

CAUSES OF VANDALISM OF ELECTRICITY POWER TRANSMISSION EQUIPMENT OF KENYA POWER & LIGHTING COMPANY IN KIAMBU COUNTY, KENYA

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Abstract: Vandalism poses a significant challenge for power transmission companies worldwide, affecting them through both direct and indirect costs. Kenya Power and Lighting Company Limited has suffered significant financial and revenue losses as a result of frequent vandalism of power equipment. Therefore, this study investigated the causes of vandalism of electricity power transmission equipment of Kenya Power & Lighting Company in Kiambu County, Kenya. The research utilized a descriptive research design to evaluate the issue of power equipment vandalism in Kiambu County. This research employed purposive and stratified random sampling methods in choosing 502 participants consisting of senior KPLC officials and county residents with business establishments. Questionnaires and key informant interview schedules were the study tools utilized to gather primary data. Published articles, journals, books, dissertations, and projects were the sources of secondary data used for collection. To ensure the research instruments were valid and reliable, pilot study and test-retest were conducted. Quantitative data was organized and inputted into Statistical Package for Social Sciences (SPSS) software version 22 for analysis, while qualitative data was structured thematically and communicated through narration. One of the main discoveries in the study on vandalism's causes was the widespread demand for electricity power equipment by dishonest vendors, as well as the high levels of poverty and lack of employment among young people, which results in the theft of power equipment. The research concludes that there are multiple factors that lead to vandalism of electricity power transmission equipment, with the primary causes being oil leakage from the transformer, aluminum conductors, and copper windings. These factors impact different stakeholders in the power distribution system, such as businesses, the transmission company KPLC, and the entire country. The study recommends that Kenya Power and Lighting Company needs to engage the Critical Infrastructure Protection Unit (CIPU) to secure its critical facilities in vandalism-prone areas and prevent unauthorized access to transformer oil, aluminum conductors, and copper windings.

Keywords: Equipment Vandalism.

1. INTRODUCTION

Destroying electrical power transmission equipment is becoming an increasingly prevalent issue in societies worldwide (Akpojedje, Onogbotsere, Mormah, & Onogbostere, 2016). The issue has resulted in a significant increase in the cost of electricity transmission, with the country losing approximately 660 million shillings over the past few years to vandalism (Wambugu, 2014). Vandalism is the intentional destruction or damage of public property by individuals who harm works of art, public and private property, and natural beauties, including electric utility installations and facilities (Ikejemba, &

Schuur, 2018). Lukman, Emmanuel, Chinonso, Mutiu, James, & Jonathan (2018) claimed that damaging electricity equipment and utility facilities is seen as an economic offense more severe than robbery due to its negative effects on a country's economy.

In developing countries in South America, Asia, and Africa, the main issue causing inconsistent power supply is the lack of reliable access. This is largely due to vandalism of transmission equipment and a lack of strong political commitments and sustainable support frameworks (Udintsev, Shvedov, Milovanov, & Sergeeva, 2020). The importance of ensuring the security of the electrical power transmission infrastructure system is highly linked to maintaining social stability and promoting economic development (Bompard, Huang, Wu, & Cremonescu, 2013). This occurs when the power transmission and infrastructural system is disrupted by different risks such as vandalism, resulting in significant economic and human casualties as well as a risk to national security (Yang, Shu, Liu, Hancke, Ferrag, & Huang, 2022).

The electric power grid in the United States includes more than 200,000 miles of high-voltage transmission lines along with numerous large electric power transformers (Goldstein, 2013). Less than 3% of transformers in U.S. power substations are high voltage (HV) transformer units, yet they transmit 60%-70% of the nation's electricity. These transformers are highly susceptible to deliberate vandalism, posing a significant threat to the reliability of electric service across a wide area. Damage to these transformers can lead to extensive blackouts, resulting in substantial economic losses in the billions of dollars. Widespread vandalism occurrences prompted a youth group from Amherst in Hampshire County, Massachusetts, to take a stand against the vandals and combat vandalism (Parfomak, 2014). The large financial losses of around US\$ 500,000 each year were caused by acts of vandalism, which were mainly triggered by alcoholism, drug abuse among the youth, and the disconnection of young people leading them to engage in destructive behaviors (Bhati, & Pearce, 2016).

Vandalism of electrical transmission equipment is deemed a criminal offense in many European countries like Germany due to the risks it poses to the safety of individuals, the public, and company employees (Burkert, Fechtner, & Schmuelling, 2021). Electricity plays a crucial role in contemporary societies, and the economic consequences of power outages due to vandalism of the transmission infrastructure are significant in several European countries (Rehman, 2021). Vandalism in power networks is common in other advanced countries like Britain, Netherlands, France, and New Zealand, causing significant economic challenges for their governments and the associated agencies responsible for delivering electricity to the public.

Power shortages caused by sabotage are prevalent in Asian nations such as Bangladesh, India, Mongolia, and Pakistan (Choma, Pretorius, & Marnewick, 2019). Vandalism in Asian countries contributes to 42% of the worldwide population lacking electricity. Despite this, governments in these countries have undertaken significant initiatives to establish basic frameworks aimed at improving electricity access in rural and urban areas, while also addressing the issue of vandalism towards power equipment and infrastructure (Al Irsyad, Halog, & Nepal, 2019).

In Sub-Saharan Africa countries, the provision of electricity to homes faces numerous obstacles like government indifference, insufficient funding, and vandalism (Limo & Mirwoba, 2018). Predicting and controlling electricity power supply interruptions in Sub-Saharan countries have become difficult due to vandalism of power infrastructure, despite significant investments by governments and key stakeholders (Ahuna, Muumbo, & McLean, 2020). For example, the issues faced by the South African electricity sector are linked to the increase in theft and damage to power cables in cities like Johannesburg, Cape Town, and Durban (Dzansi, Rambe, & Mathe, 2014). Vandalism has negatively impacted the social and financial aspects of electricity utilities in South Africa due to ineffective interventions from key industry players, such as the government.

The power transmission and supply system in Zimbabwe face many challenges, such as vandalism of power transmission equipment, triggered by factors like a harsh economic environment with high living costs and high rates of unemployment (Mazikana, 2019a). According to the national Zimbabwe Electricity Supply Authority, the expense of fixing the vandalized power supply infrastructure amounts to millions of US dollars and also poses a threat to national security due to its impact on key security installations (Mazikana 2019b). The neighboring countries of Malawi, Zambia, Mozambique, and Tanzania also face this issue, as their electricity transmission and supply are consistently interrupted by vandalism, resulting in significant economic losses for businesses and the public (Taulo, Gondwe, & Sebitosi, 2015; Muya, Kaluba, Banda, Rattray, Mubemba, & Mukelabai, 2017; and Gregory, & Sovacool, 2019).

In countries like Nigeria, Benin, Ivory Coast, and Ghana in West Africa, there are occurrences of vandalism and damage to power distribution infrastructure, leading to inconsistent and unpredictable electricity supply (Aremu, 2019). An example is the situation in Nigeria where the infrastructure for electricity transmission is facing a severe threat due to vandalism targeting assets like power lines and transmission towers (Asiimwe, Adella, Mwikirize, & Okou, 2014). One of the main

issues is the acts of vandalism at Power Holding Company of Nigeria facilities, resulting in widespread power outages (Olugbenga, Jumah, & Phillips, 2013). Vandalism of transmission infrastructures and distribution equipment was prevalent long before the current reforms. The power brokers who bring in power generators are often held responsible for the sabotage (Monyei, Adewumi, Obolo, and Sajou, 2017). During the period from January 2017 to July 2017, Nigeria's Enugu Power Distribution Company (EEDC) reported over one hundred and fifty five cases of damage to the electrical system (Nwanya, Mgbemene, Ezeoke, & Iloeje, 2018).

Uganda, Tanzania, Rwanda, and Ethiopia in East Africa are also experiencing challenges in the provision and spread of electricity caused by damage to power transmission devices like transformers, copper wires, and aluminum coils by vandals (Mbabazi, Sebitosi, Sansa-Otim, & Okou, 2013; and Woldesemaite, 2018). In recent times, the Ugandan government has increased efforts to protect electricity transmission equipment from vandals (Mbabazi, Sebitosi, Sansa-Otim, & Okou, 2013). The Ministry of Energy and Mineral Development in Uganda has made significant investments in producing, distributing, and securing electricity. According to Asiimwe JohnPaul, Adella, Mwikirize, & Okou (2014), the government continues to suffer significant financial losses amounting to billions of Uganda shillings due to widespread vandalism of power transmission equipment and infrastructure by saboteurs intent on hindering citizens' access to electricity. Tesfamichael, Twinomujuni, Ogeya, Ssebagala, & Mulugetta (2022) claim that the destruction of power transmission equipment and infrastructure is still affecting the dependability, consistency, and steadiness of electricity supply in Uganda, leading to a loss of over 260 billion shillings for the government from the breakdown of towers in areas like Mukono, Mbalala, Mbale, and Tororo district.

In their 2021 study in Ethiopia, Mugisha, Ratemo, Keza, & Kahveci suggest that the efficient and uninterrupted provision of electricity is clearly vital for both essential human requirements and economic operations. In order to achieve this goal, the Ethiopian government has started large-scale electrification projects through the universal electricity access program (UEAP) to improve the availability and accessibility of electricity for rural residents (Gautier, Nsabimana, & Walheer, 2022). In Tanzania, the government is investing a substantial amount of money through the Ministry of Energy and Minerals to ensure reliable and efficient electricity supply to the citizens and important groups (Gregory, 2020). This is based on the recognition of the necessity to lessen the increased energy costs experienced by impoverished residents in rural and peri-urban areas, who are impacted by expensive electricity fees and power outages caused by vandalism of equipment (Chakamera, & Alagidede, 2018).

In Kenya, there is a high prevalence of vandalism towards electrical power equipment, particularly targeting organizations such as Kenya Power and Lighting Company [KPLC], Kenya Electricity Transmission Company [KETRACO], and Kenya Electricity Generating Company [Kengen], reaching unprecedented levels in recent years (Njoroge, 2009). In urban areas and surrounding regions, the electricity distribution in informal settlements and slums is influenced by fragmented access to electricity grids and heavy dependence on alternative sources like unauthorized connections (Kirunguru, Huang, & Ayambire, 2018).

Acts of damaging transformers lead to regular power outages in Kenya and cost the country at least 70 million shillings each year for fixing and replacing vandalized transformers (Limo, & Mirwoba, 2018). The vandalism negatively impacts numerous customers, leading to unnecessary costs that result in billions of shillings in lost revenue throughout the economy (Tare, & Sije, 2022). Sitienei (2020) stated that vandalism cases are influenced by economic factors like high youth unemployment, expensive living costs, tough economic conditions, and the desire to quickly profit by selling equipment to the top bidders in the energy syndicate market.

The destruction of power equipment is widespread nationwide, with numerous cases being reported just this year. In a period of four months in 2022, regions like Embu, Kiambu, Kirinyaga, Muranga, and Nyeri have experienced serious damage from vandals who have stolen about 40 transformers and copper windings valued at half a million shillings (Moronge, & Nyambura, 2022). Surprisingly, it is clear that the Southern Nyanza counties of Homa Bay, Kisii, Migori, and Nyamira are at the forefront in instances of vandalizing power machinery such as transformers, copper windings, and unauthorized electricity connections (Gichana, 2022). The persistent vandalism has led to frequent power outages, significant financial losses for businesses, and even more tragically, loss of life. Reports indicate that over 20 transformers have been damaged, resulting in approximately 20 cases of electrocution. Information from KPLC shows that around 16% of unauthorized connections and 9% of intentional damage to electrical equipment result in fatalities, financial losses, and disruptions caused by power outages.

2. STATEMENT OF THE PROBLEM

Kenya Power and Lighting Company Ltd has suffered power system losses due to vandalism (KPLC Operations and Maintenance Department, 2012). Rebuilding power infrastructure or replacing damaged equipment can be very costly, as the cost of replacing a single transformer ranges from 2 million to a few million shillings, and high voltage transformers can cost between 5 million and 7 million shillings. Efforts by the KPLC company to combat power equipment vandalism include implementing trespasser trackers on transformers and collaborating with local police and anti-vandalism units. This is done by holding stakeholder meetings, setting up the mulika mwizi hotline, enhancing transformer insurance, and prosecuting vandals found with damaged power equipment (Ndungu, Nderu, Ngoo and Hinga, 2017). Regrettably, vandalism of power equipment has progressed to incredibly high levels of stress over time.

Between 2004 and 2007, the KPLC suffered a loss of KSH 399 million due to vandalism, spanning nearly four years (Njoroge, 2009). From 2009 to 2014, Kenya Power and Lighting Company incurred a loss of KSH 1.7 billion due to the replacement of vandalized power equipment and inaccurate expenses caused by vandalism (KPLC Operations and Maintenance Department, 2015). Since 2015, KPLC has been losing about KSH 70 million every year due to vandalism of electricity power equipment, with over KSH 50 million used for replacing stolen and vandalized transformers. This clearly shows that the destruction of power machinery is a significant issue that is increasing in Kenya.

3. LITERATURE REVIEW

Theoretical Literature Review

The research was based on the Theory of Rational Action (TRA) and the Theory of Planned Behavior (TPB). The theories proposed by TRA (Ajzen and Fishbein 1969, 1980) and TPB (Ajzen 1991) could clarify why individuals choose not to report, tolerate, or engage in stealing KPLC equipment, influenced by their normative and attitudinal beliefs, such as personal views, attitudes, and intentions. Essentially, TRA (Ajzen and Fishbein 1969, 1980) and TPB (Ajzen 1991) suggested that a person's behavior is influenced by their intention to act in a specific manner. The theory also indicates that behavior is primarily influenced by personal attitudes and subjective norms (individuals' opinions on the appropriate actions). According to TRA and TPB, how individuals perceive and their attitudes play a crucial role in their behavior, offering a chance to address vandalism and theft of KPLC equipment caused mostly by individuals. TRA and TPB have been employed in studies to empirically assess the behavior of individuals when making decisions. Nevertheless, research has not yet confirmed the validity of these theories in cases of vandalism and theft, specifically in relation to the damage of KPLC equipment and theft carried out by employees. This research is intended to fill this void. The explanation of how TRA and TPB are used in this study is provided. The revenue loss of the company was caused by theft and vandalism. Langner (2010) highlighted the correlation between employee unhappiness (perception) and the inclination (attitude) toward theft. According to Pickens (2005), it is essential for organizational performance to comprehend the individual's attitudes and perceptions towards the organization. This research aligns with Pickens (2005) in noting that failing to address negative attitudes toward the organization can lead to their spreading and impacting the organization's performance. Because active management of people is crucial for the organization's survival and profitability, it is essential to assess individuals' attitudes and opinions on vandalism and theft of KPLC equipment. Hence, revealing individuals' views on the theft and vandalism of KPLC equipment that do not benefit the utility can assist managers in fostering better relationships among people, ultimately enhancing organizational effectiveness. Sauser (2007) created and examined a model. Consider the idea of a "climate of theft" as the primary factor in understanding stealing actions in the workplace. As stated previously, the theft environment consists of both the chance for theft and the organization's perception norms. In these standards, people's beliefs and moral stances on stealing are included. Similar to the concept of a "theft climate," TRA and TPB offer a theoretical structure for comprehending and combating equipment theft and sabotage.

Empirical Literature Review

There are multiple reasons for power equipment vandalism in the country. It is crucial to investigate the causes of these incidents and the resulting damage to the equipment, as they cause substantial financial losses for both businesses and the government through Kenya Power and Lighting Company.

Previous research has explored the reasons behind vandalism of electrical equipment and found that there are multiple factors contributing to the overall phenomenon of vandalism. Ikejemba and Schuur (2018) examined how theft and vandalism affect the sustainability of renewable energy projects in Sub-Saharan Africa. The research found that the main causes of vandalism are inequality, struggles for survival, and sabotage by those in charge of protecting power infrastructure. Regarding the situation in Kenya, examples include security personnel and KPLC employees working with vandals for

personal gain in the illegal scheme of selling power equipment like transformer oil and copper wires (Bore, 2014; Cheruto, & Munene, 2019).

Emovon, Samuel, Mgbemena, & Adeyeri (2018) examined the reasons for and remedies to the electricity generation crisis in Nigeria. The findings showed that the power generation and supply sector is encountering various challenges, such as insufficient plant upkeep, lack of financial and resource support from the government, inadequate staff and expertise to combat vandalism and militant attacks on power infrastructure, uncompetitive electricity pricing and high fees, as well as inconsistent policy development and implementation. The results also showed that insufficient funds or misplaced policy priorities prevent staff from receiving state-of-the-art technology training, both locally and overseas, to efficiently operate power generation and monitoring systems and prevent vandalism of power transmission equipment.

Ramuhulu and Chiranga (2018) researched the reasons behind failures in railway infrastructure within the steel and cement business unit at Transnet Freight Rail. The study focused on the particular factors such as reasons, outlook, actions to reduce, and regulations to prevent infrastructure breakdown. The results showed that recurrent transformer failures caused by theft and vandalism significantly impact the functioning of the railway system. Outdated technology in equipment can also lead to power disruptions on the railway system, complicating the ability to anticipate, oversee, and prevent any unexpected events.

The hypotheses examined in the studies reviewed centered on factors that trigger vandalism of power transmission equipment. Yet, the connection between underlying causes and the occurrence of vandalism was not thoroughly investigated. Majiwa (2014), de Bercegol, & Monstadt (2018), Kembero (2018), Limo, & Mirwoba (2018), Gregory, & Sovacool (2019) did literature reviews instead of analyzing primary data they gathered. The research conducted by Maranga, Kamau, & Musyimi (2022) focused exclusively on meter tampering and its consequences for the monitoring system in the power supply industry, instead of examining all factors contributing to vandalism and its impacts.

4. RESEARCH METHODOLOGY

The research utilized a descriptive research design to evaluate the issue of power equipment vandalism in Kiambu County. This research employed purposive and stratified random sampling methods in choosing 502 participants consisting of senior KPLC officials and county residents with business establishments. Questionnaires and key informant interview schedules were the study tools utilized to gather primary data. Published articles, journals, books, dissertations, and projects were the sources of secondary data used for collection. To ensure the research instruments were valid and reliable, pilot study and test-retest were conducted. Quantitative data was organized and inputted into Statistical Package for Social Sciences (SPSS) software version 22 for analysis, while qualitative data was structured thematically and communicated through narration.

5. FINDINGS

There are multiple reasons behind power equipment vandalism in the country. These factors, along with the resulting damage to equipment, result in significant financial losses for both businesses and the government via Kenya Power and Lighting Company, making it crucial to investigate the causes. The study aimed to investigate the reasons behind power equipment vandalism by utilizing a Likert scale ranging from 1 to 5, where 5 represents strong agreement and 1 represents strong disagreement. The findings shown in Table 1.

Table 1: Causes of power equipment vandalism

Causes of power equipment vandalism	5	4	3	2	1
The unrestricted market demand for the purchase of electricity power equipment such as copper windings and aluminium wires by unscrupulous dealers	36.7%	63.3%	0.0%	0.0%	0.0%
Theft occasioned by high rate of unemployed youth and poverty	26.7%	40.0%	33.3%	0.0%	0.0%
The miscreants vandalizing electricity power equipment due to long frequent power outages	16.7%	40.0%	6.7%	13.3%	23.3%
The cartels in the energy sector who instigate vandalism to create market opportunities for their wares	36.7%	20.0%	26.7%	0.0%	16.7%
Impunity and lack of integrity by the KPLC staff who collude with rogue contractors	13.3%	60.0%	26.7%	0.0%	0.0%

According to the data in Table 1, most participants (63.3%) believed that the high demand for copper and aluminum windings in the market was a significant factor leading to vandalism of power equipment, with 36.7% strongly agreeing. The research results align with the study carried out by Aremu (2019) on the reasons, effects, and resolution to the epilepsy of electricity generation and supply in Nigeria. The research found that power tools are being damaged due to the widespread availability of unregulated markets where electrical equipment from Kenya Power and Company is bought and sold.

40.0% of respondents agreed that theft due to high rates of unemployed youth and poverty caused power equipment vandalism, while 33.3% had a neutral stance on the issue. Additionally, (26.7%) of participants firmly believed that the high levels of unemployed youth and poverty played a role in power equipment theft due to vandalism. The findings coincide with Emovon, Samuel, Mgbemena, & Adeyeri's (2018) study on Electric Power generation crisis in Nigeria, which disclosed that power equipment vandalism is driven by high unemployment rates due to poverty, leading individuals to resort to theft as a means of survival.

Additionally, a majority (56.7%) of the participants strongly agreed that miscreants vandalize electric power equipment because of frequent power outages, whereas 36.6% strongly disagreed with this reason for vandalism. Despite this, 6.7% of the participants remained neutral regarding whether miscreants vandalizing electric power equipment due to frequent and lengthy power outages was a contributing factor to power equipment vandalism. The study findings show that the majority of participants are aware of the individuals who vandalize power equipment, leading to significant issues for businesses in Kiambu County. The results support Ifeoma & Madueme's (2007) research on the cost analysis of NEPA equipment vandalism, which revealed that prolonged power outages provide an incentive for criminals to vandalize KPLC power equipment, leading to disruptions in power supply for both commercial and residential customers.

The majority (36.7%) of respondents strongly believe that cartels in the energy sector provoke vandalism to create market opportunities for their products, while 26.7% held a neutral view on this issue. In addition, 20% of the participants concurred that cartels' participation in the energy industry led to vandalism in order to generate market prospects for their products. Nevertheless, a strong (16.7%) of the participants expressed their strong disagreement regarding the notion that energy sector cartels provoke vandalism in order to capitalize on market opportunities for their products. These findings suggest that cartels playing a role in the energy industry are a primary reason for vandalism of power equipment. This research is consistent with the investigation conducted by Chingozha & Kwashirai (2021) on infrastructure vandalism and protection in a susceptible Zimbabwean setting. The results showed an increase in property damage and vandalism of power equipment infrastructure caused by individuals working within the system, resulting in significant revenue losses.

The survey showed that 60.0% of respondents believe that KPLC staff colluding with rogue contractors due to impunity and lack of integrity leads to power equipment vandalism. Additionally, 13.3% strongly agreed that this behavior significantly contributes to the vandalism. However, 26.7% of respondents (93 individuals) remained neutral regarding the potential impact of KPLC staff's lack of integrity and collusion with rogue contractors on power equipment vandalism. Therefore, the results suggest that power equipment vandalism is caused by the impunity and lack of integrity of KPLC staff collaborating with rogue contractors.

Regression Analysis Results

Table 2: Model Summary

Model 1	R	R square	Adjusted R square	Std. Error of the Estimate	Sig.
1	.881	.775	.755	.31508	.125

The strength of the causal relationship between the dependent and independent variable is indicated by the regression coefficient $R = 0.881$. Model 1 accounts for roughly (88%) of the data points. The model's estimated that 77.5% of the variation in causes of vandalism was due to challenges in mitigating power equipment vandalism, based on an adjusted R^2 value of 0.775. The study showed that factors beyond the difficulties in mitigating power equipment vandalism accounted for 22.5% of the variance in causes of vandalism.

6. CONCLUSIONS

The research findings indicate that vandalism of electricity power transmission equipment can be attributed to a range of factors, with the main causes being oil seepage from transformers, aluminum conductors, and copper windings. These factors impact different stakeholders in the power distribution system such as businesses, the transmission company KPLC,

and the entire country. It is educational to point out that poverty, high unemployment rates, and the valuable copper windings and transformer oil are the main factors driving power equipment vandalism. Other factors leading to vandalism involve employees at the KPLC committing internal sabotage, working together with criminals to damage power equipment for personal gain and in retaliation for perceived mistreatment from company management. Finally, the placement of power equipment plays a critical role in the vandalism of power equipment in Kiambu County.

7. RECOMMENDATIONS

Kenya Power and Lighting Company should utilize the Critical Infrastructure Protection Unit (CIPU) in vandalism-prone areas to secure key infrastructures and prevent access to transformer oil, aluminum conductors, and copper windings. The government, along with the Ministry of Energy and Petroleum and KPLC, must take a proactive approach in enforcing strict laws against vandalism by catching and punishing the offenders to prevent further impunity. Due to the widespread effects on the economy and businesses, it is important for KPLC and its partners like KETRACO and KENGEN to establish a solid policy on investing in material research for safer technology and materials, such as remote sensing, and implementing a Vigilant Energy Metering System (VEMS) to prevent electricity theft and vandalism..

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