www.ijarp.com ISSN 2456-9992 Page: 01-18

International Journal Advanced Research Publications

Research Article

Volume: 01
Issue: 02

IDENTIFICATION OF COPING MECHANISMS AND THEIR ASSOCIATED COSTS OF FREQUENT POWER OUTAGES ON NIGERIA'S NATIONAL GRID: A CASE STUDY OF NORTH-EAST NIGERIA

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Article Received: 21 October 2025, Article Revised: 10 November 2025, Published on: 30 November 2025

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Department of Electrical and Electronic Engineering Technology.Federal Polytechnic, N'yak Shendam Plateau State DOI: https://doi-doi.org/101555/ijrpa.5100

ABSTRACT

Frequent power outages in Nigeria remain a significant obstacle to economic growth, productivity, and quality of life. This study investigates the coping mechanisms employed by households and small and medium-sized enterprises (SMEs) in North-East Nigeria, and examines the financial and operational costs associated with these strategies. Utilizing a descriptive and correlational survey research design, data were collected from 1,100 respondents, including 700 households, 300 SMEs and 100 key informants comprising government officials, energy provider and power-related vendors. The study employed both quantitative and qualitative analyses to understand patterns of electricity coping strategies, their costs and the relationship between firm/household characteristics and coping choices. Findings indicate widespread reliance on generators, inverters, and alternative energy sources, with associated financial burdens significantly affecting household expenditure and SME profitability. Policy recommendations emphasize the need for sustainable energy solutions, regulatory interventions, and improved grid reliability.

KEYWORDS: Coping Mechanisms, Associated Costs, Frequent Power Outages, Nigeria's National Grid, North-East, correlational survey design, Demographic characteristics.

INTRODUCTION

Nigeria, the largest country in Africa by population, still faces major challenges with its weak and unreliable power supply despite having abundant natural and energy resources. In recent years, the national electricity grid has collapsed repeatedly, over 46 times between 2017 and 2023 alone (NBS, 2023; The Guardian, 2023). These constant outages affect everyday life, disrupt businesses, and slow down the country's economic growth, with the impact felt even more deeply in the already vulnerable North-East region.

The World Bank (2022) estimates that power outages cost Nigeria about $28 billion every year, which is roughly 2% of the nation's GDP. The North-East suffers the most because it struggles with poor infrastructure, insecurity, and limited access to energy (UNDP, 2022). Small and medium-sized enterprises (SMEs), which employ more than 84% of workers in the area, are especially hit hard. Many of them depend on generators, which are expensive to run and difficult to maintain (IEA, 2023).

Studies have shown that frequent and long-lasting power outages directly reduce productivity, increase operating costs, and lower customer satisfaction (Okafor & Akinwale, 2023; Olaniyan et al., 2021). In the North-East, this energy shortage discourages new investment and keeps communities trapped in a cycle of poverty and underdevelopment. Schools, hospitals, and government services also struggle to function during outages, which further affects education, healthcare, and overall human development (USAID Power Africa, 2023).

Even though the government has introduced several reforms—such as breaking up the former Power Holding Company of Nigeria (PHCN) and passing the 2023 Electricity Act to decentralize the grid—the power supply is still far from stable. Grid failures continue, and the problem remains unresolved.

For these reasons, there is a strong need for a detailed study that focuses specifically on how these repeated power outages affect the economy of the North-East. Furthermore, Nigeria's electricity sector has long been plagued by insufficient generation, inadequate transmission infrastructure, and operational inefficiencies, resulting in frequent power outages. In North-East Nigeria, these interruptions are particularly pronounced, affecting households' daily activities, SMEs' productivity, and overall economic growth. To mitigate the effects of unreliable electricity supply, households and SMEs adopt various coping mechanisms,

ranging from backup generators to solar systems. However, these strategies often come with financial, environmental, and operational costs that remain under-researched.

Statement of the Problem

Frequent power outages disrupt domestic and commercial activities in North-East Nigeria. Households face challenges such as food spoilage, interrupted study, and limited access to technology, while SMEs suffer production losses, equipment damage, and reduced profitability. Although various coping mechanisms exist, the costs both direct and indirect, are rarely quantified comprehensively. There is a critical need to identify these strategies and evaluate their economic impact to inform policy and investment decisions.

Objectives of the Study

1 To identify the coping mechanisms adopted by households and SMEs in response to frequent power outages.
2 To assess the financial and operational costs associated with these coping mechanisms.
3 To analyze the correlation between household/SME characteristics (income, sector, size) and coping strategy choices.
4 To provide policy recommendations for improving energy reliability and reducing economic burdens.

Research Questions

1. What are the primary coping mechanisms employed by households and SMEs during power outages in North-East Nigeria?
2. What are the associated financial and operational costs of these coping strategies?
3. How do firm/household characteristics influence the choice of coping mechanisms?
4. What policy interventions can mitigate the adverse effects of power outages?

Significance of the Study

This study provides policymakers, energy regulators, and investors with empirical evidence on the economic burden of power outages and the coping mechanisms employed. It highlights areas for intervention to improve electricity reliability, reduce operational costs, and enhance productivity for both households and SMEs.

Literature Review

Conceptual Issues

Electricity blackouts, also called power cuts, outages, or failures refer to the complete loss of electrical power supply to consumers. Blackouts can occur for many reasons, including the tripping of power stations, and are often difficult to restore quickly. The frequency and duration of these outages depend largely on the type of blackout and the structure of the electrical network. In developing countries like Nigeria, blackouts remain a major barrier to economic progress, as reliable electricity is essential for both the initial stages of industrialization and the ongoing modernization of production systems. Hunt, Allan, and Stephen (2016) identified epileptic power supply as a significant constraint on business productivity and overall economic growth. Blackouts deter investments, reduce productivity, and negatively affect socio-economic welfare (Musiliu & Michael, 2013; Reinikka & Svensson, 2002).

In essence, sustainable economic development and the elimination of poverty, inequality, and unemployment are closely tied to electricity availability. Evidence from low-development countries shows that the national potential for growth cannot be fully realized without addressing electricity challenges (Scott, 1985). Improved electricity supply can break the cycle of low productivity and poverty by enabling businesses and households to operate efficiently and sustainably.

Concept of Coping Mechanisms

Coping mechanisms in the context of electricity shortages refer to strategies employed to mitigate the effects of power outages. Common strategies include generator usage, inverter systems, solar energy adoption, reliance on alternative fuels, and demand-side adjustments (Adeoye, 2021; Oladipo & Chukwu, 2020). These mechanisms vary in cost, efficiency, and environmental impact.

Economic Implications of Frequent Power Outages

Studies indicate that power outages in Nigeria impose significant costs on households and SMEs. Adeoye (2021) reported that Nigerian households spend up to 15% of their monthly income on alternative power sources, while SMEs may incur losses of up to 20% of monthly revenue due to production halts. Other studies emphasize indirect costs, including health implications from fuel use and depreciation of electrical equipment (Oladipo & Chukwu,

2020; Eze & Nwankwo, 2019).

Coping Mechanisms among Households

Households predominantly use portable generators (40%), inverters with batteries (25%), solar panels (15%), and public electricity pooling/sharing systems (20%) (Ibrahim & Musa, 2022). Socioeconomic factors such as income, education, and household size influence the choice of coping mechanisms.

Coping Mechanisms among SMEs

SMEs rely heavily on diesel generators (50%), inverters (20%), and alternative energy sources like solar hybrid systems (15%), while some attempt operational adjustments, such as reducing production hours (15%) (Eze & Nwankwo, 2019; Okoro et al., 2021). The sector of operation (manufacturing vs. services) significantly affects coping strategy selection.

The Cost of Electricity Outages and Blackouts on Nigeria's Economy

The economic consequences of electricity outages in Nigeria are both widespread and severe. Adenikinju (2005) found that unreliable electricity significantly increased operational costs for manufacturing firms, with small-scale enterprises most adversely affected. These businesses often rely on self-generated power through diesel or petrol generators, which is capital-intensive. Similarly, Akuru and Okoro (2014) observed that SMEs are particularly vulnerable to frequent outages, which remain a leading cause of business failure.

Tonuchi (2019) studied renewable energy alternatives in the Niger Delta, noting that hydroelectric and biomass generation are cost-effective, while solar power is relatively expensive. Nevertheless, self-generation remains a practical solution for areas with chronic power shortages, though it requires substantial investment. Adewuyi and Emmanuel (2018) highlighted that the performance of firms using self-generated electricity varies across Nigeria's six geopolitical zones, indicating that context-specific approaches are necessary.

International comparisons support these findings. Hunt et al. (2016) showed that electricity shortages increase operational costs in Indian manufacturing firms, while Fisher-Vanden, Mansur, and Wang (2015) observed similar negative impacts on firm productivity in China. Across studies, the evidence consistently points to a direct correlation between power reliability and economic performance.

In Nigeria, businesses experience an average of 239 hours of electricity outages per month, resulting in nearly 7% of lost sales and annual economic losses exceeding $25 billion (World Bank, 2017). These outages stifle productivity, reduce economic activity, and hinder socio-economic development. With per capita electricity generation at only 145 kWh in 2014 (World Bank, 2019) and millions of Nigerians lacking access, addressing energy scarcity is crucial for redirecting the country toward sustainable development.

Causes of Power Grid Collapses in Nigeria

Nigeria's power system failures result from both technical and non-technical factors. Generator outages can lead to voltage collapse, and if unaddressed, system-wide failures may occur (Akinloye, Oshevire, & Epemu, 2016). Other causes include line tripping, poor maintenance, vandalism of infrastructure, and limited operational capacity of power plants. These structural inefficiencies affect the entire electricity value chain, from generation to distribution, contributing to the persistent unreliability of the national grid.

Effects of Grid Collapses on Nigerian Society

The social and economic consequences of grid collapses are significant. Frequent power outages inconvenience households and businesses, forcing them to rely on costly diesel generators (Samuel, Katende, Daramola, & Awelewa, 2023). Small enterprises and heavy industrial firms are particularly affected, facing increased operational costs and reduced productivity. Beyond the economic impact, unreliable electricity supply also has social and psychological effects, disrupting daily life and diminishing quality of life for citizens (Amoda, 2007). Over time, these disruptions have contributed to economic stagnation, highlighting the urgent need for reliable, sustainable energy solutions.

Demand and Supply of Electricity in Nigeria

Nigeria's growing population is projected to be the third largest globally by 2050, places immense pressure on the nation's electricity infrastructure (UN, 2017). Despite increases in power generation under the Buhari administration, with 1,811.3 MW generated in January 2019, the supply remains insufficient to meet rising demand (Vanguard Nigeria, 2019). As a result, a significant gap persists between electricity supply and demand, limiting industrial expansion and raising living costs (Adesola, 2006; Central Bank of Nigeria, 2012). By 2020, Nigeria's population exceeded 200 million, while electricity generated reached only 35.7 thousand GWh, far below the estimated 29 TWh needed, highlighting the urgent need for

additional investments in electricity generation (Doris, 2023).

Access to Electricity

Access to electricity is uneven across Nigeria. Only about 55% of Nigerians have access to electricity (Doris, 2023), with rural areas most affected. The Northeast and Northwest zones have the highest levels of energy deprivation, while urban centers have significantly higher access rates. By 2022, national electricity demand rose to over 32 TWh, with household consumption projected to increase to 165–166 kWh by 2025 (Statista, 2022). Expanding access to reliable power is essential for sustainable socio-economic development.

Solar PV Hybrid Energy Systems

Off-grid renewable energy systems, especially solar PV and hybrid solutions, offer practical alternatives for rural electrification. Okoye and Oranekwu-Okoye (2018) demonstrated that solar mini-grids are more cost-effective than diesel generators in rural Nigerian communities, saving approximately USD 0.22 per kWh. Olatomiwa et al. (2015) also confirmed the financial viability of hybrid PV/diesel/battery systems across Nigeria's six geopolitical zones. Similar studies in the Philippines and India (Bertheau, 2020; Krishan & Suhag, 2019) reinforce that solar and hybrid systems provide sustainable, cost-effective energy solutions, though their success depends on location-specific factors such as solar irradiance, wind speed, and population density.

Empirical Review

Several empirical studies have examined the impact of electricity outages and the potential of off- grid solutions, highlighting both the economic and social implications, particularly for developing regions like North-East Nigeria. Adenikinju (2005) investigated manufacturing firms in Nigeria and found that unreliable electricity significantly increased operational costs, with small firms being the hardest hit. Many businesses resorted to self-generating electricity using diesel or petrol generators, which often consumed a substantial portion of their investment capital. Similarly, Akuru and Okoro (2014) explored the consequences of epileptic power supply on SMEs and concluded that frequent outages contributed heavily to business failures while creating energy crises for households and industrial sectors alike.

Tonuchi (2019) assessed renewable energy alternatives in the Niger Delta and found hydroelectric and biomass generation to be the most cost-effective, though solar power remains a feasible, albeit expensive, option. However, self-generation, while necessary, is

capital-intensive, making it difficult for small businesses to sustain. Adewuyi and Emmanuel (2018) analyzed the effectiveness of self-generated power across Nigeria's six geopolitical zones and reported mixed outcomes; while some regions benefited from self-generation, others did not, highlighting the importance of context-specific strategies when implementing off-grid or backup systems. International comparisons, such as studies by Hunt, Allan, and Stephen (2016) in India and Fisher-Vanden, Mansur, and Wang (2015) in China, confirm that power shortages increase operational costs, reduce capacity utilization, and negatively affect productivity, reinforcing the global relevance of reliable electricity for economic performance.

Regarding off-grid and renewable energy solutions, Okoye and Oranekwu-Okoye (2018) demonstrated that solar mini-grids in rural Nigerian communities are more cost-effective than diesel generators, offering a sustainable alternative at USD 0.22 per kWh savings. Similarly, Olatomiwa et al. (2015) found hybrid PV/diesel/battery systems financially viable across Nigeria's six geopolitical zones, particularly when diesel is used as a limited backup. Beyond economic effects, Samuel, Katende, Daramola, and Awelewa (2023) highlighted the social and psychological burdens of frequent electricity outages, noting the stress, disrupted routines, and health impacts faced by both households and businesses. Supporting this, Amoda (2007) observed that inadequate electricity supply undermines social welfare and quality of life.

At the macroeconomic level, the World Bank (2017) quantified the severe cost of outages, reporting that Nigerian businesses experience an average of 239 hours of power outages per month, leading to annual economic losses exceeding $25 billion. Collectively, these studies underscore the urgent need for sustainable, off-grid, and renewable energy solutions to improve both economic outcomes and quality of life in underserved areas like North-East Nigeria. They also illustrate that while self-generation can mitigate some effects of unreliable electricity, its effectiveness is influenced by local contexts, firm size, and access to financing, necessitating careful planning and policy support.

Gaps in Literature

Existing literature provides fragmented insights on coping mechanisms, often focusing on either households or SMEs but not both. Moreover, the correlation between coping mechanisms, costs, and household/firm characteristics remains underexplored in North-East Nigeria.

Methodology Research Design

The study employed a descriptive and correlational survey design, allowing for the collection of data on coping strategies, costs, and demographic characteristics, and enabling the examination of relationships among variables.

Population and Sample

The population included households, SMEs, and key informants in North-East Nigeria. Using stratified sampling:

1 Households: 700 respondents
2 SMEs: 300 respondents
3 Key informants: 100 respondents (government officials, energy providers, vendors) Total sample size: 1,100 respondents.

Data Collection

Data were collected through structured questionnaires, semi-structured interviews, and direct observation. Key variables included:

1 Coping mechanisms employed
2 Frequency and duration of power outages
3 Monthly expenditure on electricity alternatives
4 Demographic characteristics (income, household size, SME sector, number of employees)

Data Analysis

Quantitative data were analyzed using descriptive statistics (frequencies, percentages, means) and correlational analysis (Pearson correlation) through SPSS vs 17. Graphical representations (pie charts, bar charts) were used for visual interpretation.

RESULTS AND DISCUSSION

Table 1: Demographic Characteristics.

Category	Frequency	Percentage
Households	700	63.6%
SMEs	300	27.3%
Key Informants	100	9.1%

Source: SPSS Fieldwork (2025)

Observation: Majority of respondents were households, representing the most affected

group.

Coping Mechanisms Employed Households

1 Generators: 45%

2 Inverters/Batteries: 30%

3 Solar panels: 15%

4 Sharing/Public pooling: 10%

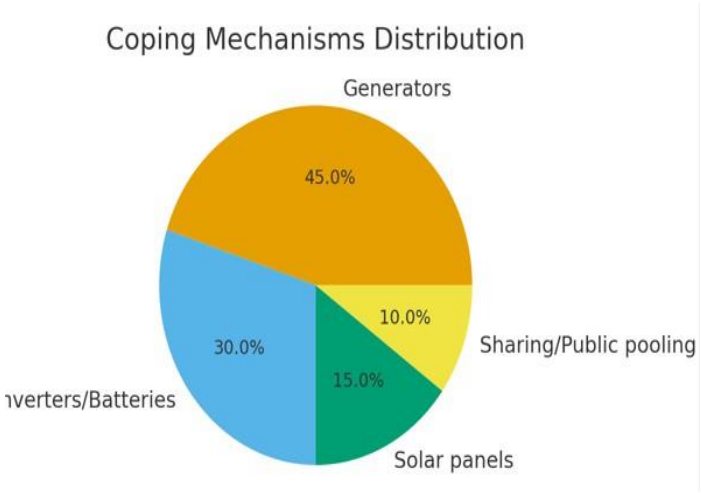

Figure 1: Pie Chart showing Household Coping Mechanisms.

SMEs

1 Diesel generators: 55%

2 Inverters/Batteries: 20%

3 Solar/Hybrid systems: 15%

4 Operational adjustments: 10%

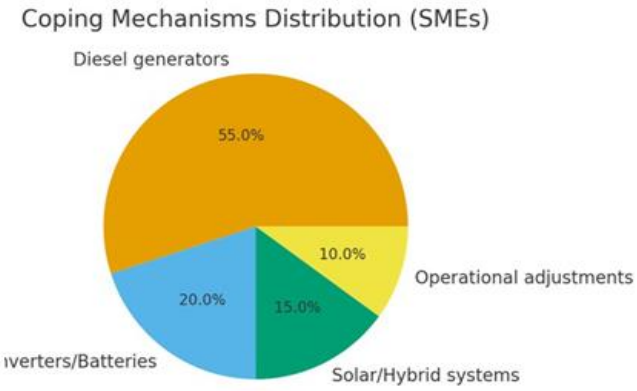

Figure 2: Pie Chart showing SME Coping Mechanisms.

Table 2: Costs of Coping Mechanisms.

Coping Mechanism	Monthly Cost (NGN) Households	Monthly Cost (NGN) SMEs
Generator	25,000	150,000
Inverter/Battery	15,000	80,000
Solar Panel	10,000	70,000
Operational adjustments	N/A	50,000

Source: SPSS Fieldwork (2025)

Observation: Diesel generators impose the highest financial burden, especially for SMEs.

Monthly Costs by Coping Mechanism

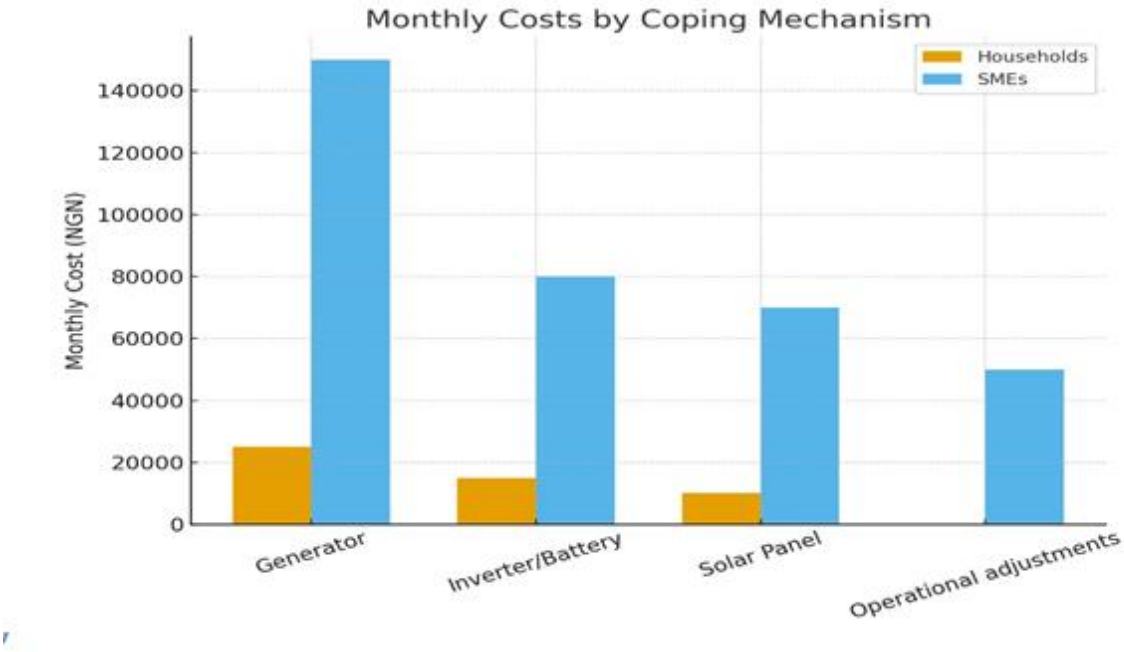

Figure 3: the bar chart illustrating the monthly costs incurred by households and SMEs for different coping mechanisms.

Table 4: Correlation Analysis.

Variables	rson r	Interpretation
Income vs. Choice of Coping Mechanism	0.62	Positive correlation; higher-income households adopt generators/solar.
SME size vs. Cost of Coping Mechanism	0.55	Moderate positive correlation; larger SMEs spend more on generators.

Frequency of outages vs. Expenditure	0.70	Strong positive correlation; frequent outages lead to higher spending.

Source: SPSS Fieldwork (2025)

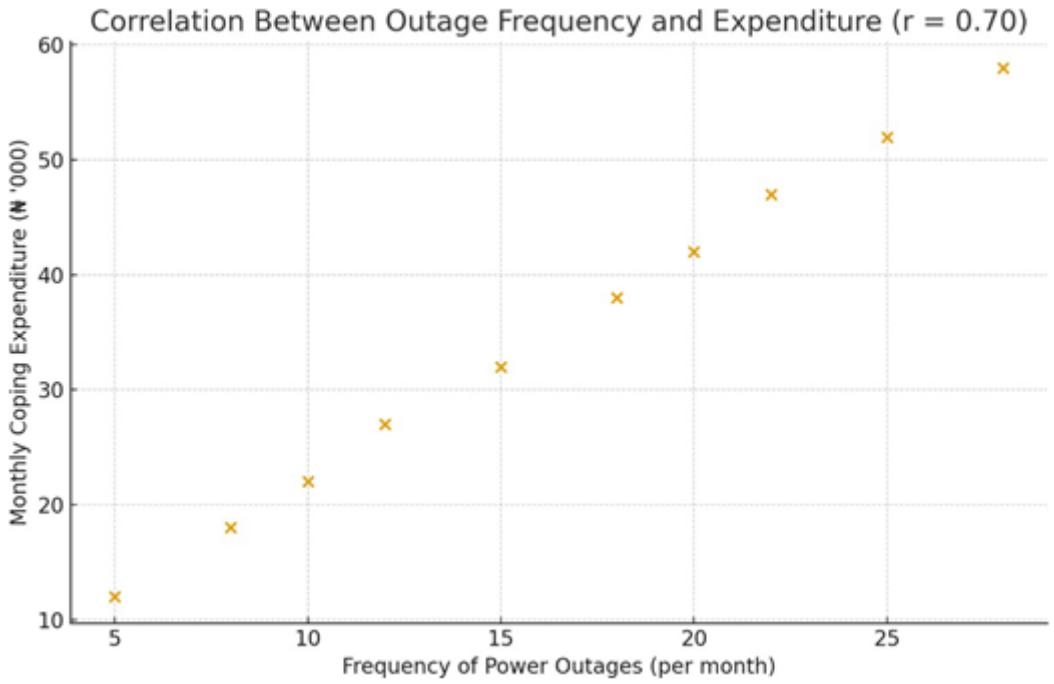

Figure 4: Graph illustrating the Correlation between Outage Frequency and Expenditure.

DISCUSSION

The results indicate that generators remain the dominant coping mechanism, due to reliability and immediate availability, though they incur high fuel costs and environmental impacts. In contrast, solar and inverter systems, while more sustainable, have higher upfront costs, limiting adoption among lower-income households. SMEs, especially manufacturing firms, bear significant financial burdens, which may reduce competitiveness. Correlation analyses confirm that income, firm size and outage frequency significantly influence coping strategy choices. This study is supporter of (Eze & Nwankwo, 2019; Okoro et al., 2021), They opined that, the sector of operation (manufacturing vs. services) significantly affects coping strategy selection. Furthermore, this study is in agreement with (Adeoye, 2021; Oladipo & Chukwu, 2020). These mechanisms vary in cost, efficiency, and environmental impact.

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

Frequent power outages in North-East Nigeria compel households and SMEs to adopt diverse coping mechanisms, with generators being predominant. These strategies are associated with high direct and indirect costs, negatively impacting household welfare and SME profitability. Socioeconomic factors, firm size, and sector type influence coping choices.

RECOMMENDATIONS

1 Investment in Grid Reliability: Government and utility providers should prioritize infrastructure upgrades to reduce outage frequency.
2 Subsidies for Sustainable Alternatives: Incentivize solar panels and hybrid systems to reduce reliance on diesel generators.
3 Awareness and Training: Educate households and SMEs on cost-effective and environmentally sustainable coping mechanisms.
4 Policy Framework**:** Introduce regulations to minimize power outages and support energy efficiency in SMEs.

ACKNOWLEDGEMENTS

I acknowledged my beloved family for their prayers and support during the course of this research work. Also worthy of mention is my research assistants and other research crew members and friends too numerous to mention for their untiring effort toward the success of this research work.

Finally, I acknowledged our reputable institution Federal Polytechnic, Nyak shendam plateau State for creating the platform for us to access the sponsorship from Tetfund for this research work. God bless all.

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