Mediating Effect of Energy Management on SME Development amid the Power Crisis in Sri Lanka: Lessons and Public Policy Insights

C. R. Edirimuni
Ceylon Electricity Board, Colombo, Sri Lanka
chamil.edirimuni@ceb.lk

H. D. D. C. Liyanagamage
The Open University of Sri Lanka, Nugegoda, Sri Lanka
hdcha@ou.ac.lk

Abstract

This study investigates the multifaceted impact of power crises on the development of Small and Medium Enterprises (SMEs) in Sri Lanka, focusing on the period from March 2022 to February 2023 and examines how power shortages and load shedding affect SME productivity, employment, competitiveness, sustainability, and growth, by exploring the role of energy management in mitigating these adverse effects. Using quantitative methods, the study analyzes survey data of 143 SMEs selected through convenience sampling in the Western Province of Sri Lanka. The findings highlight the significant negative impact of power crises, revealing reduced productivity, diminished employment opportunities, decreased competitiveness, and obstacles to business sustainability and growth. Notably, the study demonstrates the positive effect of energy-efficient practices in mitigating the impact caused by power crises. The study provides further evidence that the negative influence of power-related issues is consistent across different SME sizes and industries. These insights have important policy implications, suggesting the need for collaboration between the government and the private sector to address SME challenges. The study underlines the importance of investing in power infrastructure, promoting economic diversification, and encouraging sustainable business practices. Furthermore, long-term planning, financial literacy initiatives, and targeted support to ensure the resilience and development of SMEs in the face of power crises are suggestive.

Keywords: Energy Crisis, Energy Management, Public Policy Insights, SME Development, Sri Lanka

1. Introduction

The power crisis that Sri Lanka experienced from March 2022 to February 2023 has had a severe impact on the country's Small and Medium Enterprises (SMEs), affecting their operations, productivity, and competitiveness. The power crisis, along with the economic downturn in 2022, created substantial hindrances for the industry (Central Bank of Sri Lanka, 2022). The report noted that power curtailments, fuel shortages, and electricity supply cuts severely hindered manufacturing activities, leading to a contraction in the Purchasing Managers' Index (PMI) and a decline in production output.

In August 2022, the electricity tariffs increased by an average of 75%, adding further strain on SMEs. According to the study *History Repeating Itself: Sri Lanka's Electricity Crisis* (2022) energy sector of Sri Lanka has played a crucial role in driving the economic growth of the nation. However, the recurring power outages and erratic energy supply have created obstacles to economic progress and poverty alleviation efforts. As the study reveals, the energy demand is closely tied to the Gross Domestic Product (GDP) of the country, meaning power disruptions can have an immediate and detrimental impact on GDP.

Across various media platforms, the sentiment is clear; the inadequacy of power supply and continuous blackouts have significantly increased operational expenses for SMEs, lowered productivity, and diminished business sustainability. Addressing these issues is crucial for the growth of the SME sector of Sri Lanka, which is responsible for employing a significant portion of the labor force and contributing 40% to the country's GDP. The sector accounts for 93.3% of total industries and 32.3% of employment, according to the Asian Development Bank (ADB) in 2021. The social and economic contributions of SMEs are critical for Sri Lankan society.

The adverse impact of power crises on SMEs is not unique to Sri Lanka. Studies from other countries, such as Turkey, Uganda, Pakistan, and China, show that power outages and shortages reduce productivity, increase operational costs, and harm competitiveness. For instance, Cole et al. (2018) found that power disruptions in Turkey led to decreased productivity and profitability for SMEs. Similarly, power failures in Uganda lowered SME productivity by 31%. In Pakistan, Zaidi et al. (2020) observed a decrease in SME sales and revenue due to power outages. In China, Fisher-Vanden et al. (2015) found that energy shortages negatively affected company revenues, even if productivity losses were less severe.

Power outages are common in developing countries and often have a severe impact on SMEs due to their limited financial resources and technical expertise.

Additionally, SMEs typically lack access to alternative energy sources, which makes them more vulnerable to revenue losses, equipment damage, supply chain interruptions, and reduced competitiveness. In Sri Lanka, the recent power crisis, driven by government-imposed curtailments from March 2022 to February 2023, has left a lasting impact on businesses. SMEs have had to cope with prolonged power failure, fuel shortages, and higher energy costs, all of which have reduced their operational efficiency.

According to reports from the Public Utilities Commission (2022) the average weekly loss of production due to power cuts is approximately 10 hours. This loss of productivity, combined with rising costs for backup generators and other power sources, has put massive financial pressure on SMEs. Equipment damage, supply chain delays, and lost sales have further intensified these challenges, hindering business growth and causing social disruptions.

Another significant effect of the electricity crisis is the decrease in investment in the SME sector. Investors are becoming increasingly hesitant to commit to businesses in an environment of uncertainty. Additionally, the power crisis has made it more difficult for SMEs to export their products, as power outages prevent them from meeting production demands. The financial burden on SMEs due to rising production costs has been substantial, leading to a decline in business growth and competitiveness. This, in turn, has wider economic implications for Sri Lanka, including a decline in GDP growth, rising unemployment, and a decrease in living standards.

The power crisis has also created barriers to sustainable business practices. Many SMEs struggle to adopt energy-efficient measures due to the high upfront costs and lack of government support. In the long term, energy-efficient technologies could help reduce operational costs and mitigate the impact of future power crises, but such solutions are often out of reach for smaller businesses without financial support or incentives. Hence, this research aims to analyze the impact of the power crisis on SME development in Sri Lanka and to identify potential policy solutions that could alleviate the burden on these businesses. By exploring key dimensions such as business growth, productivity, employment, competitiveness, and business sustainability, the study provides a comprehensive understanding of the challenges faced by SMEs during the power crisis. The research also examines whether the size and industry type of SMEs influence the relationship between power disruptions and SME development.

Additionally, the study will investigate the mediating role of energy-efficient practices in mitigating the negative effects of the power crisis. The adoption of such

measures could help SMEs reduce their reliance on conventional energy sources and improve their operational efficiency during times of power shortages. However, widespread implementation of energy-saving initiatives will require coordinated efforts from policymakers, the private sector, and international partners. The future of Sri Lanka's SME sector depends on the country's ability to address the underlying causes of the power crisis and to develop long-term strategies for energy sustainability. By implementing evidence-based policies and fostering collaboration between key stakeholders, the government can help ensure that SMEs remain a vital force in Sri Lanka's economic recovery and growth. Strengthening the resilience of SMEs will not only protect jobs and livelihoods but also contribute to a more sustainable and competitive economy in the long term.

This research provides valuable insights into the impact of the power crisis on Sri Lankan SMEs and offers a roadmap for policymakers to support the recovery and growth of the sector. By addressing the challenges of the power crisis head-on and promoting energy-efficient practices, Sri Lanka can ensure a brighter future for its SME sector and the broader economy.

2. Literature Review

2.1. Theoretical and Empirical Background

2.1.1. Power Crisis and SME Development

The literature on the impact of power crises on SMEs covers several key theoretical frameworks and empirical studies that shed light on how these challenges affect business operations, growth, and productivity.

Several theoretical frameworks are employed to understand how power crises impact SMEs. The Environmental Uncertainty Theory (Lawrence & Lorsch, 1967) explains how external disruptions, such as energy issues, create challenges for businesses, forcing them to adapt. In this context, power crises create uncertainty, leading SMEs to modify their operations and strategies. Institutional theory (Scott, 2013) further highlights the role of laws, regulations, and government policies in influencing organizational behavioaber during crises. Porter's Five Forces model (2008) adds another dimension by analyzing the competitive pressures that SMEs face, including the bargaining power of suppliers, which is heightened during power shortages. The Resource-Based View (RBV) by Barney (1991) is particularly useful for analyzing how SMEs use their internal resources to navigate power crises. This model helps explore how SMEs' unique resources, such as innovation capabilities and adaptive strategies, help them overcome energy-related challenges, ensuring competitive advantage and long-term sustainability.

Empirical evidence from various countries shows the wide-ranging effects of power

crises on SMEs. For instance, Cole et al. (2018) found that power outages in Turkey significantly reduced productivity, increased operational costs, and lowered profitability. Similarly, they also observed a 31% decline in SME productivity in Uganda due to power outages, while Zaidi et al. (2020) documented revenue losses for SMEs in Pakistan during power shortages. Power crises also have social and psychological impacts. Ajibola et al. (2021) reported that power outages in Nigeria caused stress and anxiety among SME owners and employees. Furthermore, power shortages hinder technological adoption and innovation, slowing down business growth, as shown by Gajdzik et al. (2024).

The rising cost of electricity compounds these problems. Abeberese (2017) demonstrated how increased electricity costs in India negatively affected business profitability, productivity, and investment. The study found that higher electricity rates not only raise operational costs but also discourage SMEs from adopting energy-efficient technologies, further lowering productivity. For instance, a 1% reduction in electricity prices could increase firm output by 1.5%, underscoring the substantial economic benefits of affordable power.

Fisher-Vanden et al. (2015) studied the impact of electricity shortages on firms in China, a country with growing energy demands, and found that electricity shortages lead to significant declines in labor and total factor productivity, with firms adjusting their operations and seeking alternative energy sources to mitigate the impact. The study emphasizes the importance of proactive strategies to mitigate power shortages, as similar issues could impact SME productivity in countries like Sri Lanka. Kessides (2013) explored the effect of Pakistan's power crisis on industries, including SMEs and found that power shortages crippled industries like textiles, which account for a large portion of exports and jobs. SMEs, particularly, faced severe production delays, increased operational costs, and reduced competitiveness, collectively hindered their growth. The study also highlighted the link between power outages and employment, as job losses were rampant due to the disruption of business operations.

Power crises have a direct impact on employment. Kessides (2013) showed that power outages in Pakistan led to job losses and reduced employment growth, particularly in industries reliant on a consistent power supply. The study pointed out that SMEs, as major employers, were severely affected, with layoffs and reduced hiring during blackouts. Similar findings were reported in Istepanian's (2014) study on Iraq, where power shortages led to job losses and reduced production capacity, stalling business expansion plans. Shrestha et al. (2023) studied the February 2021 power crisis in the U.S. Southwest, highlighting how increased electricity costs and outages disrupted businesses. Although the context differs from Sri Lanka, the financial and operational challenges faced by businesses in the U.S. Southwest during

this period provide valuable insights into how power crises could impact SMEs in other regions.

Carlsson et al. (2020) examined the financial impact of power outages on industrial firms in Ethiopia. The study quantified the cost of power outages in terms of production losses, reduced productivity, and additional expenses, such as the use of backup power sources. While the study focused on larger manufacturing firms, its findings can be applied to SMEs, which may face even higher costs due to their smaller operational scale and dependence on reliable electricity. Similarly, Cissokho (2019) studied the impact of electricity shortages on SMEs in Senegal's industrial sector, revealing significant productivity losses. The study emphasized the need for a reliable and affordable power supply for SME growth, noting that power outages severely hampered business development. Cole et al. (2018) supported these findings, showing that power outages in Sub-Saharan Africa reduced productivity and profitability for local businesses, further underlining the importance of a consistent electricity supply for SME success.

2.1.2. Energy Efficiency Measures in Different Contexts

The literature on energy efficiency measures for SMEs across different contexts highlights technological, operational, and policy-driven strategies, with particular emphasis on challenges in developing countries. Technological upgrades, such as adopting energy-efficient equipment (e.g., Light-Emitting Diode (LED) lighting and energy-efficient motors), integrating renewable energy like solar or wind, and employing energy management systems (EMS), are frequently recommended (Aboelmaged & Hashem, 2019; Hasanbeigi et al., 2012). Operational measures, including employee training on energy-saving practices and conducting energy audits, are also crucial for identifying inefficiencies and optimizing resource use (Trianni et al., 2016). Similarly, policy support plays a significant role, with government incentives like subsidies, tax breaks, and low-interest loans to facilitate energy efficiency adoption (Thollander et al., 2020). Challenges such as limited financial resources and knowledge gaps, which are unique to SMEs in developing countries, often hinder the implementation of these measures (Otoo et al., 2018).

Studies from regions like South Asia and Sub-Saharan Africa emphasize localized solutions, such as small-scale solar installations and community-based energy projects, to address unreliable power supply and high energy costs (Hubble et al., 2016). Several studies show that while SMEs in developed countries leverage advanced technologies, adapting these solutions to resource-constrained settings is essential for effective implementation (Nehler et al., 2018). Overall, these interventions demonstrate the potential for energy efficiency to enhance SME productivity, sustainability, and resilience.

2.2. Hypotheses Formulation

The existing studies on power crises mostly focus on larger enterprises, with less attention given to the specific challenges faced by SMEs. Although significant research has been conducted in the context of developing countries such as Turkey, Uganda, Pakistan, and Nigeria, many of these studies concentrate on the impact of power outages on general business performance, productivity, and profitability. However, few studies investigate deeply into the unique vulnerabilities of SMEs during power crises, particularly in terms of their capacity to adopt innovative solutions, adjust to rising energy costs, or sustain long-term growth.

Moreover, while research such as Abeberese (2017) and Fisher-Vanden et al. (2015) address the impact of rising electricity costs and power shortages on business performance, these studies focus on large industrial firms, leaving a gap in understanding the specific implications for SMEs. Similarly, insights from studies like those conducted by Cissokho (2019) provide valuable information on the financial burden of power crises however, they do not fully address the particular context of SMEs in smaller economies like Sri Lanka.

Furthermore, limited attention has been paid to how power crises affect employment within SMEs. Although findings of Kessides (2013) and Istepanian (2014) explore job losses in the broader industrial context, there is inadequate research on how SMEs cope with employment challenges during blackouts and energy disruptions. Finally, while recent studies such as Shrestha et al. (2023) offer insights into the impact of power crises on businesses, they are based in regions like the U.S. Southwest, where the economic and energy infrastructure significantly differs from that of Sri Lanka. This highlights the need for research that is specific to the Sri Lankan SME sector, particularly in understanding the local challenges posed by power crises and rising electricity costs.

In summary, the lack of focused research on SMEs, especially in smaller, developing economies like Sri Lanka, and the limited exploration of employment and innovation strategies during power crises, represent critical gaps that need to be addressed. The present study develops the following hypotheses to address this knowledge gap in the context of Sri Lanka.

H1: *Power crises significantly impact the business growth of SMEs.*

This hypothesis is based on prior research by Von Ketelhodt et al. (2008) and Cole et al. (2018), which shows that power crises disrupt SME operations, resulting in lost business opportunities and hindering growth.

H2: *Power crises significantly impact productivity in the SME sector.*

Power outages and related disruptions can negatively affect SME productivity by interrupting operations and raising costs, as documented by Abeberese (2017) and Fisher-Vanden et al. (2015).

H3: *Power crises significantly impact employment within the SME sector.*

This hypothesis is grounded in findings by Kessides (2013) and Istepanian (2014), which indicate that power crises can reduce employment opportunities and contribute to job losses in the SME sector.

H4: *Power crises significantly impact the competitiveness of SMEs.*

Studies of Cole et al. (2018) establish a clear link between power crises and competitiveness, demonstrating that power disruptions undermine the competitive standing of SMEs.

H5: *Power crises significantly impact the business sustainability of SMEs.*

According to Bansal (2000) and Abeberese (2017), power cuts can increase operational costs and reduce profitability, ultimately threatening the long-term sustainability of SMEs.

H6: *Energy management measures mediate the relationship between power crises and SME sector development.*

Drawing on the work of Akil (2020) and other research, this hypothesis posits that energy-efficient measures can mitigate the negative effects of power shortages, playing a crucial role in SME sector development amid power crises.

H7: *The impact of power crises on SME sector development varies with firm size.*

Cissokho (2019) and Cole et al. (2018), suggest that SMEs of different sizes experience varied impacts from power shortages. Larger SMEs, for instance, may have more resources to manage these challenges than smaller ones.

H8: *The impact of power crises on SME sector development varies by industry type.*

Research by Cole et al. (2018) and Von Ketelhodt et al. (2008) indicates that the nature of an industry influences how power shortages affect SMEs, with manufacturing businesses, which are heavily reliant on electricity, often experiencing greater impacts than service-oriented firms.

3. Methodology

This study investigates the association between power crises and multiple dimensions of SME sector development in Sri Lanka. It aims to assess how power shortages, particularly power curtailments, impact SME development, with a focus on business growth, productivity, employment, competitiveness, and sustainability. To offer a comprehensive analysis, the research also considers moderating variables, including industry type and firm size, as well as the mediating role of energy management practices, which may affect the strength and nature of these relationships.

The independent variable is the *power crisis*, measured through the effect on day-to-day operations and the challenging nature of power cuts, using a five-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). The dependent variables include various dimensions of business performance: *business growth* (measured by income level, profitability, new market entries, and an increase in customer base), *productivity* (measured by output increase and production efficiency), *employment* (assessed through the hiring of new employees, employee benefits, competitive salaries, and workforce growth), *competitiveness* (gauged by competitive position, price changes, and market share growth), and *business sustainability* (measured by sales growth and new investments). These dependent variables are also assessed on a five-point Likert scale, indicating the degree to which respondents agree with the statements.

Moderating variables include *firm size*, classified by the number of employees (micro, small, or medium enterprises), and *industry type*, categorized by business sectors such as manufacturing, services, trading, agriculture, or other, both measured on a Likert scale. The mediator variable, *energy efficiency*, is assessed through the implementation of energy-efficient measures and the resulting electricity cost savings, also using a five-point Likert scale. This framework helps to understand how the power crisis influences SME performance, while considering moderating factors like firm size and industry type, and the potential mediating role of energy efficiency measures in mitigating the impact of power shortages.

To comprehensively assess the impact of power crises on the development of the small and medium enterprise (SME) sector, this study adopts a quantitative research approach, emphasizing objectivity, accuracy, and statistical analysis. To ensure the reliability and validity of the results, data were collected from a representative sample of SMEs across various industries. The study employs primary data sources to analyze the effects of power crises on the SME sector. A structured survey questionnaire was the primary tool for data collection, designed to capture the impact of power crises on SME development in Sri Lanka. The survey included closed-ended questions with Likert scale items to facilitate the quantification of responses, enabling

comprehensive statistical analysis.

The SME sector in Sri Lanka is diverse and consists of various industries, including manufacturing, construction, agriculture, services, and trade. Many SMEs in Sri Lanka are micro-enterprises with a total investment of less than LKR 15 million. According to ADB 2021, Sri Lanka, by 2018 there were 21,260 enterprises out of which 14, 890 are small and 5,074 are medium enterprises which accountable to 94% of total industries. The target population for this study comprised SMEs from a range of industries operating within the Western Province of Sri Lanka. Data collection was conducted between 30th March 2023 and 30th May 2023. Industry-specific social media groups and professional networks were leveraged to reach the target population. Convenience sampling was used by distributing the questionnaire in professional networks where SME owners and managers were active. An invitation email containing the survey link was sent to SMEs. A total of 143 responses were collected, which meets the sample size requirement for statistical analysis as calculated based on a 95% confidence level. Participants provided informed consent before accessing the survey, and their responses were anonymized. Ethical considerations, including informed permission and data protection safeguards will be given priority throughout the whole research process. This methodology effectively captures the current challenges faced by SMEs in relation to power crises, providing valuable insights for policymakers to develop strategies aimed at supporting the SME sector amidst ongoing energy challenges.

4. Analysis and Discussion

4.1. Sample Overview

The preliminary analysis of the survey data shows a diverse representation of SMEs across various size categories, industries, and stages of development. The majority of respondents (44%) are micro-enterprises with 1 to 10 employees, followed by 36% representing small-sized enterprises, and 20% from medium-sized businesses with 51 to 250 employees. This distribution reflects the dominance of smaller firms within the sample. In terms of the age of businesses, 41% of SMEs have been operational for 1 to 5 years, indicating a substantial presence of young firms. Meanwhile, 29% are in their mid-growth phase (6 to 10 years), and 15% have been established for 11 to 15 years. Only 4% of SMEs are less than a year old, while 11% have been in business for over 15 years, highlighting a diverse mix in terms of business maturity.

The survey also covers a wide range of industries, with 35% of respondents from the services sector, 33% from manufacturing, and 20% from agriculture. Trading companies make up 10% of the sample, while only 1% represents the food and beverage industry, indicating a very limited presence of such businesses. This diverse composition provides a comprehensive dataset for analyzing the impact of power

crises on SMEs, with the results highlighting a notable focus on manufacturing and services, alongside other sectors like agriculture and trading. However, the limited representation of food and beverage firms is notable.

4.2. Validity and Reliability Analysis

The reliability and validity of the research questionnaire were evaluated to ensure accurate measurement of the study's constructs and variables. Cronbach's Alpha was used to assess internal consistency, yielding a value of 0.760 overall and 0.769 for standardized items, indicating high reliability. This demonstrates that the questionnaire is a reliable tool for data collection, ensuring that participant responses accurately reflect the underlying constructs. Validity was assessed using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The high KMO value of 0.905 exceeded the recommended threshold of 0.6, confirming the dataset's suitability for factor analysis due to strong inter-correlations among variables. Bartlett's Test of Sphericity also showed significant relationships between variables, with a low p-value and high chi-square statistic, further validating the questionnaire's ability to capture the intended constructs.

Together, the reliability and validity results confirm that the questionnaire is a robust and effective tool for measuring the constructs of interest, enhancing the overall quality of the research.

4.3. Descriptive Statistics–SME Development, Power Crisis Effect, and Energy Management Measures

This analysis uses descriptive statistics to provide a comprehensive overview of survey responses regarding the impact of power crises on the SME sector development. Key statistics, such as mean, standard deviation, mode, minimum, and maximum values, are presented for each variable, allowing for a clear understanding of the characteristics and patterns within the dataset.

Table 01: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Power Crisis	143	1.00	5.00	4.1002	1.02170
Business Growth	143	1.00	5.00	1.9720	1.00356
Productivity	143	1.00	5.00	1.9580	0.94849
Employment	143	1.00	4.75	2.1014	0.96517
Competitiveness	143	1.00	4.75	2.1189	1.05518

Bus Sustainability	143	1.00	5.00	2.1119	0.98894
Energy Mgt	143	3.00	4.60	3.6335	0.34964
Valid N (list wise)	143				

Source: Survey Data

The descriptive statistics offer valuable insights into the severity of the power crisis from the perspective of small and medium enterprises (SMEs) and the overall development of the SME sector across various dimensions. The data reveals that SMEs in the sample experienced a significant power crisis, with an average impact rating of 4.1002 and a low standard deviation of 1.02170, indicating that the SMEs' assessments of the crisis impact were relatively consistent. Respondents reported generally low levels of business growth and productivity within their enterprises. The mean employment score of 2.1014 suggests that SMEs struggled to maintain their workforce during the crisis. Similarly, the average competitiveness score of 2.1189 implies that the ability of SMEs to compete effectively in the market was somewhat weakened during the power crisis. Additionally, the mean business sustainability rating of 2.1119 indicates that SMEs encountered substantial challenges in sustaining their operations, requiring additional efforts to remain viable. The mean value 3.6335 suggests that SMEs perceive their energy management initiatives as being at a moderate level. This value reveals that while the measures are beneficial, they have not yet reached optimal effectiveness.

These findings underscore the need for further hypothesis testing and in-depth analysis to better understand the broader implications of the power crisis on the development and resilience of the SME sector.

4.4. Correlation Between Power Crisis and SME Development

This section employs correlation analysis to explore the relationships between the power crisis and various aspects of SME sector development, as business growth, productivity, employment, competitiveness, and sustainability. The findings show significant negative correlations between the power crisis and each of these aspects of growth, productivity, workforce retention, competitiveness, and sustainability.

Table 02: Results of Correlation Analysis

		Power Crisis	Business Growth	Productivity	Employment	Competitiveness	Bus Sustainability
Power Crisis	Pearson Correlation						
Business Growth	Pearson Correlation	-.774**					
Productivity	Pearson Correlation	-.721**	.906**				
Employment	Pearson Correlation	-.694**	.866**	.864**		.888**	.885**
Competitiveness	Pearson Correlation	-.626**	.852**	.913**	.888**		.883**
Bus Sustainability	Pearson Correlation	-.703**	.897**	.910**	.885**	.883**	
	N	143	143	143	143	143	143

Source: Survey Data

4.5. Hypotheses Testing: The Impact of Power Crisis on SME Sector Development

Regression analysis was used to test hypotheses and estimate the importance of relationships established. The purpose is to determine the nature and degree of the associations between the variables. We specifically sought to ascertain the relationship between changes in the power crisis variable and changes in business growth. The study enables us to understand the importance of the power crisis as a predictor of business growth. The results of the regression analyses are summarized in Table 03.

Table 03: Results of Regression Analysis

Model	Aspect of SME Dev	R^2	Adjusted R^2	Standard Error of Estimate	F-statistic (ANOVA)	P-value (ANOVA)	Coefficient (B)	Significance (P-value)
1	Business Growth	0.599	0.596	0.63778	210.589	0.0000	-0.76	0.000
2	Productivity	0.519	0.516	0.65985	152.4	0.0000	-0.669	0.000
3	Employment	0.482	0.478	0.6972	131.135	0.0000	-0.656	0.000

4	Competitiveness	0.392	0.388	0.82556	90.979	0.0000	-0.647	0.000
5	Business Sustainability	0.494	0.49	0.70608	137.564	0.0000	-0.68	0.000
6	SME Development	0.543	0.540	0.6417	167.61	0.0000	-0.682	0.000

Source: Survey Data

The results of the regression analysis examining the casual relationship between the power crisis and business development dimensions, including business growth, productivity, employment, competitiveness, and business sustainability in the SME sector are presented in this table. Model 1 has an R-squared value of 0.599, indicating that 59.9% of business growth variance can be explained by the power crisis. The model is statistically significant (p-value < 0.001), and an F-statistic of 210.589 confirms this. Hence, the hypothesis suggesting a relationship between business growth and the power crisis is accepted. The R-squared value is 0.519 of model 2 evidenced that the model explains 51.9% of productivity variance relative to power crisis. The model is significant ($p < 0.001$) with a negative coefficient for the power crisis, indicating that increased power issues negatively affect productivity.

Similarly, the R-squared value of model 3, 0.482, indicates that 48.2% of employment variance is explained by the power crisis. The model's statistical significance ($p < 0.001$) supports the hypothesis that the power crisis negatively impacts employment. Whereas model 4 shows a strong linear relationship with an R-squared value of 0.392. The power crisis hurts competitiveness, confirmed by a p-value of 0.000. Model 5 shows an R-squared value of 0.494, indicating that the power crisis significantly affects business sustainability. The model is statistically significant ($p < 0.001$), with a negative coefficient for the power crisis. Overall, the regression analyses consistently indicate that the power crisis is a significant predictor negatively impacting business growth, productivity, employment, competitiveness, and sustainability in SMEs, with strong statistical support across various metrics. The results of the regression analysis indicate that 76% of business growth, 67% of productivity, 66% of employment, 65% of competitiveness, have been adversely affected by power crises in SMEs in Sri Lanka. Accordingly, at the 95% confidence level, the hypotheses HI–H5 are accepted, indicating that the results are statistically significant.

Power crises are found to disrupt multiple aspects of SME operations, with the acceptance of hypotheses H1 and H2 confirming the negative consequences for business growth and productivity. The extremely low p-values (0.000 for both

hypotheses) highlight the severity of these effects. The study builds on previous research by Abeberese (2017), which established that unstable power supplies disrupt businesses, increasing operational costs and hampering productivity, which in turn affects employment. These results affirm existing literature stressing the importance of reliable power for SME growth. When faced with power disruptions, SMEs experience production delays and higher expenses, making it challenging to sustain operations and retain staff.

The study also found that power crises diminish competitiveness of SMEs and sustainability, as seen with the acceptance of H3, H4, and H5. These hypotheses also reported low p-values of 0.000, indicating the strong impact of irregular power supplies on business performance. The findings confirm studies by Carlsson et al. (2020) and Cissokho (2019), which discussed the difficulties SMEs face during power crises, including maintaining competitiveness and employment levels. This may be particularly true as businesses find it more challenging to succeed in the market when they deal with an irregular power supply, as it lowers their level of competitiveness. The results of the regression analysis also indicate long-term sustainability challenges of Sri Lankan SMEs with unrealistic power supply. This can happen when SMEs struggle to compete with the increased cost of production. These findings are consistent with Hunjra et al. (2015) whose findings revealed that job retention becomes more difficult during power crises, as businesses face pressure to cut costs, including labor.

4.6. Exploring the Mediation Effect of Energy Management

This analysis explores the mediating role of Energy Management (EnergyMgt) in the relationship between Power Crisis and the development of Small and Medium Enterprises (SMEs). In this context, EnergyMgt functions as a mediating variable, revealing the mechanism by which an independent variable influences a dependent variable. For this analysis, SME sector development was considered as a composite variable covering all five development dimensions considered in this study. The objective is to gain insights into how EnergyMgt may mediate the relationship between the Power Crisis and the development of the SME sector.

Table 04: Results of Mediation Analysis

		M (Engy Mgt)					Y (SME Dev)			
Antecedent		***B***	***SE***	***p***	***β***		***B***	***SE***	***P***	***β***
X (Power Crisis)	a	0.199	0.37	0.000	0.417	c ć	-0.682 -0.555	0.053 0.052	0.000 0.000	-0.737 -0.599

M (Engy Mgt)	-	-	-	-	b	-0.643	0.109	0.000	-0.331
	$R^2 = 0.174$					$R^2 = 0.634$			
	F = 29.63, p< 0.001					F = 121.19, p< 0.001			

Source: Survey Data

From a simple mediation analysis conducted using ordinary least squares path analysis (performed by the PROCESS SPSS macro, Hayes, 2022), evidence was found for the hypothesis that energy management significantly mediated the relationship between power crisis and SME development. As can be seen in Table 4, the power crisis was positively associated with energy management (a= 0.199), and energy management was negatively associated with SME development (b=-0.643). A bootstrap confidence interval for the indirect effect (ab =-0.128) based on 5,000 bootstrap resamples was entirely above zero (-0.188 to -0.061), suggesting that energy management mediates the association between power crisis and SME development, and hence accepting H6.

The acceptance of H6 highlights the potential benefits of energy-efficient practices for SMEs during power crises. The p-value of 0.000 for H6 suggests that energy-saving measures can help SMEs mitigate the harmful effects of unstable power supplies. In other words, the results of the above analysis reveal that the negative impact of the power crisis on SME development is significantly reduced when energy management measures are in place. This finding could particularly be true as SMEs that adopt energy-efficient technologies are more resilient to power crises, better managing energy consumption and reducing costs. This finding is in contrast to Fisher-Vanden et al. (2015), who argued that energy-efficient practices might have a limited impact. However, the present study aligns with the findings of Nyanzu and Adarkwah (2016), underscoring the positive role of energy efficiency in enhancing SME resilience. These findings suggest that energy policy initiatives should focus on encouraging SMEs to invest in energy-saving technologies, as this can reduce their vulnerability to power disruptions and foster growth.

4.7. Exploring Moderation Effect of Firm Size and Industry Type

The regression analysis (presented in table 5) investigates how power crisis, along with interactions involving SME Size and Industry type, impacts SME Development. The table provides coefficients for two models and includes significance tests (p-values), R-squared values, and F-statistics.

Table 05: Summary Results of the Moderator Analysis

Coefficient	Model 1 (PowerCri x SizeSME)	Model 2 (PowerCri x Industry)
Constant	5.164 (p = 0.000)	4.744 (p = 0.000)
PowerCri	-0.833 (p = 0.000)	-0.693 (p = 0.000)
SizeSME	-0.172 (p = 0.539)	-
Industry	-	0.051 (p = 0.756)
Int_1	0.084 (p = 0.204)	0.004 (p = 0.923)
R2	0.57	0.55
F Stat	60.82***	56.61***

Source: Survey Data

As per the results presented in table 5, size of the SME (SizeSME), shows a non-significant effect on SMEDev (β = -0.172, p = 0.539), meaning that the size of the firm does not independently affect SME development. The interaction between PowerCri and SizeSME (Int_1) is also non-significant (β = 0.084, p = 0.204), indicating that SME size does not significantly moderate the effect of power crisis on SME development. The model explains 57% of the variation in SME development (R^2 = 0.57), with an overall F-statistic of 60.82, which is highly significant (p< 0.001).

Industry type, also does not show a significant effect on SMEDev (β = 0.051, p = 0.756), suggesting that the industry in which an SME operates does not independently drive development. The interaction between Power Crisis and Industry (Int_1) is non-significant (β = 0.004, p = 0.923), indicating that industry type too does not moderate the relationship between power crisis and SME development. This model explains 55% of the variation in SME development (R^2 = 0.55) and has an F-statistic of 56.61, which is also highly significant (p < 0.001). Both models highlight the significant negative impact of the power crisis on SME development. Hence, both H7 and H8 are rejected. Neither the size of the SME nor the industry significantly moderates this effect, suggesting that the negative influence of power-related issues is consistent across various SME sizes and industries.

Rejection of Hypothesis H7 indicates that the size of an SME is irrelevant, and it is severely affected by power crises. Further H8, which was rejected, indicates that the nature of the firm does not significantly affect how power crises impact operations; however, affect all industries uniformly. The study highlights that power crises

between March 2022 and February 2023 impacted SMEs of all sizes indiscriminately, making it difficult for them to maintain operations.

5. Conclusion and Recommendations

The results from the regression models demonstrate that the power crisis has a consistently negative impact on various aspects of SME development, hindering business operations, reducing output, limiting employment opportunities, diminishing competitiveness, and impeding overall business sustainability. More interestingly, findings of the present study suggest that energy-saving measures can help SMEs mitigate the harmful effects of unstable power supplies. These findings underscore the critical need for addressing power supply issues to support the resilience and growth of SMEs and encourage energy management strategies among SMEs.

Based on the findings of this study, several actionable recommendations are proposed to address the energy challenges faced by SMEs in developing countries. SMEs should prioritize conducting regular energy audits to identify inefficiencies and high-energy-consuming processes, enabling targeted improvements. Investing in energy-efficient technologies, such as light-emitting diode (LED) lighting, improved insulation, and energy-efficient motors, can significantly reduce operational costs without compromising productivity. Exploring renewable energy sources, such as solar and wind power, is particularly crucial in regions with abundant natural resources, as small-scale installations can reduce reliance on unreliable grid power and lower energy costs. Implementing Energy Management Systems (EMS) is also recommended, as they allow SMEs to monitor energy usage in real-time, optimize consumption, and identify opportunities for improvement. Additionally, training employees in energy-saving practices, such as switching off equipment when not in use, fosters a culture of energy awareness and efficiency. Policymakers and governments must provide financial incentives, such as subsidies, low-interest loans, and grants, to facilitate SME investments in energy-efficient technologies, while ensuring stable energy tariffs to enable long-term financial planning. Strengthening energy infrastructure to improve reliability and expanding access to renewable energy sources are also critical steps to minimizing disruptions and enhancing competitiveness. Collaboration with local energy experts and stakeholders is encouraged to gain insights, share best practices, and align with regional sustainability goals. Finally, investing in research and development for alternative energy solutions and innovative technologies is essential to reduce SMEs' vulnerability to energy crises. By adopting these measures, SMEs can enhance their resilience, improve competitiveness, and continue contributing to economic growth and sustainability.

In conclusion, this study provides a thorough analysis of the challenges faced by Small and Medium-sized Enterprises (SMEs) in Sri Lanka during the power crisis between March 2022 and February 2023. The findings demonstrate the significant negative impact of power disruptions on SME growth, productivity, competitiveness, and job creation. These challenges highlight the need for targeted policies to address the specific vulnerabilities of SMEs, based on their size and industry. The power crisis also disrupted Sri Lanka's labor market, causing layoffs and stunting employment growth, which in turn hinders broader economic development and poverty reduction efforts. Power shortages have constrained SME productivity, limiting their ability to compete both domestically and internationally. Addressing the energy crisis is essential not only for SME survival and expansion but also for Sri Lanka's overall economic progress.

A key insight from this research is the role of energy-saving initiatives in reducing SMEs' dependence on conventional energy sources, lowering operational costs, and maintaining productivity during power crises. The adoption of energy-efficient technologies is vital for SME sustainability and competitiveness. Policymakers should prioritize such initiatives through government programs to mitigate the effects of power crises on SMEs and contribute to national energy sustainability. Ultimately, the study emphasizes the need for evidence-based policies to enhance SME resilience, recognizing their importance as engines of economic growth in Sri Lanka. Strengthening SME resilience to power crises will be crucial for sustaining the nation's economic development and improving citizens' well-being.

6. Limitations and Future Research

Low representativeness of the sample, with a significant number of young firms, presents a limitation in this study. Younger firms, often in their growth stages, may be more adaptable to challenges like power crises, whereas older firms typically have established processes and infrastructure to better manage disruptions. This difference in maturity can influence the findings, potentially skewing the results and limiting their generalizability to the broader SME population.

This study underscores the need for further research on the impact of power crises on SMEs across different regions, noting that findings from Sri Lanka may not apply universally due to unique economic and infrastructure factors. Future studies should explore local power supply variations and use qualitative approaches to gain insights into the specific challenges SMEs encounter during power emergencies.

Global benchmarking studies on SME resilience across countries with varying energy policies, which could reveal effective regulatory models, are also suggestive. Feasibility studies on energy storage and renewable solutions would further identify

economically viable options, reducing SMEs' reliance on unstable grids. Additionally, research on the combined effects of energy crises and other disruptions, such as supply chain issues, could inform multifaceted crisis management strategies.

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