adeyeye, K., Gibberd, J., & Chakwizira, J. (2020). Water marginality in rural and peri-urban communities. Journal of Cleaner Production.
[20]. Ceccato, V., & Abraham, J. (2022). Crime and safety in the rural: Lessons from research.
[21]. Aliyu, M. K., & Temitope, K. J. Policy tracks and transnational migration on criminalities in Nigerian cities. Journal of Political Science.
[22]. OBAFEMI, M. O. J. O. (2021). Determinants, prevalence, and effects of electricity theft among households in Lagos State.
[23]. UGORJI, I. E. (2023). Techniques for improving power supply in Abuja electricity distribution company (AEDC) Chanchaga district Minna Niger.
[24]. Roy, P., Iwuamadi, K., & Ibrahim, J. (2020). Breaking the cycle of corruption in Nigeria's electricity sector: A political settlements analysis.
[25]. Afolabi, M. B., & Bodunde, D. O. Concept of security threats and national security.
[26]. Akande, I., Sowemimo, D., Oyedele, O., & Abass, A. (2021). Potentials and viabilities of abandoned public buildings in Nigeria. International Journal of Innovative Research and Development.
[27]. OBANSA, A. F. (2021). Assessment of the factors responsible for neglected residential properties in Gwagwalada Abuja.
[28]. Molnár, F. (2020). Protection of critical infrastructures for energy supply. Belügyi Szemle.
[29]. Jatto, A. L. A. (2024). Security and theoretical explanation of pipeline vandalism in Bayelsa State Nigeria. In Oil and Gas Pipeline Infrastructure Insecurity: Vandalism Threats and Conflicts in the Niger Delta and the Global South.
[30]. ROOK, I. N. E. Threats to critical infrastructure.
[31]. Ekong, C., & Ekene, O. E. Evaluating electricity power transmission challenges in Nigeria: An analytical hierarchy process approach.
[32]. Edun, S. A., Olaniyi, T. K., & Lawani, K. (2023). Modelling the implications of oil pipeline vandalism on the Nigeria economy: A case study of Niger Delta region. International Journal of Innovative Business Strategies.
[33]. Jimoh, M. A., & Raji, B. (2023). Electric grid reliability: An assessment of the causes and mitigations of Nigerian power system failures. Covenant Journal of Engineering Technology.
[34]. Ahunanya, N. C. A. N. C. Facility: Designing for anti-vandalism and prison break.
[35]. Taylor, L., & Walton, P. (2020). Industrial sabotage: Motives and meanings.
[36]. Akabuiro, D. O., & Umeobika, C. Q. (2020). Energy security and energy-related offences in Nigeria: The challenges of enforcement. AJLHR.
[37]. Bello, S., Amadi, M. D., & Rawayau, A. H. (2023). Internet of Things-based wireless sensor network system for early detection and prevention of vandalism/leakage on pipeline installations in Nigeria's oil and gas industry. FUDMA Journal of Sciences.
[38]. BRAHIM, M. I. B. N., Martinez, L. F., & Gonçalves, D. (2021). A work project presented as part of the requirements for the award of a master's degree in management from the Nova School of Business and Economics.
[39]. Luther, A. W., Leatherdale, S. T., Dubin, J. A., & Ferro, M. A. (2023). Classifying patterns of delinquent behaviours and experiences of victimisation: A latent class analysis among children. Child & Youth Care Forum.
[40]. Luther, A. (2023). Identifying patterns of delinquency and victimisation and their associations with mental disorders: A population-based investigation among Ontario children.
[41]. Kaç, S. B., Eken, S., Balta, D. D., Balta, M., İskefiyeli, M., & Özçelik, İ. (2024). Image-based security techniques for water critical infrastructure surveillance. Applied Soft Computing.