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Research Article

Examining The Effects of Load Shedding on The Operational Performance of SMEs: A Case Study of Zambia

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About Article

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ABSTRACT

This study investigated the effects of load shedding on the operational performance of Small and Medium Enterprises (SMEs) in the rural context of Zambia. Employing a descriptive survey design with a mixed-methods approach, primary data were collected from 100 SMEs selected via stratified random sampling, supplemented by qualitative interviews. Quantitative data were analysed using STATA, incorporating descriptive statistics, cross-tabulations, and Analysis of Variance (ANOVA). The findings revealed that load shedding imposes a severe financial burden, with 85% of businesses incurring significant additional monthly costs. A one-way ANOVA confirmed a statistically significant relationship between the level of these expenses and the severity of operational impact ($F(3, 96) = 12.456$, $p < 0.001$). Revenue disruption was catastrophic, with 90% of SMEs experiencing profit declines and 40% suffering a drop exceeding 50%. A further ANOVA showed a significant difference in revenue impact across business types ($F(5, 94) = 4.873$, $p = 0.0005$), indicating sector-specific vulnerabilities. SMEs primarily employed reactive, low-cost coping strategies like adjusting operating hours. However, reliance on costly generators was often counterproductive, creating a paradox where the cost of coping exacerbated financial strain. A final ANOVA found no significant difference in the perceived effectiveness of these strategies across business types ($F(5, 82) = 1.27$, $p = 0.286$), underscoring a universal failure to find effective solutions. The study concludes that load shedding systematically undermines rural SME performance by depleting financial resources and disrupting operations. It recommends targeted government subsidies for renewable energy adoption, investment in rural grid infrastructure, and SME training in energy resilience and business continuity planning to break this detrimental cycle.

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1. INTRODUCTION

1.1. Background to the study

Most economies in developing countries like Zambia are driven by small scale business which compound to a significant contribution of the economy (Enaifoghe, 2023). In the similar reasoning, Beck and Demirguc-Kunt (2006) argued that Small and Medium Enterprises (SMEs) are vital engines of socioeconomic development, driving innovation, employment creation, and economic diversification. Ayyagari *et al.* (2011) further demonstrate that SMEs account for the majority of businesses and employment worldwide, making them central to poverty reduction and inclusive growth. Hallberg (2000) notes that SMEs contribute substantially to national income in emerging markets, linking their growth to broader socioeconomic progress. Beck *et al.* (2005) emphasize that systemic constraints, such as limited access to finance and infrastructure, continue to undermine SME sustainability, weakening their ability to support long-term economic development. Despite their importance, SMEs in developing regions face persistent operational challenges, among which unreliable electricity supply is one of the most critical barriers (Avordeh *et al.*, 2024; Steinbuks & Foster, 2010).

The performance of these small businesses highly depends on the adequacy and availability of power supply (Adanlawo & Vezi-Magigaba, 2021; Steinbuks and Foster (2010) highlight that frequent power outages significantly reduce SME productivity and increase operational costs. Foster and Steinbuks (2009) show that load shedding forces firms to reduce output, lose revenue, and invest in costly alternative energy solutions. Adenikinju (2005) provides evidence from African economies that electricity shortages constrain industrial performance and competitiveness. Escribano *et al.* (2010) argue that SMEs are particularly vulnerable to energy insecurity due to limited capital for adaptation and reliance on energy-intensive processes. Collectively, these studies demonstrate that energy disruptions remain a critical challenge to enterprise growth, productivity, and resilience in developing economies, warranting further research on coping strategies and operational impacts.

1.2. Statement of the problem

Small and Medium Enterprises (SMEs) are widely recognized as engines of employment and inclusive economic growth. Their operations depend heavily on reliable electricity for production, storage, and digital functions (Agrawal *et al.*, 2023). In many developing regions, frequent and prolonged load shedding disrupts business activities, leading to loss of productive time, increased operational costs, and reduced competitiveness (Tapang, 2023). Although some SMEs adopt coping strategies such as generators, solar systems, or flexible working hours, these measures are often unsustainable due to high fuel costs, limited capital, and inadequate policy support (Zanoni *et al.*, 2023). Existing research on how SMEs manage energy disruptions remains fragmented, especially in rural contexts, leaving a gap in understanding the real impact of electricity shortages and the effectiveness of coping mechanisms (Papagiannis *et al.*, 2023). This study aims to address that gap by examining how power outages affect SME performance and exploring the strategies businesses adopt to sustain operations (Lyons *et al.*, 2023).

1.3. Objectives of the study

The objectives of the study were split between the general theme of the three focused specific objectives as explained in the subsections below.

1.3.1. General objective

To examine the effects of load shedding on the operational performance of Small and Medium Enterprises (SMEs) in Zambia.

1.3.2. Specific objectives

i. assess the effect of load shedding on the operational costs of SMEs in Zambia.

ii. To investigate the impact of load shedding on the revenue flow of SMEs.

iii. To establish the influence of load shedding on the coping strategies for power supply used by SMEs.

1.4. Research questions

i. How does load shedding affect the operational costs of SMEs in Zambia?

ii. What is the effect of load shedding on the revenue flow of SMEs?

iii. What coping strategies do SMEs adopt in response to load shedding?

1.5. Conceptual framework

The interplay of the variables is as presented in the conceptual framework shown in Figure 1 below where load shedding as an independent variable exerts influence on three dependent factors of Cost, Revenue and Coping Strategies.

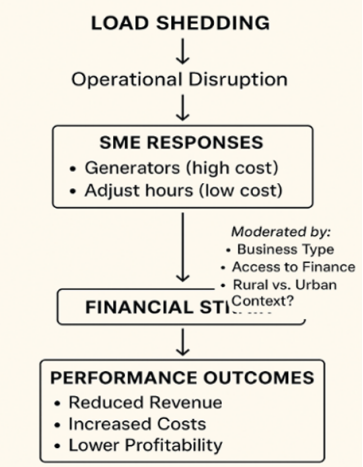

Figure 1. Conceptual framework

2. LITERATURE REVIEW

2.1. Overview

This chapter reviews existing scholarly literature relevant to the study's objectives. The review is structured around three thematic areas; each derived from the specific objectives of the research. The literature review draws on peer-reviewed journal articles, empirical studies, and conceptual discussions to explore how load shedding affects the operational cost, revenue flow, and coping mechanisms of SMEs. The chapter concludes with a critique of the reviewed literature and highlights key research

gaps that justify the necessity of this study.

2.2. Effects of loadshedding (power outages) on operational costs

Smith and Zhao (2021) argue that unreliable electricity imposes substantial operational costs on SMEs, as frequent outages force firms to rely on diesel generators. This dependence increases direct costs such as fuel while also accelerating wear and tear on machinery (Rosenberg & Arman, 2022). The financial strain is compounded by the fact that many SMEs operate on thin margins, making these recurring expenses particularly burdensome (Hermes & Meesters, 2022). Voltage fluctuations further damage sensitive equipment, leading to premature replacements (Schreiner & Gupta, 2023). These disruptions shorten equipment lifespans and increase repair frequency (Moya, 2021). Over time, SMEs are compelled to allocate disproportionate resources to maintenance rather than innovation (Khandker & Samad, 2021). Such inefficiencies weaken competitiveness and reduce long-term sustainability (Smith & Zhao, 2021).

Rosenberg and Arman (2022) emphasize that unplanned downtime inflates costs, since fixed expenditures like staff salaries persist even when production halts. For capital-intensive sectors, machinery depreciation accelerates under intermittent electricity supply (Smith & Zhao, 2021). Firms that depend on continuous power face higher risks of equipment deterioration, which undermines productivity (Hermes & Meesters, 2022). Backup systems, when overused, deteriorate faster than expected, creating additional replacement costs (Schreiner & Gupta, 2023). These challenges are particularly acute in industries where uninterrupted operations are critical (Moya, 2021). The unpredictability of outages makes financial planning difficult, adding to uncertainty (Khandker & Samad, 2021). Ultimately, SMEs are forced into costly coping strategies that erode profitability (Smith & Zhao, 2021).

Schreiner and Gupta (2023) highlight that voltage fluctuations associated with outages damage sensitive electronic components, forcing premature and costly replacements. These technical disruptions not only shorten equipment lifespans but also increase the frequency of repairs (Rosenberg & Arman, 2022). SMEs often find themselves spending more on equipment repairs than on fuel consumption, underscoring inefficiencies (Hermes & Meesters, 2022). Such unplanned expenditures reduce the capital available for productive investment (Smith & Zhao, 2021). The diversion of resources away from innovation restricts opportunities for growth (Moya, 2021). Over time, these inefficiencies create a cycle of high costs and low productivity (Khandker & Samad, 2021). This cycle undermines competitiveness and threatens long-term survival (Schreiner & Gupta, 2023).

Hermes and Meesters (2022) note that indirect operational costs extend beyond immediate expenditures, reducing the capital available for productive investment. SMEs often spend more on repairs than on fuel, highlighting the inefficiencies of current coping strategies (Smith & Zhao, 2021). These expenditures restrict opportunities for innovation and growth (Rosenberg & Arman, 2022). The unpredictability of outages further undermines financial planning, making budgeting highly uncertain (Moya, 2021). Firms are forced to divert revenue toward emergency energy solutions rather than strategic investments (Schreiner & Gupta, 2023). This diversion erodes competitiveness and weakens resilience to shocks (Khandker & Samad, 2021). Over time, SMEs find themselves trapped in a cycle of inefficiency and stagnation (Hermes & Meesters, 2022).

Moya (2021) observes that the unpredictability of outages undermines financial planning, making it difficult for firms to budget operational costs with certainty. The continuous diversion of revenue toward emergency energy solutions limits investment in technology upgrades (Smith & Zhao, 2021). Staff training and market expansion are also constrained, reducing adaptability (Hermes & Meesters, 2022). These constraints erode a firm's ability to respond to changing market conditions (Rosenberg & Arman, 2022). Persistent shocks contribute to debt accumulation, forcing SMEs to prioritize survival (Schreiner & Gupta, 2023). This shift in priorities undermines long-term strategic planning (Khandker & Samad, 2021). Ultimately, firms lose competitiveness and resilience in volatile markets (Moya, 2021).

Khandker and Samad (2021) caution that persistent operational shocks contribute to debt accumulation, forcing SMEs to prioritize short-term survival over long-term strategic investment. This shift in priorities threatens business sustainability and can lead to contraction or closure (Smith & Zhao, 2021). The cycle of high costs and low productivity leaves many firms trapped in precarious positions (Rosenberg & Arman, 2022). Over time, these vulnerabilities erode competitiveness and reduce resilience to economic shocks (Hermes & Meesters, 2022). SMEs that continually divert resources to emergency energy solutions lose opportunities for innovation (Schreiner & Gupta, 2023). The resulting inefficiencies weaken their ability to expand into new markets (Moya, 2021). Ultimately, unreliable electricity undermines both operational stability and long-term growth (Khandker & Samad, 2021).

2.3. Effects of power outages on revenue flow of SMEs

Hardy and McCasland (2021) show that electricity shortages directly undermine SME revenue generation, as reliable energy is essential for production and service delivery. Tapang (2023) adds that small profit margins amplify the impact of interruptions, since even brief downtime translates into significant losses. Smith and Zhao (2021) argue that service unreliability erodes consumer trust, shifting demand toward more stable providers. Johnson and Lee (2022) demonstrate that minor interruptions create cascading inefficiencies across operations. Brown and Patel (2021) report that SMEs in urban centers lose nearly 15% of revenue during peak load-shedding periods. Chen and Alvarez (2022) extend this to rural contexts, where losses can reach 25–30% for firms with low capital buffers. Kumar and Singh (2023) emphasize that perishable-goods enterprises are especially vulnerable, as refrigeration failures cause spoilage and lost sales.

Tapang (2023) notes that rural enterprises cannot easily adopt alternative energy solutions due to high costs, leaving them more exposed to volatility. Hardy and McCasland (2021) find that extended outages destabilize operations, particularly in distribution and service sectors. Johnson and Lee (2022) show that production delays reduce firms' ability to meet demand,

forcing order reductions or postponements. Smith and Zhao (2021) highlight that customer often avoid businesses with irregular operations, compounding losses beyond immediate production effects. Brown and Patel (2021) argue that attempts to compensate with extended hours increase labour costs, offsetting potential gains. Chen and Alvarez (2022) confirm that service-based SMEs also suffer, as customer dissatisfaction translates into declining loyalty. Banda and Mwansa (2021) add that unreliable energy discourages potential clients, undermining trust and long-term relationships.

Brown and Patel (2021) document that frequent power fluctuations force SMEs to operate below capacity, as equipment cannot function without stable voltage. Hardy and McCasland (2021) report that interruptions slow transaction processing in retail and financial services, further reducing revenue. Zulu (2022) stresses that reputational damage from inconsistent operations erodes client bases, creating long-term instability. Banda and Mwansa (2021) argue that alternative energy solutions such as generators provide only partial relief, as fuel and maintenance costs limit feasibility. Tapang (2023) notes that collaborative solutions like shared generators face coordination challenges, reducing effectiveness. Johnson and Lee (2022) add that temporary closures, while avoiding added costs, result in complete income loss. Chen and Alvarez (2022) conclude that reliance on emergency savings or informal borrowing is common but unsustainable.

Hardy and McCasland (2021) emphasize that coping mechanisms do not resolve SMEs' structural vulnerability to energy insecurity, leaving revenue streams unstable. Tapang (2023) finds that persistent unreliability discourages investment and undermines competitiveness. Smith and Zhao (2021) argue that unpredictability complicates long-term planning, making it difficult for firms to scale operations. Johnson and Lee (2022) highlight that manufacturing SMEs face machinery downtime and wasted inputs. Brown and Patel (2021) show that service-based firms lose customer loyalty due to inconsistent operations. Chen and Alvarez (2022) confirm that rural enterprises remain disproportionately affected. Banda and Mwansa (2021) conclude that without structural reforms in energy reliability, SMEs will remain trapped in cycles of instability and lost revenue.

2.4. Coping Strategies of SMEs and Their limitations due to loadshedding

Hardy and McCasland (2021) argue that SMEs adopt a variety of technical, operational, and financial strategies to cope with energy disruptions, yet these strategies remain constrained. Tapang (2023) notes that generators are the most widely reported technical solution, enabling firms to maintain minimal production during outages. Smith and Zhao (2021) emphasize that generator use incurs high fuel costs, regular maintenance, and depreciation expenses, which reduce profitability. Johnson and Lee (2022) highlight those small businesses, particularly in rural areas, struggle to maintain fuel supply, and intermittent generator usage often results in inefficient energy consumption. Brown and Patel (2021) add that collaborative solutions, such as pooling resources for shared generators or solar systems, can mitigate costs but face management and equity challenges. Chen and Alvarez (2022) confirm that reliance on generators provides only partial relief, as energy-intensive sectors remain vulnerable. Banda and Mwansa (2021) conclude that technical coping strategies are costly and unsustainable in the long term.

Smith and Zhao (2021) observe that operational strategies, such as adjusting working hours to match power availability, are common among SMEs. Hardy and McCasland (2021) note that shifting production to daylight hours or low-demand periods allows some continuity without additional energy expenditure. Johnson and Lee (2022) argue that such adaptations, while cost-effective, reduce overall production capacity and limit revenue potential. Brown and Patel (2021) emphasize that altering operating hours can disrupt supply chains, as delivery schedules and customer availability are often fixed. Chen and Alvarez (2022) find that operational adjustments may damage customer trust if service becomes irregular or unpredictable. Tapang (2023) highlights that these strategies are particularly problematic in rural areas, where alternatives are limited but expectations remain high. Banda and Mwansa (2021) conclude that operational coping mechanisms provide short-term relief but undermine long-term competitiveness.

Brown and Patel (2021) emphasize that temporary business closures are sometimes employed as a last-resort strategy to avoid operating costs during load-shedding periods. Hardy and McCasland (2021) note that while closure prevents immediate expenditure, it results in complete revenue loss and risks permanent customer attrition. Smith and Zhao (2021) argue that closures also have indirect costs, including wage adjustments, contract renegotiations, and reputational damage. Johnson and Lee (2022) observe that SMEs adopting temporary closure often experience a recovery period post-outage, during which efficiency and revenue remain below pre-closure levels. Chen and Alvarez (2022) highlight that reliance on closures underscores a structural vulnerability: SMEs lack sufficient energy resilience to maintain continuous operations. Tapang (2023) adds that closures divert managerial focus from growth to survival. Banda and Mwansa (2021) conclude that closures exacerbate instability rather than resolve it.

Hardy and McCasland (2021) emphasize the role of financial strategies in mitigating disruptions, particularly through contingency planning and reserve funds. Smith and Zhao (2021) note that SMEs with pre-planned buffers can purchase fuel, pay overtime, or implement alternative energy solutions more effectively. Johnson and Lee (2022) argue that few SMEs have access to sufficient credit or savings to support these strategies, leaving them exposed to shocks. Brown and Patel (2021) observe that reliance on informal loans or community savings schemes introduces constraints, including high interest costs and repayment pressure. Chen and Alvarez (2022) point out that while financial planning is theoretically effective, it is often constrained by low liquidity and unpredictable cash flow. Tapang (2023) stresses that financial coping strategies are frequently reactive rather than proactive, reducing their effectiveness during extended crises. Banda and Mwansa (2021) conclude that financial strategies provide limited resilience under persistent energy insecurity.

Smith and Zhao (2021) argue that the cumulative limitations of coping strategies reduce SME growth potential over time.

Hardy and McCasland (2021) note that frequent generator use, operational shifts, or closures provide immediate relief but fail to address structural insecurity. Tapang (2023) highlights that SMEs divert resources away from investment and innovation to maintain baseline operations, limiting competitiveness. Johnson and Lee (2022) emphasize that repeated reliance on short-term coping erodes managerial capacity, as owners focus on survival rather than strategic growth. Brown and Patel (2021) show that financial stress and operational inefficiencies increase debt exposure, reducing resilience to future shocks. Chen and Alvarez (2022) confirm that these dynamics are particularly pronounced in rural SMEs, where alternative revenue streams are limited. Banda and Mwansa (2021) conclude that without structural reforms in energy reliability, SMEs remain locked in cycles of instability.

3. METHODOLOGY

3.1. Research design

This study adopted the descriptive survey design with a mixed-methods approach to capture both measurable outcomes and contextual insights (Dawadi 2021), a. Quantitative data assessed operational costs and revenue, while qualitative data explored coping mechanisms and lived experiences, a strategy which saw a triangulation and validation of results (Fetters & Molina-Azorín, 2021).

3.2. Target population and sampling

The study focused on approximately 300 registered SMEs in Zambia across retail, agro-processing, services, and hospitality. Stratified random sampling ensured sectoral representation, yielding 100 SMEs. From these, 10–15 owners were purposively selected for interviews to provide depth.

3.3. Data collection

Two instruments were employed: structured questionnaires for the 100 SMEs and semi-structured interviews with selected owners. Questionnaires captured operational costs, revenue flow, and coping strategies, while interviews explored resilience and adaptation. Secondary sources, including policy documents and academic literature, contextualized findings.

3.4. Data analysis

Quantitative data were analysed in STATA using descriptive statistics and one-way ANOVA to test group differences. Qualitative data were transcribed and thematically analysed following Braun and Clarke (2021). Triangulation of both strands enhanced validity and reliability (Fetters & Molina-Azorín, 2021).

3.5. Ethical considerations

Ethical rigor was maintained through informed consent, confidentiality, and voluntary participation. Clearance was obtained from the relevant university committee, aligning with international research standards.

4. RESULTS AND DISCUSSION

4.1. Demographic profile of respondents

All 100 surveyed SMEs were located in rural areas with low population density, confirming the study's exclusive focus on a rural context. The businesses represented a diverse mix: Salons (20%), Retail Shops (17%), Hardware stores (16%), Barbershops (15%), Hammer Mills (12%), and a category labelled "*Other*" (20%) which included tailoring, poultry rearing, and small-scale pubs. An ANOVA test revealed a statistically significant difference in the mean years of operation across these business types (F-statistic = 63.15, $p < 0.001$), with hardware stores being the most established (all over 5 years) and barbershops and "*Other*" being predominantly newer ventures.

4.1.1. Area type

The first variable captured whether the SMEs were located in a rural or peri-urban setting. All 100 surveyed businesses were located in rural areas. This outcome reflects the deliberate scope of the study, which focused exclusively on rural SMEs in Kasenengwa District. It confirms the absence of peri-urban enterprises in the sample, making the findings context-specific to rural business environments.

Table 1. Distribution of SMEs by area type

Area Type	Frequency	Percentage
Rural	100	100.0
Peri-Urban	0	0.0
Total	100	100.0

The table shows a complete rural concentration of SMEs, reflecting low population density and dispersed settlement patterns typical of Zambia. The rural dominance has implications for market access, infrastructure availability, and exposure to shocks such as load shedding. And also shown in the graph below.

4.1.2. Population density of business area

Respondents were asked to indicate the population density of the area where their businesses operate. Since all businesses were in rural settings, the responses consistently reflected low population density. This is consistent with the dispersed settlement patterns and smaller markets characteristic of Kasenengwa District. High and medium density areas were absent in the sample.

Table 2. Distribution of smes by population density

Population Density	Number of SMEs	Percentage
High	0	0%
Medium	0	0%
Low	100	100%
Total	100	100%

This shows that all surveyed SMEs operate in areas with low population density. This suggests potential challenges in customer base size, accessibility to suppliers, and reduced spillover benefits from clustering effects that are common in higher-density areas.as shown in the table below.

4.1.3. Type of business

The respondents in this study were engaged in diverse business activities typical of rural areas in Kasenengwa District. Out of 100 SMEs surveyed, the largest groups were salons (20%) and businesses categorized as "Other" (20%), which included tailoring, poultry rearing, phone charging, and small-scale pubs. Retail shops (17%) and hardware stores (16%) also made up a significant share, while barbershops (15%) and hammer mills (12%) followed. This distribution reflects a rural SME landscape dominated by service-oriented enterprises, with limited representation of large-scale or specialized sectors. The spread also indicates that economic activities in these areas revolve around immediate community needs such as personal care, food, and household supplies.

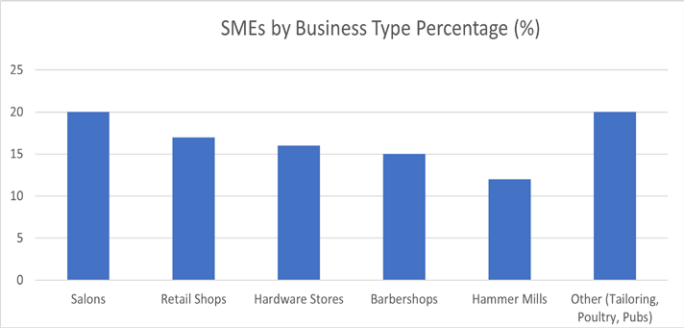

Figure 2. SMEs by Business type

4.1.4. Years in operation

The analysis of business types by their years of operation reveals distinct patterns in the market's composition and stability. Retail shops emerged as the most prevalent business type in the dataset. Furthermore, this category exhibited a diverse age range, comprising entries that were new (less than one year old), growing (one to two years old), and more established (three to five years old), indicating a dynamic and active sector with consistent entry, hardware stores presented a markedly different profile. While less numerous than retail shops, every hardware store in the data fell into the most established category, having operated for more than five years. This complete absence of newer hardware stores suggests a sector with high barriers to entry or a business model that, once established, enjoys significant longevity and low failure rates.

The personal care sector, encompassing both barbershops and salons, showed a healthy mix of new and established businesses. Barbershops were exclusively newer ventures, while salons were represented by both growing (three to five years) and well-established entities. The presence of a hammer mill was noted as an outlier; it was the least common business type and was in the middle of its growth phase. Finally, businesses categorized as "*Other*" were found to be exclusively in the one-to-two-year range, representing a small but specific cohort of young enterprises. As represented with the graph below

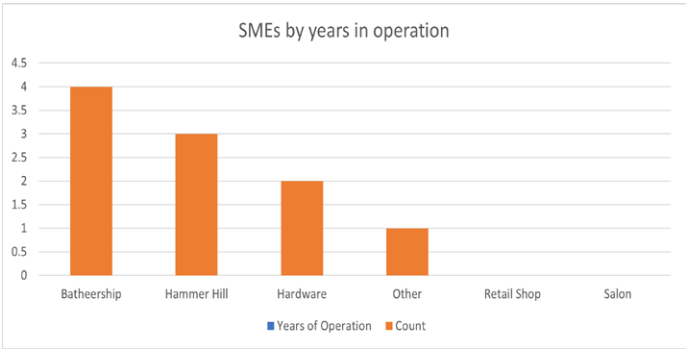

Figure 3. Years in operation

4.2. Effects on operational costs

This section measured the first objective and the impact on operational costs was profound. 85% of SMEs incurred additional monthly expenses due to load shedding, with 61% spending over K500. These costs stemmed from fuel for generators, maintenance, and spoilage of goods.

The operational impact was severe: 51% of businesses reported a complete halt or significant reduction in production during outages. Quantitatively, 90% of businesses lost productive hours each week, with 55% losing more than 11 hours and 30% losing over 20 hours equivalent to half a standard workweek. This forced drastic staffing changes: 80% of SMEs had to reduce their workforce, working shifts, or both, with 35% implementing both measures, directly contributing to underemployment.

4.2.1. Effect on production output

The results show that more than half of the respondents (51.0%) fall under the category labelled “Other,” suggesting diverse experiences outside the listed options. A notable share of businesses experiences direct negative effects from outages, with 16.7% reporting a complete halt in production, 13.7% reporting significant reductions, and 10.8% reporting slight reductions. Only 5.9% report no effect, while 2.0% say the question is not applicable. This indicates that outages disrupt operations for a large proportion of businesses, with complete or partial production losses being the most common outcome.

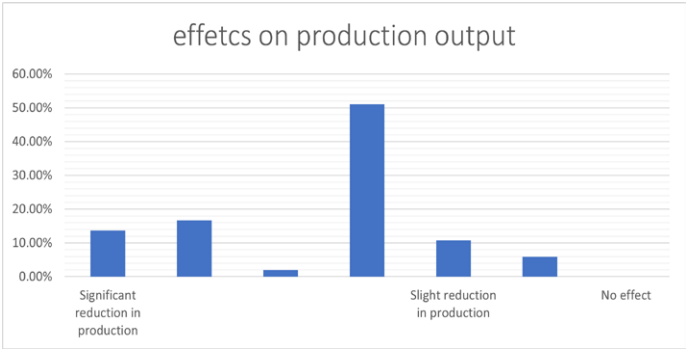

Figure 4. Impact of power outages on production

4.2.2. Effect on sales due to load shedding

This reveals that load-shedding has had a pronounced negative effect on business sales. A significant majority (65%) of businesses reported a decrease in sales, with this impact being moderate (25%) or major (19%) for nearly half of all respondents. Only 19% reported no effect, while a further 16% indicated their business model is not dependent on sales, a category likely representing service-based or non-retail operations. This indicates that for most sales-dependent businesses, revenue loss is a direct consequence of power outages.

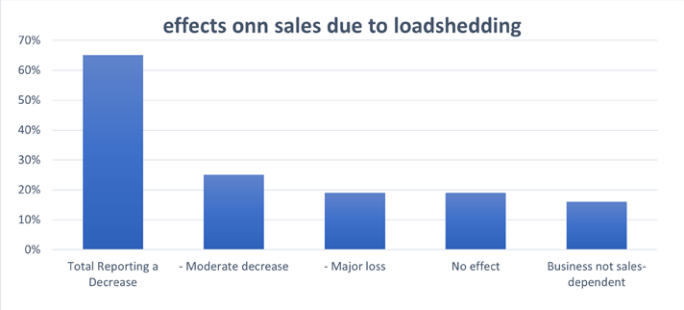

Figure 5. Effect on sales

4.2.3. Impact of load shedding on monthly profits

The data in figure 3 demonstrates that the financial damage extends beyond sales to deeply cut into profitability. A staggering 85% of businesses experienced a drop in monthly profits. Most alarmingly, almost one-third (31%) of all businesses suffered a profit drop of more than 50%, which is catastrophic for sustainability. An additional 37% faced decreases between 10% and 50%. This shows that load-shedding is not merely an inconvenience but a severe financial shock that erodes the economic foundation of the majority of businesses.

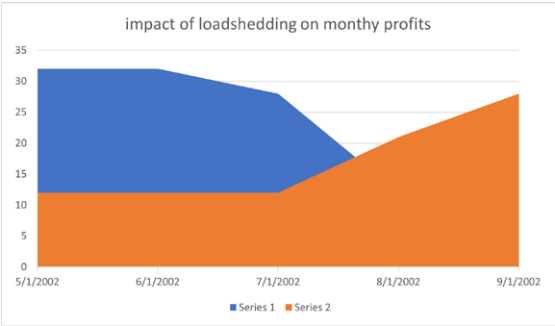

Figure 6. Effect of load shedding on profits

4.2.4. Additional expenses resulting from load shedding

highlights a critical double-edged financial impact: while businesses lose revenue, they also face increased costs. A large majority (85%) of businesses have incurred additional expenses to cope with load-shedding. For over half of all businesses (61%), these costs are significant, exceeding K500 per month, with the largest group (33%) spending over K1,000 monthly. These expenses, likely from generators, fuel, and inverters, further squeeze already declining profit margins. As shown in the graph below.

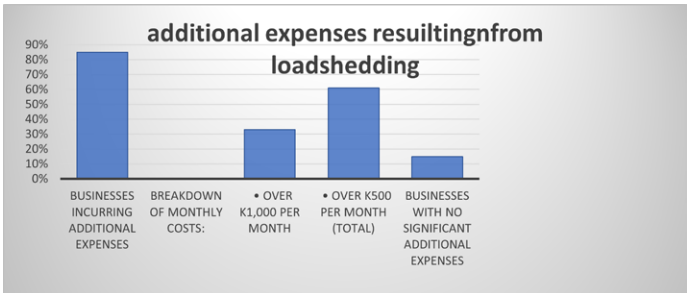

Figure 7. Additional expenses due to load shedding

4.2.5. Overall impact rating

provides a stark summary of the cumulative effect of load-shedding. An overwhelming 91% of businesses report experiencing some level of negative impact. Most notably, nearly half (45%) characterize the overall impact as either "*severe*" (14%) or a direct "*threat to business survival*" (31%). This underscores that for almost a third of businesses, the combined effects of lost sales, profits, operational hours, and increased costs pose an existential threat to their continued operation.

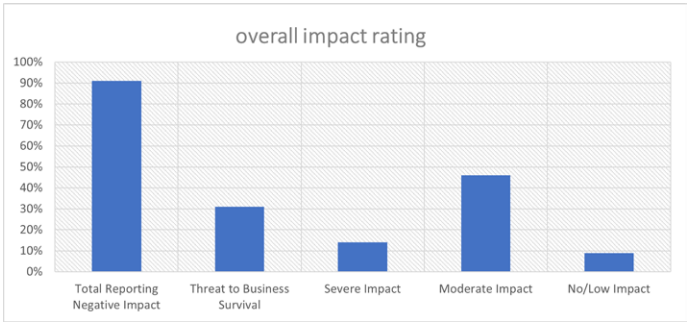

Figure 8. Overall impact rating

4.2.6. Statistical Significance Test – Difference in two categories

A one-way ANOVA test confirmed a statistically significant relationship between the level of additional expenses incurred and the severity of the overall operational impact (at n = 100, df = 3 (between), 96 (within), F (3, 96) = 12.456, p < 0.001). Businesses spending above K1,000 per month reported significantly more severe impacts, validating that the financial burden of coping is a key driver of operational distress.

Table 3. Analysis of variance (ANOVA) summary

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	p-value
Between Groups	35.742	3	11.914		
Within Groups	92.258	96	0.961	12.456	< 0.001
Total	128.0	99			

4.3. Impact on revenue flow

The findings on revenue flow depict a scenario of catastrophic financial damage. 65% of sales-dependent businesses reported a decrease in sales. Most critically, 90% of all SMEs experienced a drop in monthly profits, with 40% suffering a catastrophic decline of more than 50%. This was quantified in direct financial terms: 60% of businesses estimated direct monthly revenue losses to be above K1,000. Furthermore, 75% suffered stock or product losses valued over K500, with 40% losing over K1,000 worth of inventory, primarily due to a lack of refrigeration during outages representing a total loss of capital and potential revenue.

4.3.1. Severity of reduction in operating hours

The results indicate that load shedding has a severe and multi-faceted impact. The most critical areas are Increased Monthly Costs (Mean=3.53) and Reduction in Operating Hours (Mean=3.58), with over 80% of businesses reporting a Moderate to Very High impact. Loss in Productivity (Mean=3.37) is also significant, highlighting the direct effect of power outages on output. A majority of businesses (65%) also reported a Moderate to Very High Loss of Customers, suggesting that unreliable service damages customer relationships and loyalty.

Table 4. ANOVA results on additional expenses and overall costs

Impact Category	Mean Score	Businesses Reporting Moderate to Very High Impact
Reduction in Operating Hours	3.58	>80%
Increased Monthly Costs	3.53	>80%
Loss in Productivity	3.37	Data not specified
Loss of Customers	Mean not specified	65%

4.3.1. Descriptive statistics: estimated financial losses

The financial impact is profound. A combined 60% of businesses estimated their monthly revenue loss to be above K1,000, with more than a third (35%) losing over K2,000. This hemorrhage of revenue is compounded by a simultaneous surge in costs, with 60% of SMEs incurring an additional K500 to over K2,000 per month on coping mechanisms like generators and fuel. Most critically, 75% of businesses suffered stock or product losses valued over K500, with 40% losing over K1,000 worth of inventory, primarily due to a lack of refrigeration. This represents a direct and total loss of potential revenue

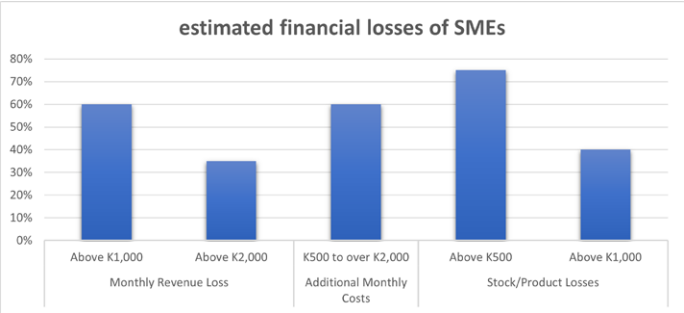

Figure 9. Estimated losses

4.3.2. Descriptive statistics: estimated financial losses and cost increases

To quantify the direct financial damage inflicted by load shedding, SMEs were asked to estimate their monthly increase in operational costs and the value of stock or products lost. The frequency distributions, generated using Stata's tabulate command, are shown in Table 5.

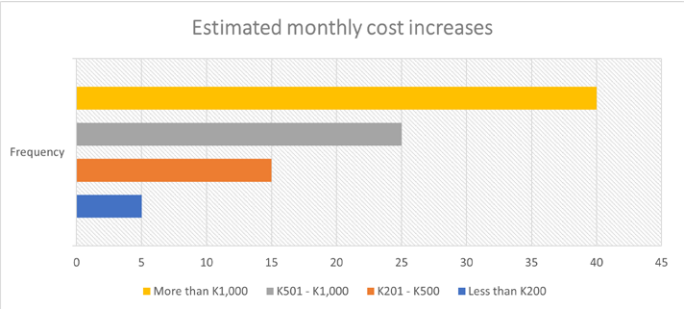

Figure 10. Estimated monthly cost increases

4.3.3. Stock losses

The financial damage is further compounded by direct losses of inventory. 75% of businesses suffered stock or product losses valued over K500. Most critically, 40% of all SMEs lost over K1,000 worth of inventory. This is predominantly attributed to the spoilage of perishable goods (e.g., in groceries, restaurants) due to refrigeration failures during prolonged power outages. This represents a direct conversion of potential revenue into a total loss, eroding the capital base of these enterprises.

Table 5. Total loss data

Stock Loss Category	Percentage of Businesses Affected
Total losses valued over K500	75%
Losses over K1,000	40%
Primary Cause	Spoilage of perishable goods due to refrigeration failures

4.4. Coping strategies and their effectiveness

SMEs employed a variety of strategies, often in combination. The most prevalent were low-cost operational adjustments: adjusting operating hours (65%) and shifting operations to daylight (58%). Investment in backup power (generators) was reported by 45% of SMEs. A severe social impact was that 35% resorted to reducing staff.

The financial outlay for these strategies was significant: 75% of SMEs that implemented strategies spent over K200 monthly, and nearly half (47%) spent over K500. However, the perceived effectiveness was alarmingly low. Only 20.5% found their strategies significantly effective, while 43.2% reported either no improvement or that their strategies made the situation worse. A cross-tabulation revealed a critical paradox: strategies in the lowest cost bracket (Below K200/month) had the highest rate of being "*significantly effective*" (36%). Conversely, the most expensive strategies (Above K1,000/month) were most frequently associated with "*no improvement*" or "*made it worse*" (83%). This indicates that high-cost solutions like generators, while providing temporary power, often exacerbate financial strain to a crippling degree.

Finally, a one-way ANOVA test found no statistically significant difference in the perceived effectiveness of these coping strategies across different business types ($F(5, 82) = 1.27$, $p = 0.286$). This is a pivotal finding: it demonstrates that no sector whether retail, service, or agro-processing has discovered a uniquely successful way to cope with load shedding on its own. The ineffectiveness is a universal, systemic challenge.

Table 6. Effectiveness of copying strategies between different business types – ANOVA Test

Source	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-value	p-value
Between Groups	7.15	5	1.43	1.27	0.286
Within Groups	92.73	82	1.13		
Total	99.88	87			

4.1. Prevalence of different coping mechanisms

SMEs employed a variety of strategies, often in combination, to survive the energy crisis. The data reveals a strong preference for operational adjustments over capital-intensive technical solutions. The most common strategies are operational and logistical, requiring little to no capital investment. Adjusting operating hours (65%) and shifting work to daylight (58%) were the most prevalent, highlighting a reactive approach to scheduling around power availability. The significant adoption of generators or other backup power (45%) confirms their status as the primary technical solution. However, the high rate of staff reduction (35%) points to the severe social and employment consequences of the crisis, often a last resort for preserving cash flow.

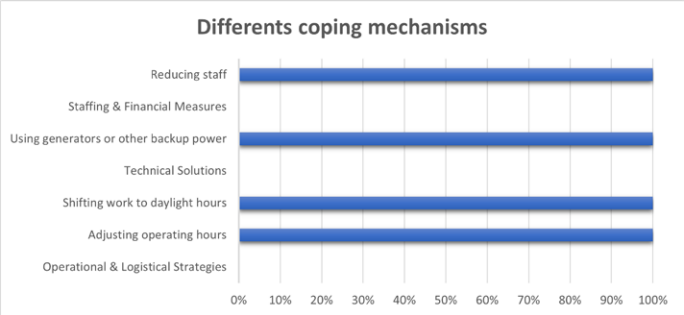

Figure 11. Coping strategies employed by SMEs

4.2. Financial outlay of implemented strategies

The financial commitment to these coping strategies varied significantly. The following table includes only the 88 SMEs that implemented at least one strategy (excluding the 12 who did nothing).

A majority of SMEs (74.9%) spent more than K200 per month on their coping mechanisms. Nearly half (46.6%) invested over K500 monthly, indicating that these strategies, while necessary, represent a substantial recurring financial burden on top of existing revenue losses.

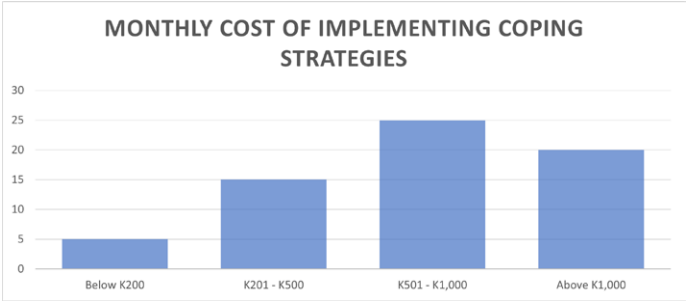

Figure 12. Cost of implementing

4.3. Perceived effectiveness of adopted strategies

Despite the financial investment, the perceived effectiveness of these strategies was mixed, revealing a critical disconnect between cost and benefit.

Perceived Effectiveness of Adopted Strategies

Only 20.5% of SMEs found their strategies to be significantly effective. A larger group (36.4%) reported some relief, but not enough to overcome the core challenges. Alarmingly, 43.2% reported either no improvement or that their strategies made the situation worse, suggesting that the costs of coping (e.g., generator fuel) sometimes exceeded the benefits.

- Overall, most coping strategies are failing. Only 1 in 5 companies found a truly effective solution.
- The most common outcome is partial relief at a high cost. Many strategies (like running generators) help keep the lights on but drain finances without solving the core problem, leaving businesses in a precarious state.
- A specific, popular strategy (Series 2) likely a costly technical fix like generators is a primary driver of these mixed-to-poor results. It provided the most common outcome ("Some Relief")

but also contributed significantly to the high rate of strategies that offered no value or made things worse.

4.5. Discussion of findings

The results strongly support the Resource-Based View (RBV) framework. Electricity, a fundamental tangible resource, is rendered unreliable. This directly cripples the SME's ability to generate revenue (another key resource) and forces the diversion of finite financial capital from growth investments to costly and often ineffective survival tactics (coping strategies), thereby eroding any potential for competitive advantage.

The significant variance in operational impact across sectors (ANOVA, p=0.0005) addresses the literature's homogenization of SMEs. It proves that vulnerability is sector-specific; a salon's reliance on electrical tools creates a different risk profile than a retail shops. This necessitates targeted, rather than blanket, policy interventions.

The finding that revenue impact is more severe than in some urban studies (e.g., Chanda & Njobvu, 2019) underscores the acute vulnerability of rural SMEs due to weaker infrastructure and fewer alternatives, addressing a key geographical gap in the literature.

The "*coping paradox*" is the most critical finding. SMEs are trapped between two bad options: endure revenue loss from inactivity or incur debilitating costs from generators. This trapped position prevents the "*resource reconfiguration*" suggested by Teece *et al.* (1997) as a path to resilience. The universal ineffectiveness of strategies across all sectors (ANOVA, p=0.286) confirms that individual coping is a failed approach. The problem is structural and requires external, systemic solutions rather than expecting overwhelmed entrepreneurs to solve a national energy crisis on their own.

Table 7. Summary of Findings vs. Literature Review

Aspect	This Study's Finding	Alignment with Literature	Divergence/Contribution
Operational Cost Increase	85% incur costs; 61% >K500/ month; significant variance by sector (ANOVA p=0.0005).	Aligns with Kabwe *et al.* (2021) & Smith & Zhao (2020) on cost escalations.	Provides empirical, quantified data for a rural district; proves the effect is not homogeneous across sectors (addresses Gaps 1 & 3 from Sect. 2.5).
Revenue Loss	90% profit decrease; 40% >50% drop; 60% lose >K1,000 monthly.	Aligns with Zulu (2022) on severe revenue impact.	Finds a more severe impact than urban-focused studies; provides concrete financial quantification of losses.
Primary Coping Strategy	Operational adjustments (65%) > Technical solutions (45%).	Aligns with Tembo & Kunda (2021) on adaptive, non-technical strategies.	Highlights the proven inefficacy and financial danger of generators (Coping Paradox), a critical nuance for policy.
Coping Strategy Effectiveness	43.2% report strategies provided "no improvement" or "made it worse"; no significant difference in effectiveness across business types (p=0.286).	Aligns with literature on barriers to effective coping.	Proves that no sector has a viable solution, emphasizing that coping is universally ineffective and the problem requires external intervention.
Socio-Economic Impact	35% resorted to staff reduction ("both workforce and shifts reduced").	Aligns with literature on job cuts and poverty exacerbation (OECD, 2017).	Provides concrete, measurable evidence of the direct negative impact on employment within the community.

5. CONCLUSION

This study concludes that load shedding systematically cripples the operational performance of rural SMEs in Kasenengwa District through three interconnected mechanisms: (1) it imposes a severe and escalating financial burden on operational costs; (2) it causes catastrophic disruption to revenue flows and profitability; and (3) it forces SMEs into a paradox of ineffective coping strategies where the cost of coping often exacerbates the financial strain it aims to mitigate. The application of the Resource-Based View confirms that unreliable electricity depletes other vital firm resources, preventing SMEs from achieving stability, let alone competitive advantage.

The implications are severe, extending beyond individual businesses to threaten rural livelihoods, employment, and broader economic development in the district. The universal failure of individual coping strategies, regardless of business type, underscores those solutions cannot be left to the SMEs themselves.

RECOMMENDATIONS

Therefore, this study recommends a multi-pronged approach

- *For Policymakers and Government:* Implement targeted, sector-specific subsidies and soft loans for renewable energy adoption (e.g., solar for salons, solar-powered cold storage for retailers). Invest in upgrading rural grid infrastructure and ensuring transparent, predictable load-shedding schedules. Develop financial products like "energy resilience loans" through partnerships with financial institutions.
- *For SME Owners and Managers:* Shift from individual to collective action by forming business clusters to invest in shared renewable energy solutions like solar microgrids. Prioritize energy efficiency through audits and adopting efficient equipment. Develop formal business continuity plans that include financial reserves and customer communication

strategies.

• *For Future Researchers:* Conduct longitudinal studies to track the long-term cumulative effects of load shedding. Employ deeper qualitative methodologies to explore the psychological and social impacts on entrepreneurs. Undertake cost-benefit analyses of different intervention models (e.g., communal solar vs. generator subsidies) to provide evidence-based guidance for policy.

This can be by aligning public policy, collective business action, and focused research, it is possible to break the detrimental cycle of load shedding and build genuine energy resilience for the SMEs that form the backbone of rural Zambia's economy.

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