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Sustainability of Coping Strategies Among Electricity Dependent SMEs during Load Shedding: Evidence from Welding Enterprises in Lusaka, Zambia

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Abstract

Load shedding has become a persistent constraint on the operational sustainability of small and medium enterprises (SMEs) in Garden, Zambia. This study examines the sustainability of coping strategies adopted by welding SMEs in Garden Compound, Lusaka, an electricity-intensive sector highly vulnerable to power disruptions. A mixed methods approach was employed, combining survey data from 107 SME operators with 25 in-depth interviews. The findings indicate that 90.5% of respondents experience daily power outages lasting between 2 and 8 hours, resulting in reduced productivity, customer loss, and declined revenues. To mitigate these effects, SMEs primarily rely on diesel and petrol generators, alongside adaptive measures such as flexible working hours and manual production methods. However, these strategies were found to be financially unsustainable due to high operational costs. The study concludes that existing coping mechanisms are largely short-term survival responses rather than long-term solutions. It recommends targeted policy interventions, improved electricity infrastructure, and access to affordable financing to enable SMEs to adopt sustainable energy alternatives such as solar power systems.

1. Introduction

Small and Medium Enterprises (SMEs) are widely recognized as key drivers of economic growth, and employment, particularly in developing economies. In Zambia, SMEs constitute over 97% of registered businesses, and contribute significantly to both Gross Domestic Product (GDP), and employment creation (International Trade Centre, 2023). Despite their economic importance, the operational sustainability of the SMEs is increasingly threatened by persistent electricity supply disruptions.

Load shedding, defined as the intentional reduction of electricity supply to prevent the collapse of power grids has become a recurring crisis in Zambia due to rising electricity demand, inadequate investment in generation infrastructure, and heavy reliance on hydropower, which is vulnerable to droughts (Mundia & Kaluba, 2018; World Bank, 2019). For electricity-dependent sectors such as welding, power outages significantly disrupt operational continuity, resulting in reduced productivity, increased operational costs, and direct revenue loss (Umar et al., 2022). A recent study in Kitwe District found that 80% of small-scale entrepreneurs experienced increased operational costs due to power outages, with 12% reporting decreased profitability and 8% facing business closures (Banda, Simukoko and Patson, 2020).

While previous research has explored various coping strategies, including the use of generators and solar alternatives (e.g. Bwali and Mubuyaeta, 2024; Charity and Tembo, 2023) , few studies have focused specifically on SMEs with limited financial resources in Zambia's informal sector. Furthermore, no existing Zambian study has quantitatively assessed the sustainability of these coping strategies that is, whether they can be maintained over the long term without eroding the enterprise's capital base.

1.2 Statement of the Problem

SMEs, which form a significant part of the Zambia's economic framework, are disproportionately affected by power shortages, leading to reduced productivity and business closures (Jonas, 2024). The adverse consequences of this electricity crisis are affecting not only operations of the SMEs but the country at large. Jesuit Centre for Theoretical Reflection (JCTR) in their recent report revealed that load shedding is likely to cripple SMEs as the majority of them heavily depend on Electricity and are unable to afford alternative energy sources (JCTR, 2019). Thus, electricity remains key to the country's growth and prolonged non-availability of electricity will result in dysfunctional business operations of the SMEs. Several scholars, such as (e.g., Guy, 2017; Charity & Tembo, 2023), have explored and recommended various coping strategies for businesses, including the use of generators, inventers and solar alternatives. However, few have focused on the long term sustainability of these coping strategies, particularly SMEs such as Welders who heavily depend on electricity for their daily operations. Therefore, despite adopting these coping strategies, the long term economic sustainability of these strategies remain uncertain and under researched.

1.3 Study Objectives

- To examine the extent of load shedding experienced by welding SMEs during load shedding.
- To determine the coping strategies SMEs have adopted during power outages.
- To assess the economic sustainability of the coping strategies.

2. Literature and Theoretical Review

The literature review provides an empirical and theoretical background on load shedding, guided by the study's objectives. It defines key terminologies, including load shedding, Small and Medium Enterprises (SMEs), and sustainability, while also reviewing existing literature on the impact of load shedding at global, regional, and local levels.

2.1 Small and Medium Enterprises (SMEs)

Small and Medium Enterprises (SMEs) are generally defined as independently owned businesses that operate with limited capital, a small workforce, and relatively low levels of formalization. In Zambia, SMEs are commonly categorized based on the number of employees, level of investment, and scale of operations. Micro enterprises typically employ fewer than five people, small enterprises employ between 6 and 20 employees, while medium enterprises may employ between 21 and 100 employees depending on the sector. In the context of welding enterprises in Lusaka, most SMEs fall within the micro and small enterprise categories, largely consisting of informal or semi-formal businesses such as welding workshops, small retail shops, hair salons, and food vendors.

Global Perspective on SMEs.

Globally, SMEs are defined based on different criteria, including the number of employees, annual revenue, or total assets, which vary across countries and regions. In the European Union, SMEs are classified as enterprises with fewer than 250 employees and an annual turnover not exceeding €50 million (European Commission, 2020). Surveys (Duarte, 2004; World Bank, 2019) define SMEs as independently owned businesses with fewer than 200 employees, highlighting that in Portugal, SMEs constitute approximately 98% of all businesses. The importance of SMEs extends beyond economic representation to their broader social and economic implications, including job creation and innovation.

The effects of load shedding on SMEs are evident across global, regional, and local contexts. Globally, power outages disrupt business operations, particularly in energy intensive industries such as manufacturing, IT, and retail. In developing economies, unreliable electricity supply significantly hinders SME growth, reducing production capacity and increasing costs (World Bank, 2023). Recent World Bank syntheses and reviews published in 2024–2025 converge on a clear global pattern: unreliable electricity reduces firm output and revenues, raises operating costs, and disproportionately hurts smaller firms and electricity-intensive sectors (World Bank, 2025a; Avordeh, 2024).

African Perspectives

Across Africa, SMEs play a crucial role in economic development, contributing significantly to employment and GDP. However, a common characteristic of SMEs in Africa is their vulnerability to infrastructure challenges, particularly unreliable electricity supply, which affects productivity and business sustainability (Management and Economics Research Journal, 2023). In Zambia, SMEs form the backbone of the economy, but many face operational challenges due to frequent power outages. According to the Jesuit Centre for Theoretical Reflection (JCTR, 2019), the majority of SMEs in Zambia.

2.2 Gaps in Literature

While several studies have examined the effects of load shedding on SMEs in Zambia, limited research has focused on the long term sustainability of the coping strategies adopted by electricity dependent enterprises such as Welding businesses. This study addresses this Gap by evaluating whether these strategies constitute viable long term solutions or merely short term survival mechanisms. Previous research (e.g., Guy, 2017; Charity & Tembo, 2023) has explored coping strategies including generators and solar alternatives, few studies have focused specifically on SMEs with limited financial resources in Zambia's informal sector. Furthermore, no existing Zambian study has quantitatively assessed the sustainability of these coping strategies that is, whether they can be maintained over the long term without eroding the enterprise's capital base. This gap is significant because a strategy that ensures survival today may be financially self-defeating tomorrow.

Therefore, without a comprehensive understanding of both the impact of load shedding on SMEs and the long-term viability of their coping mechanisms, policy interventions risk being misdirected. This study addresses this gap by examining the sustainability of coping strategies among welding SMEs in Lusaka, Zambia.

2.3 Theoretical framework

This study draws on multiple theories to assess the extent of load shedding, coping strategies adopted by the Welding SMEs during load shedding and the economic long term sustainability of the coping strategies during load shedding. Using these theories provides a structured understanding of both internal and external factors influencing long term economic sustainability of the coping strategies adopted by SMEs during load shedding.

Resource-Based View (RBV) Theory

The Resource-Based View posits that firms gain competitive advantage through the effective utilization and management of their unique resources and capabilities (Wernerfelt, 1984). In the context of SMEs facing load shedding, this theory suggests that the ability to leverage internal resources, such as skilled personnel, financial capital, and technological assets, can significantly influence their resilience and adaptability during power outages. Research indicates that SMEs that strategically reconfigure their resources are better positioned to mitigate the adverse impacts of disruptions like load shedding, thereby enhancing their overall sustainability and performance (Zhang et al., 2022; Björndahl and Nilsson, 2023). By focusing on resource optimization,

SMEs can develop innovative solutions such as alternative energy sources or flexible operational strategies that allow them to maintain service delivery despite external challenges (Bwali and Mubuyaeta, 2024).

Resilience Theory

Resilience Theory emphasizes an organization's capacity to recover from disruptions and adapt to changing environments (Garmezy, 1991). For SMEs affected by load shedding, resilience is vital for sustaining operations and ensuring long-term viability. The theory suggests that fostering resilience involves not only preparing for potential disruptions but also learning from past experiences to improve future responses. SMEs can enhance their resilience by developing adaptive strategies, such as diversifying energy sources or implementing robust contingency plans (Björndahl and Nilsson, 2023; Mutambo et al., 2023). This proactive approach enables SMEs to withstand the shocks of load shedding while maintaining operational continuity and customer satisfaction.

Cybernetic Theory

Cybernetic theory, originating in the 1940s with the work of Norbert Wiener, is a transdisciplinary field that examines the interactions and feedback mechanisms within complex systems, encompassing technology, biology, and social sciences. Defined by Wiener as "the science of control and communication in the animal and machine," cybernetics focuses on how systems self- regulate through feedback loops, enabling them to adapt to changing environments and maintain stability despite external disturbances (Wiener, 1961). For SMEs facing load shedding, this means that businesses must not only react to power outages but also learn from their experiences to enhance their resilience over time. This adaptive capacity is key as SMEs often operate with limited resources and face significant operational constraints during load shedding events. By employing feedback mechanisms, SMEs can assess the effectiveness of their coping strategies, such as investing in alternative energy sources or adjusting operational schedules, thereby refining their approaches to mitigate the impacts of load shedding.

Moreover, cybernetic theory highlights the significance of communication and information flow within organizations. For SMEs, effective communication regarding energy management strategies and employee roles during load shedding is essential for fostering a culture of adaptability. By establishing clear channels for information sharing, SMEs can ensure that all stakeholders are informed and engaged in the decision-making processes related to energy use and operational adjustments. This collective awareness enhances the organization's ability to respond swiftly to disruptions, ultimately contributing to its sustainability.

2.4 Conceptual Framework

The figure below outlines the conceptual framework were the primary dependent variable is economic sustainability Welding SMEs while the independent variables include staff downsizing, alternative sources of energy and operational hours.

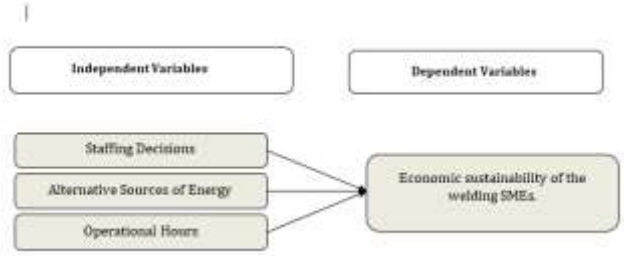

Figure 1: Conceptual Framework

3 Methodology

The study adopts a mixed method approach incorporating both qualitative and quantitative case study design. Data were collected through semi-structured questioners and face to face interviews to SME owners and business operators.

A census approach was adopted, meaning all 150 registered welding SMEs were invited to participate. Data collection yielded 107 valid questionnaire responses, representing a response rate of 71.3%. Non-response was primarily attributable to temporary business closures (n=18), owners being unavailable after three contact attempts (n=15), and refusals (n=10). For the qualitative component, purposive sampling was employed to select 25 interview participants from among the survey respondents.

4 Results and Discussion

This chapter interprets and contextualizes the findings presented in Chapter Four, and presents the findings of the study based on the data collected from 107 welding SMEs in Garden Compound, Lusaka.

4.1 Implications of the Demographic Profile

The demographic profile of the participants has important implications for the study's findings and their interpretation. All respondents (100%) in the sample were male, reflecting the gender composition typical of the welding trade in the study area. The majority of business operators (57.0%) were between 26 and 45 years old, representing the core working-age population. Educational levels among respondents were varied but generally modest; while 41.1% had attained secondary education, a combined 56.1% had either no formal education (29.0%) or only primary education (27.1%). An overwhelming

majority (99.1%) of the surveyed enterprises were classified as 'Retail' (welding workshops selling fabrication and repair services), with 77.1% having operated for more than 4 years. The surveyed SMEs were predominantly micro-enterprises, with 72.2% employing between 3 and 4 individuals.

4.2 The Extent of load shedding on SME Operations

The data revealed that load shedding was a pervasive and frequent challenge for SMEs in Garden Compound. An overwhelming majority (90.5%) experienced power cuts daily, and for over two-thirds of the businesses (69.5%), these outages lasted between 2 and 8 hours. Reduced productivity was the most cited challenge (32.1%), followed by increased operational costs (26.4%) and loss of revenue (21.7%). A near-unanimous 97.1% of respondents confirmed that load shedding had negatively impacted their customer base. Furthermore, a significant majority of respondents disagreed that their businesses could maintain long-term financial health (65%) and profitability (64.9%) under current load shedding conditions.

4.3 Copies strategies adopted by SMEs

The dependence on diesel generators was universal (96.3%), indicating a critical, yet costly, reliance on fossil fuels as the primary coping mechanism. The vast majority (94.3%) spent between K500 and K2,000 every week on alternative power, primarily fuel for generators. Beyond energy sources, SMEs adjusted their work modalities: almost half (46.2%) resorted to manual processes, about a third (31.1%) altered their operating hours, while 18.9% simply reduced output. The mean scores for the extent of adoption of these operational changes confirmed that shifting to manual processes was the most adopted strategy (M=3.85, SD=1.12), followed by changing business hours (M=3.40, SD=1.05) and reducing production output (M=3.10, SD=0.98).

4.4 Synthesis & Theoretical Implications

Through this analytical synthesis, it has clearly demonstrated that load shedding transcends the realm of a mere logistical or economic inconvenience; it is a holistic and systemic crisis. Its impacts radiate from the core operational mechanics of the workshop to destabilize the very foundations of the enterprise: it cripples operational logic through forced paralysis and coordination failure; it triggers a financial loss that consumes both current revenue and future capital; it erodes the social relations of trust with customers and employees that are the bedrock of informal commerce; it imposes a severe psychological toll that depletes entrepreneurial agency and cognitive bandwidth; and ultimately, it collapses the future vision of the business, replacing growth-oriented ambition with a myopic struggle for weekly survival.

The coping strategies enacted by these SMEs, while a powerful testament to human ingenuity, business determination and community solidarity, have been revealed as largely degenerative and self-limiting. They are not pathways to adaptation but mechanisms of costly endurance. Whether through the Faustian bargain of generator dependency, the productivity sapping regression to manual labor, the aspirational yet inaccessible ideal of solar power, the cognitively taxing acrobatics of micro scheduling, or the fragile bonds of informal sharing, each strategy is locked in a negative feedback loop with the original problem. They provide short-term functionality at the expense of long-term viability, consuming the very financial, social, and human resources needed to escape the trap. The near universal qualitative condemnation of these strategies' affordability, powerfully corroborated and quantified by inferential statistics most notably the regression analysis identifying energy expenditure as the key negative predictor of sustainability forms the irrefutable core of the argument against their long-term viability.

5 Conclusions and Recommendations

5.1 Conclusions

Extent of load shedding on SME Operations.

This objective was achieved through qualitative analysis of insights gathered from interviews with SME Welders & business owners. The study concludes that load shedding has severe and wide ranging effects on welding SMEs in Garden Compound, impacting them on multiple levels simultaneously. At the most basic operational level, power outages bring work to a complete standstill because welding equipment is entirely electricity-dependent. This is not simply lost time; it disrupts the entire workflow, causing delays, mistakes, and poor-quality work that affects customer satisfaction.

Financially, the impact is twofold. Businesses lose income during the hours they cannot operate, yet they must still pay rent, and staff salaries. This creates a serious cash flow problem. Over time, they also lose customers to competitors who can deliver more reliably, which damages their reputation and reduces future business opportunities.

The study further reveals that load shedding damages relationships. Customers lose trust when orders are delayed, often blaming the business rather than the power utility. Within the business, workers face uncertain income, which leads some to seek more stable employment elsewhere. This loss of skilled workers is particularly damaging because experienced welders are difficult to replace.

Finally, the constant unpredictability of outages takes a heavy psychological toll on business owners. They live with continuous stress and anxiety, which affects their decision-making and leaves them unable to plan for the future. Many end up using personal savings meant for school fees or business expansion just to survive week to week. In summary, load shedding does not merely disrupt operations it systematically undermines every aspect of these small businesses, pushing many toward eventual closure.

Coping Strategies adopted by SMEs.

This objective was achieved by examining how the coping strategies used by welding SMEs are universally adopted but ultimately do not provide a sustainable way forward. Nearly all businesses (96.3%) rely on fuel generators to keep operating during power outages. While generators allow work to continue, they come with high fuel costs that eat into profits. What was once a revenue problem becoming a cost problem. Businesses also face ongoing expenses for maintenance and repairs, and the noise and fumes from generators create problems with neighbors and the local environment.

When generators cannot be used, many businesses (46.2%) resort to manual labor. This means doing by hand what machines normally do in seconds. The result is much slower work, lower quality, and physically exhausted workers. Over time, this approach discourages young people from entering the trade and leads to a loss of skilled craftsmanship in the community.

Solar power is widely seen as the ideal solution clean, quiet, and cost-effective in the long run. However, the high upfront cost (often K45,000 to K60,000) makes it completely out of reach for businesses earning modest profits. Banks and other lenders do not offer affordable loans to informal businesses without formal collateral, so solar remains an unattainable dream. This creates a situation where only larger, well-established businesses can access clean energy, while small workshops remain trapped in expensive and polluting diesel use.

Businesses also cope by constantly rescheduling their work around power availability what some call "temporal acrobatics." This requires constant attention and mental energy but does not solve the underlying problem. Workers share generators and tools among themselves, and this community support helps in the short term. However, when everyone faces the same struggles, this support has limits. In summary, while SMEs show great ingenuity in coping with load shedding, all their strategies come with significant costs and do not offer a lasting solution.

Sustainability of the coping strategies.

The study concludes that the coping strategies adopted by welding SMEs are not sustainable over the long term. The statistical evidence supports what business owners already know from experience: using generators is simply too expensive. The majority of generator users described it as "very expensive," and their views on profitability were significantly more negative compared to the few businesses that do not rely on generators. Most tellingly, the amount spent on alternative energy each month was the strongest factor predicting whether a business owner believed their enterprise could survive. The more they spend on coping, the less hopeful they become about the future. In short, the very act of keeping the business running today undermines its chances of surviving tomorrow.

When it comes to labor, the picture is equally troubling. Moving workers to part-time or casual arrangements may reduce costs in the short term, but it creates uncertainty for employees. Skilled workers, who are the backbone of any welding business, begin looking for more stable work elsewhere. A key insight from the study is the difference between resilience and adaptability. Most business owners said they were resilient meaning they were still in business despite everything. But they also said they had not adapted meaning they were still struggling with the same problems day after day, with no real progress. As one respondent put it, this kind of survival leads to "a slow death." They are trapped in a cycle of constantly reacting to power cuts without ever finding a way out.

Ultimately, the study concludes that individual businesses cannot solve this problem on their own. The issue is not a lack of effort or ingenuity SME owners have shown plenty of both. The problem is that the systems around them have failed: the power supply is unreliable, and the financial system does not offer affordable loans for clean energy. Until these deeper issues are addressed, even the most determined business owner will struggle to survive.

5.2 Research Recommendations

- **Create Accessible Financing for Renewable Energy:** A dedicated fund should be established to help SMEs afford solar energy systems. This could include direct subsidies covering part of the upfront cost, partnerships with fintech companies to offer pay-as-you-go solar options, and collateral-free loans that use the equipment itself or group guarantees as security. The key is to match financing products to the reality of informal businesses that lack traditional collateral like land or vehicles.
- **Financial Institutions to offer affordable Energy financing for SMEs:** Banks and microfinance institutions must move beyond traditional lending models. They should develop credit scoring systems based on mobile money transaction histories, utility payment records, and customer testimonials. Asset financing where the equipment itself serves as collateral would also help SMEs acquire solar systems or energy-efficient tools without requiring property titles.
- **Power Utilities to implement a predictable timetable:** Industry bodies such as the ZESCO to implement a predictable load shedding timetable for SMEs that minimizes load shedding during peak hours. This will enable SMEs such as Welders continue operating and achieve service delivery during peak hours.
- **Adoption of cost effective & sustainable energy practices:** SME owners should form registered associations or cooperatives to strengthen their collective voice. This would help them advocate for better services, access group loans, negotiate better prices from suppliers, and bid for larger contracts together. Associations can also facilitate bulk purchasing of fuel, equipment, and raw materials, reducing individual costs. Individual businesses should also keep careful records of energy expenses to make informed decisions and demonstrate their viability to potential lenders.

Declaration of Competing Interests

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The article followed all ethical standards appropriate for this kind of research.

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