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Load Shedding in South Africa: Implications for Financial Sustainability of Manufacturing Companies

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South Africa has been experiencing constant power disruptions since 2007. Manufacturing companies that rely on a steady supply of electricity for their production may find other source of energy supply, which can provide a competitive advantage. On the other hand, the alternative source of energy may result in extra expenses which may have a negative impact on their performance. This study explored the impact of power outages on the financial performance of South African listed manufacturing companies. A secondary quantitative research approach was employed in the study, looking at financial data from 107 companies for ten years (2012 to 2021). The research used data collected from McGregor BFA and the Department of Energy. Fixed and random effect regression approaches were used to analyse data. Return on assets and Tobin's Q were selected as the dependent variables. The findings demonstrated a negative and significant relationship between load shedding and financial sustainability, demonstrating that an increase in load shedding hours decreases financial performance. This finding indicates that frequent power outages in South Africa decrease the profitability and market value of manufacturing companies. The findings call into question, the notion that the manufacturing companies can maintain their profit levels by passing the extra cost of alternative power onto customers. The study further identified the important role of firm-specific factors such as sales, company age, size, risk, and retention rate in influencing financial performance. The study calls for urgent action from industry stakeholders and policymakers to address the energy supply challenges, emphasising the need for investments in reliable electricity infrastructure and alternative energy solutions.

Keywords: *manufacturing companies, power shortages, average electricity price, total load shedding hours and financial performance*

Introduction

Over the past 16 years, load shedding has been a problem in South Africa, which has impacted all citizens and causing operational challenges to both the public and private sectors. Load shedding is defined as the planned or unplanned loss of electricity supply. The manufacturing sector is no exception. Load shedding and power shortages are among the critical issues these manufacturing businesses must deal with (Meles 2020, Pillay and Andrisha 2023). In South Africa, the manufacturing industry depends on a steady supply of reliable electricity. There are many areas in which load shedding impacts the operations of the manufacturing companies. Power

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outages cause additional costs, which pushes businesses to improvise or pass those costs along to customers.

Companies in this industry either find alternative energy sources or cease operations during load shedding. In this context, the manufacturing companies face a trade-off between absorbing the costs of power outages and investing in costly alternative energy solutions. Running generators is the common energy alternative, but this incurs additional fuel and maintenance costs (Afolabi and Laseinde 2019). Others decide to cut back on staff or operating hours, particularly during pre-planned power outages. Power outages can lead to costly downtime, forcing production to halt. Some businesses choose to operate on weekends, which increases labour costs. Thus, dependable power sources are essential to manufacturing businesses (Meyer and Habanabakize 2019). Similarly, when the demand for a product declines, the supply follows suit, which has an adverse effect on employee morale and creates an unfavourable work environment with decreased production levels (Andrade et al. 2020, Niever et al. 2021, Chaime 2023).

The rising operational costs, reduced productivity, and supply chain disruptions from load shedding translate into weakened profitability, declining investor confidence, and financial strain for manufacturing firms. However, companies with adequate financial resources can choose alternate forms of energy production. These extra costs through alternative energy capacity helps to provide a competitive advantage as their competitors may not have the resources to provide alternative energy to maintain operations. This suggests that manufacturing companies that spend extra resources to provide alternative power supply would be able to meet the needs of their existing customers, attract new customers, increase their turnover and eventually improve their financial performance.

The power outages in the South African manufacturing sector raise significant questions, including the following. Who ultimately bears the cost associated with load shedding? Do customers absorb these costs? Do manufacturing companies include the cost of power outages in their product prices? Do these manufacturing companies factor power outages into product pricing, or do they pass these costs directly to customers? These questions provide a complex understanding relating to the effect of the load shedding on the financial performance of manufacturing companies in South Africa. The issue that needs to be resolved is whether the performance of manufacturing companies is impacted by the power shortages in South Africa (Fakih et al. 2020).

While previous studies such as those of Naidoo (2023), Mabunda et al. (2023), Bello-Pierre et al. (2023) and Klishi (2024) have explored the general effects of load-shedding on business operations and economic growth in South Africa, there is a lack of focused research on its specific impact on the financial sustainability of manufacturing companies. Prior studies rely on survey-based or descriptive analyses, which, while useful, lack the statistical rigour of panel data regression models. Our study aims to address this gap by applying quantitative econometric techniques, ensuring a more objective and data-driven assessment of financial sustainability. In addition, existing literature overlooks how power outages influence long-term financial health and the market value within the manufacturing sector. This study aims to fill this gap by providing a detailed analysis of the financial implications of

load-shedding on JSE-listed manufacturing companies, offering valuable insights into both the operational and financial adaptations required to navigate South Africa's energy crisis, from 2013 to 2022. Extending research over a longer period would provide insights into whether firms adapt and recover financially over time or if persistent load shedding leads to permanent financial distress.

Load Shedding and Electricity Generation in South Africa

Load shedding, often known as power shortages, is the loss of network supplies or electrical power to the end user. Basic supply and demand theory can be used to explain load shedding (Kazmi et al. 2019, Andrade et al. 2020). To prevent system bottlenecks, load shedding rations the electrical grid otherwise, there can be a complete blackout. A blackout is an unexpected lack of electricity that happens in an emergency (Klishi 2024). Load shedding on the other hand, is planned or unplanned loss of electricity supply, irrespective of the type of energy loss. Its occurrence disrupts energy transmission, distribution, and generation; therefore, mitigation mechanisms need to be applied to prevent a blackout. This loss affects not only the public but the business community at large (Meles 2020). Load shedding often results in equipment failure, damage to power plants, and maintenance concerns. According to Milin et al. (2022), load shedding is a worldwide phenomenon; hence many countries are seeking alternative energy sources to supplement their current energy supplies because an uninterrupted electricity supply is essential for the survival of all countries, organisations, businesses, and people. Load shedding significantly affect production, with various economic and social consequences. Electricity is now a valuable resource whose scarcity impacts the livelihoods of all people, in all countries. A stable electricity infrastructure is essential for a nation's ability to transition its industries from being labour-intensive to capital-intensive and for them to continue to grow (Bowman 2020).

Load Shedding in South Africa

Load shedding is a problem for South Africa and many other African countries. Eskom, the state-owned producer, transmitter and distributor of electricity in South Africa has implemented load shedding because of energy deficiencies and dilapidated energy infrastructure. This impacts all citizens of South Africa because over 95% of South Africa's power is produced, transmitted, and distributed exclusively by Eskom (Bowman 2020). The power company utilises load shedding as a preventative measure to keep the electrical grid from completely collapsing. This rolling black out typically happens when the amount of electricity available is less than needed (Eskom 2020). The energy provider then applies load shedding to safeguard the system. Energy experts say power rationing is primarily implemented to protect the system from a total blackout (Bowman 2020).

Load shedding in South Africa began in 2007, with 2022 having the most annual load shedding hours of 1949, which is equivalent to 81 days (Ayamolowo et

al. 2022). Eskom, transmitter and distributer uses load shedding and load reduction measures when there is a system restriction in the networks for electricity generation, transmission, or distribution (Styan 2019). Such strategies are often necessary during energy shortages because South Africa also exports electricity to neighbouring African nations (Bowman 2020). The impact of such drastic load shedding on households and businesses has been severe, as Eskom supplies over 95% of the electricity in South Africa (Inglesi 2023, Naidoo 2023, Mabunda et al. 2024). Moreover, despite the implementation of load shedding, Eskom has consistently needed business rescue from the government. By 2020, the company owed over 450 billion South Africa Rands to the South African Government (Analytica 2020).

Some scholars and commentators trace the load shedding crises in South Africa to the Reconstruction and Development Programme (RDP), which was created in 1994. This programme was one of the many methods employed by the post-apartheid government to address the socioeconomic housing issue in South Africa (Bowman 2020). Housing and electricity access was one of the primary goals of the plan. This programme was considered transformative because twelve million South Africans lacked proper housing during the time of independence in 1994. The RDP built about 5 million homes between 1994 and 2001. After that milestone was reached, the next topic on the agenda was electricity access. About 1.75 million additional houses were connected to the national grid due to South Africa's nationwide electrification project (Akadırı et al. 2021). Eskom then advised the authorities that due to the strain caused by the newly connected houses on the electricity grid, new capital expansion projects were required for increased capacity to handle the additional consumers. The South African government and Eskom agreed to construct additional power plants and generators. While there was a 36 700 MW (megawatts) demand for electricity, Eskom could supply 38 500 MW. The above MW appears adequate in theory, but according to international best practices, the company should be able to produce 15% more than required (Masibi 2015).

Planned power interruptions are essential for the manufacturing sector's production schedule to run effectively. However, public and commercial electricity consumers, who are referred to as "end users," claim that load shedding schedules are unpredictable (Gehringer et al. 2018). When there is load shedding, labour costs go up since manufacturing enterprises must still pay employee salaries and other fixed costs that cannot be avoided even when work is halted due to load shedding (Nkosi & Govender 2022). This raises the cost of production per unit.

Theoretical Review

Several theories attempt to explain how load shedding and financial sustainability of companies are related. The impact of load shedding and the financial sustainability of companies can be explained using the resource-based view (RBV) theory. The RBV theory emphasises the value of successfully utilising internal resources for formulating future strategic decisions (Barney 1991, Helfat et al. 2023). According to Barney (1991), load shedding has a negative effect on a company's financial sustainability. However, when strategically positioned, a company's unique qualities might provide the

company with a competitive advantage over its competitors. For instance, an entity with extra resources such as cash can afford backup generators for a steady operations and supplies. As a result, companies that operate without interruptions during load shedding can maintain happy customers and increase revenue. This may therefore result in that business having better financial performance than its rivals during load shedding.

Resources, according to the RBV theory, are any assets, business processes, capabilities, firm attributes, knowledge, or information that a company has. Barney (1991) suggested that these unique resources are controlled by companies which are employed to understand and carry out strategies to increase effectiveness and efficiency. The resources used by a company can come from both internal and external sources. Some examples of internal sources are research and development capabilities, logistics, brand management, and low-cost procedures. The function of suppliers is an example of an external resource. The RBV theory can be used to explain how companies that are resourceful perform better during load shedding because they can use their resource to acquire alternative source of energy. On the other hand, companies with limited resources will be affected negatively because they would stop operation, leading to increase cost and low productivity.

Empirical Literature Review

The results of previous studies have highlighted the connection between load shedding and business performance. There is broad agreement among academics that load shedding adversely affect a company's financial performance. For instance, Masibi (2015) examined the effects of load shedding on small medium micro-enterprise information and communication technology companies in the Matlosana, South Africa. The study was qualitative and provided evidence that suggests that load shedding has a negative effect on SMMEs and that the brand of the SMMEs suffered because of frequent power outages. Similarly, Lenoke (2017) and Afolabi and Laseinde (2019) further conducted different studies in South Africa to assess the effects of load shedding on the country's economic development and showed a negative correlation between load shedding and economic expansion. These studies highlight negative effects of load shedding on the overall productivity and the concomitant effects on financial performance.

Examining sector-specific impacts Goldberg (2015) took a different angle and evaluated the effects of an uneven power supply on South African retailers. The research revealed that numerous retailers had purchased backup generators, spending millions of Rands in the process. A comparable study by Botha (2019) focused on how power outages affected the efficiency of a food shops in Nelson Mandela Bay. Using a quantitative analytical approach, the survey revealed that 93% of the businesses had invested in alternate power sources and 73% of the businesses responded that power outages negatively influenced their productivity. Similarly, Grainger and Zhang (2019), extended this discussion to a sample of 4500 manufacturing companies in Pakistan. It was found that unstable power supply negatively affects the performance of businesses. The results from Grainger and

Zhang's (2019) study reaffirm that power instability negatively impacts business performance. In a related study, Mabunda et al. (2023) analysed the effect load shedding has on a small and medium enterprises in South Africa and demonstrated that load shedding impacted the operations of businesses and had a negative financial impact on them.

Load shedding has become a defining challenge for South African businesses, particularly in the manufacturing sector, where a steady power supply is essential for productivity and financial stability. Naidoo (2023) painted a bleak picture of the energy crisis in South Africa, linking the frequent power outages to declining industrial output, job losses, and dwindling investor confidence. Naidoo (2023) highlighted that Eskom faces aging energy infrastructure and persistent governance failures, leaving businesses to grapple with unpredictable disruptions that make long-term financial planning nearly impossible. Inglesi-Lotz (2023) further highlighted how the impact of load shedding negatively affects smaller businesses, which lack financial strength. The authors reported that manufacturing firms that cannot afford expensive backup power supply find themselves stuck in a cycle of lost revenue, rising operational costs, and reduced competitiveness, making it difficult to survive.

The reality of the impact of load shedding on business performance is even harsher for SMEs. Mabunda et al. (2024) revealed that during load shedding, many small businesses operate at just 39% of their usual revenue, which forces them to lay off workers, scale back production, or shut down operations entirely. This, in turn, has a ripple effect: unemployment rises, local economies weaken, and municipal revenue collection drops. In a similar study, Pillay and Beharry-Ramraj (2024) highlight that without reliable electricity, many small businesses do not survive beyond their third year, suggesting that load shedding accelerates business failure rates.

Beyond South Africa, Tembe and Hlengwa (2022) expanded the discussion beyond and provided a cross-national perspective, highlighting that load shedding was seen as a major problem that affected not only local companies but also international companies. The authors examined how power interruptions affected business sales in various African nations. The findings confirmed a negative correlation between power interruptions and company revenue using firm data from 14 countries from the World Bank Enterprise Survey. The results also revealed that businesses without backup power sources, such as generators, were negatively impacted by power outages.

Despite the prevailing view that load shedding is detrimental, some studies suggest a more nuanced perspective. A study by Cole et al. (2018) introduced an interesting perspective to the discussion by reporting that businesses relying on alternative electricity supply during power outages are impacted differently than those that do not have access to alternate energy sources. This is because, businesses that use alternative energy sources can keep operating during power disruptions. There will be an extra charge for this. The authors however, highlighted that a problem arises when power disruptions are less common where there are no communicated schedules for power outages, which poses a threat since these companies cannot plan for power outages.

Despite most of the past studies providing evidence to show a positive relationship between load shedding and financial performance, some studies suggest a potential positive relationship between load shedding and financial performance. For instance, a study by Fakih et al. (2020) revealed a positive and significant correlation between planned power outages and financial performance, indicating that some businesses may adapt and even thrive under certain predictable conditions. The literature reviewed has provided evidence of the negative impact of load shedding on the financial sustainability of manufacturing companies and other sectors. Most studies agree that load shedding disrupts operations, increases costs, and ultimately hinders economic growth. However, the evidence showed that there are some exceptions where planned power outages, under specific conditions, might have a positive impact on financial performance.

The conflicting findings highlights the complexity of the issue and suggests that while load shedding generally harms companies' financial sustainability, certain adaptive strategies or circumstances might mitigate these effects. This creates notable gaps in the literature as there is limited research on the long-term financial implications of load shedding on manufacturing companies in South Africa. Additionally, the previous studies mostly adopted a descriptive approach, relying on primary data through interview and questionnaires. An examination of this load shedding phenomenon using secondary data has not been fully explored. Addressing these gaps would contribute to an understanding of how load shedding impacts financial sustainability and what strategies could help mitigate its adverse effects.

Research Design and Methods

This study adopted a quantitative inferential research approach. The study targeted 201 manufacturing companies in South Africa listed on the Johannesburg Stock Exchange (JSE). The period of interest was: 2013 to 2022. The period was chosen because it coincided with the period South Africa experienced intense load shedding hours. Companies or businesses that engage in manufacturing and rely on energy for production are those that have been included in the current study. A random purposive sample of 107 out of 201 manufacturing companies was selected based on inclusion and exclusion criteria, ensuring they were listed on JSE, rely on electricity for production, and were affected by constant power outages. The study adopted two criteria to select the companies included in the study. First, companies selected were those with financial data from 2013 to 2022 were selected to ensure the integrity of panel data analysis. This criterion as adopted to address issues relating to missing data. Second, the companies had to be listed for not less than 5 years, to ensure a robust longitudinal analysis. Based on the criteria, 107 firms were selected for the study. Secondary data was employed for the study. Data were collected from two main sources, financial and load shedding data. The financial data of the companies was gathered from McGregor BFA, and the data on load shedding was obtained from the websites of Eskom and the Department of Energy. The study employed a multiple regression estimation technique was used to estimate the impact of load shedding on the firms' financial performance.

Econometric Model

Econometric models were used to estimate the impact of power outages on the financial performance and the manufacturing companies' value. Panel data regression analysis method was employed for the current investigation. Equations 1 and 2 below were used for the estimation. The equations were developed using the modified Ohlson (1995) value-relevant model. The study adopts the modified Ohlson (1995) model as the primary framework for measuring firm financial performance. Ohlson's model is widely used to assess firm valuation by incorporating accounting and market-based measures (Pantow et al. 2015). The model is particularly relevant for this study as it integrates both profitability (ROA) and market valuation (Tobin's Q) as dependent variables, providing a dual perspective on financial performance. ROA and Tobin's Q were used as dependent variables for Models 1 and 2 respectively.

$$ROA_{it} = \beta_0 + \beta_1 TLH_{it-1} + \beta_2 Sales_{it} + \beta_3 RR_{it-1} + \beta_4 Size_{it} + \beta_5 Age_{it} + \beta_6 Risk_{it} + \varepsilon_{it} \quad 1$$

$$TobinQ_{it} = \beta_0 + \beta_1 TLH_{it-1} + \beta_2 Sales_{it} + \beta_3 RR_{it-1} + \beta_4 Size_{it} + \beta_5 Age_{it} + \beta_6 Risk_{it} + \varepsilon_{it} \quad 2$$

The variables used in the models are explained below.

Dependent Variables

Return on Assets (ROA) and Tobin's Q were selected as financial performance indicators due to their distinct but complementary measurement capabilities.

ROA: ROA represents the return on assets of the companies. ROA is a financial ratio that measures a company's profitability in relation to its total assets. The percentage of net income on total assets was used to calculate the ROA. ROA was employed as it measures the operational efficiency and profitability of firms and captures the immediate financial impact of load shedding on firm earnings. Pantow et al. (2015) regard ROA as a reliable indicator of a company's profitability.

Tobin's Q: The Q ratio is another name for Tobin's Q ratio. It was calculated as ratio of the market value of equity to the book value of all assets. Companies determine their financial success using Tobin's Q ratio. Salehi et al. (2022) state that using Tobin's Q to measure company value is commendable because it is not affected by practices in the accounting space and also performs better than other accounting ratios. When the ratio is greater than one, it signifies that the company's market value is greater than its total assets, and the company may thus be overvalued (Ishaq, Islam and Ghouse, 2021). A Tobin's Q value below 1 indicates that the company is undervalued.

Retention Rate (RR): The retention rate is the percentage of net income kept on hand to expand the manufacturing business. The term "plough back" is another name for the retention ratio. The other option is to distribute the income in the form of dividends. This ratio helps decision-makers understand how much cash the organisation is holding

back to reinvest in the enterprise. The researcher was curious to learn if these manufacturing companies had decided to reinvest in the business based on the findings of the current investigation. This might be an indication that companies were investing more in alternative energy sources to address the problem of power interruptions rather than giving dividends to shareholders.

Total Load shedding Hours (TLH): The TLH refers to the number of hours for the length of power outages. Kilowatt-hours were used to measure the load shedding time. The load shedding hours were obtained from the websites of Eskom and the Department of Energy and classified according to the various load shedding stages, from stage 1 to stage 6.

Sales: Sales is the amount of revenue a company has generated. Using McGregor BFA, the sales of the manufacturing companies were retrieved for a ten-year period. According to Shawar and Siddiqui (2019), sales have been widely used to predict financial performance. This view is consistent with those of Panda (2015) and Cole et al. (2018), who note that most academics have selected sales as one of the top influencers of a company's performance. As a result, the current study has chosen sales as a metric for assessing the factors that influence the financial performance of manufacturing companies.

Age: Age is a measure of how long a company has existed since its establishment.

Risk: Risk gauges how vulnerable a business is to outside financial influence and control. The debt-to-equity capital ratio was used to calculate risk.
Size: Size is measured as the natural logarithm of the total asset of the company (Salehi et al. 2022). The size of a company has a significant impact on the profitability of companies. Many scholars utilise company size to estimate a company's performance (Salehi et al. 2022). Meles (2020) suggests that a company's financial performance increases with size.

Results & Discussion

Descriptive Statistics

The summary statistics of the variables are presented in Table 1.

Table 1. *Descriptive Statistics*

Variable	Obs.	Mean	Std. Dev.	Min	Max
ROA (%)	916	6.83	25.41	-176.75	47.22
Tobin's Q	916	1.36	1.87	0.26	12.04
TLH (hours)	916	249.01	340.08	0.00	1949.00
Sales (billions of rands)	916	1.75	8.99	0.13	35.86
RR (%)	916	85.16	13.62	13.70	100.00
Size (billions of rands)	916	0.77	73.46	0.16	47.93
Age (years)	916	40.00	27.00	12.00	128.00
Risk (%)	916	47.72	14.56	9.87	518.30

Table 1 shows that the mean total load shedding hours (TLH) is 249.01 hours, indicating that over a ten-year period, businesses lost an average of 249 hours per year due to load shedding. The average sales were R1.75 billion, with an average return on assets (ROA) of 6.83% and a Tobin's Q of 1.36. Additionally, manufacturing companies had a high retention rate (RR) of 85.16%, suggesting a preference for retaining earnings rather than distributing them as dividends to shareholders. The average company size was R0.77 billion, with an average age of 40 years, and a risk percentage of 47.72%.

Multicollinearity Test

Regression analysis should only be performed following the test for multicollinearity among the independent variables (Alabi et al. 2020). The findings of the multicollinearity between the independent variables are shown in Table 2.

Table 2. *Correlation Results*

	TLH	Sales	RR	Size	Age	Risk	VIF
TLH	1.000						**3.82**
Sales	-0.010	1.000					**6.75**
RR	-0.018***	0.019**	1.000				**2.03**
Size	-0.008**	0.569*	-0.003	1.000			**3.58**
Age	-0.005	0.091***	0.0278	-0.018**	1.000		**5.92**
Risk (%)	-0.056*	0.039	0.036***	-0.015	-0.036*	1.000	**4.71**

Note: *** = significance at 0.01; ** = significance at 0.05; * = significance at 0.1

The correlation coefficients demonstrate that the relationship between the independent variables are weak. Table 2 shows that the highest coefficient is 0.569, representing the relationship between size and sales. The weak correlation coefficients show no multicollinearity problems because all the coefficients are below 0.70 which is the acceptable threshold. The VIF results further confirm the absence of multicollinearity as all the coefficients are below the acceptable threshold of 10.

The Regression Results

The study examined the impact of load shedding on the financial sustainability of the manufacturing companies in South Africa. The study employed fixed effects and random effect estimation techniques for the analysis. The study also implemented a two-step system Generalized Method of Moments (GMM) estimator to address potential endogeneity issues arising from unobserved heterogeneity and simultaneity bias. The GMM approach ensured that the results remained consistent even in the presence of autocorrelation or omitted variable bias. The findings from this estimation reinforce the negative impact of load shedding on financial performance, which highlights the robustness of our conclusions.

The financial performance of the companies was measured using two different metrics; ROA and Tobin's Q. Table 3 presents the result of the impact of load shedding on ROA.

Table 3. *The Impact of Load Shedding on Financial Performance*

	Random Effect	**Fixed Effects**	**SYS-GMM**
ROA_{it-1}			0.421*** (6.94)
TLH_{it}	-0.012*** (-3.74)	-0.004** (2.07)	-0.286*** (-4.27)
$Sales_{it}$	-0.006 (-0.11)	-0.021 (-0.37)	-0.273* (-1.85)
RR_{it}	0.156*** (7.82)	0.139*** (6.60)	0.087** (2.04)
$Size_{it}$	-0.794 (-1.47)	-0.026 (-0.32)	-0.384 (-1.17)
Age_{it}	0.000** (1.97)	0.000** (2.35)	1.234*** (8.18)
$Risk_{it}$	-17.322*** (-4.35)	-4.129 (-1.59)	2.392 (1.14)
Constant	151.282*** (4.09)	33.053* (1.82)	7.998 (9.05**)
Observations	916	916	906
R-squared	0.8492	0.8965	
Adjusted R^2	0.8107	0.8528	
F-stats	172.825	164.07	
Prob. of F-stats	0.000	0.000	
Prob. of Hausman Test	0.106	0.106	
Durbin-Watson stats.	2.291	1.683	
AR2			0.271
Hansen stat			0.359

The results of the influence of load shedding on the ROA of manufacturing companies are summarized in Table 3. The insignificant p-value (0.106) of the Hausman test suggests that the random effect estimation technique is appropriate. Table 3 shows a coefficient of total load shedding hours of -0.0118, with a p-value of 0.000. The result demonstrates that load shedding has a negative and statistically significant impact on ROA. This result suggests that TLH has a significant inverse

impact on the financial performance of the manufacturing companies in South Africa.

There are several possible reasons for this relationship. The financial burden of load shedding is twofold: direct costs related to alternative energy sources and indirect costs such as reduced production efficiency and supply chain disruptions. First, load shedding leads to frequent power outages, which disrupts the production processes of the manufacturing companies. This operational disruption results in reduced output, which directly affects the companies' ability to generate revenue. This would reduce their ROA. In this circumstance, companies that use alternative energy sources could also be impacted by the higher input costs as a result of employing alternative energy sources. Consistent with the RBV, companies with greater financial flexibility may invest in renewable energy solutions such as solar or battery storage systems, thereby mitigating operational disruptions.

Conversely, companies with limited access to capital may resort to cost-cutting measures, including workforce reductions and lower inventory levels, which can further impact financial stability. These results are consistent with previous studies by Goldberg (2015), Cole et al. (2018), Mabunfa et al. (2023), Botha (2019), and Tembe and Hlengwa (2022), who reported a significant negative impact of load shedding on company performance across various sectors. On the contrary, these findings contradict with those of Fakih et al. (2020), who found a positive and significant relationship between load shedding and financial performance.

Interestingly and surprisingly, result shows that sales have a negative and insignificant relationship with ROA. This result implies that a decrease in sales has no significant impact on ROA. The reason may be that load shedding may have forced the companies to incur extra cost to improve their revenue. The extra cost incurred to increase revenue may have been more than their commensurate return. The result further demonstrates the coping mechanism of the companies during the load shedding period. As presented in Table 3, the retention rate (RR) variable also has a coefficient of 0.1559 and a p-value of 0.000, showing a positive and statistically significant relationship between RR and ROA. This result suggests that a rise in the RR leads to an increase in ROA. The finding is in line with those of studies by Sasidharan et al. (2022), but contradicts with those of Banerjee and Majumdar (2018), who discovered that the RR had no effect on ROA.

Additionally, the risk variable displays a negative coefficient (-17.3217) and statistically significant p-value (0.000). This result demonstrates that reducing risk-related variables lead to an increase in ROA, indicating that the lesser the risk and uncertainties caused by load shedding, the better the financial performance of manufacturing enterprises. Therefore, manufacturing companies must reduce risks to a manageable level. The result further shows that age of the companies also has a positive and statistically significant impact on ROA. The conclusion is that organisations with a long history are well known, and greater reliance is placed on their resources and goodwill to drive the company's performance. The longer these companies have been in business, the more profitable they become. The prediction ability of the model is demonstrated by the R-squared (R^2). The R^2 of the model is 0.9247, suggesting that the independent variables can predict the dependent variable up to 92.47%. This demonstrates the model's strong predictive ability. The F-

statistics test and the p-value of the model are 172.825 and 0.000, respectively. This result suggests that the model is fit for the estimation.

The Impact of Power Outages (Hours) on Company Value

The study also assessed the impact of load shedding on the value (Tobin's Q) of manufacturing companies in South Africa. Table 4 presents the results from the study.

Table Error! No text of specified style in document.**.** *The Impact of Load Shedding on Companies' Value*

Variables	**Random Effect**	**Fixed Effects**	**SYS-GMM**
TQ_{it-1}			0.953*** (7.49)
TLH_{it}	-0.0002 (-1.47)	0.001 (0.32)	-0.085** (-2.07)
$Sales_{it}$	0.0037 (0.91)	0.003 (0.85)	-0.072* (-1.85)
RR_{it}	0.0028** (1.99)	0.002** (2.16)	0.116** (2.16)
$Size_{it}$	-0.0092 (-1.25)	-0.217*** (6.22)	-0.043 (-1.09)
Age_{it}	0.000 (1.41)	0.000 (1.85)	0.086*** (5.95)
$Risk_{it}$	0.0501** (2.23)	-0.354** (-2.22)	0.149 (1.05)
Constant	1.1468** (3.72)	12.838*** (4.71)	7.195 (9.05*)
Observations	916	916	906
R-squared (R^2)	0.9018	0.8891	
Adjusted R^2	0.8702	0.8517	
F-stats	107.29	137.21	
Prob. > F-stats	0.000	0.000	
Prob. of Hausman Test	0.217	0.217	
Durbin-Watson stats.	2.194	2.378	
AR2			0.618
Hansen stat			0.334

Tobin's Q is used in Table 4 to analyse the impact of the load shedding on company value. The random effect model was used to estimate the variables under investigation since the Hausman test probability was insignificant (p-value = 0.217). The results show that the coefficient of TLH in Table 4 is -0.0002 with a p-value > 0.05. This finding demonstrates a negative and statistically significant association between the two variables. According to this finding, an increase in TLH corresponds to a decrease in Tobin's Q. The result is aligned with economic reasoning. First, load shedding disrupts manufacturing processes, which causes production delays, increased operational costs, and inefficiencies. These events decrease the overall productivity and profitability of the companies and negatively impact their value.

In addition, the companies experiencing load shedding often incur additional unplanned expenses such as cost of backup power sources including generators, or repairs for damaged machinery. These unplanned expenses negatively affect the financial resources of companies and reduce their profits margins. When this happens, investors may perceive these companies as higher-risk investments, leading to a decline in their stock prices and, consequently, a lower Tobin's Q. This conclusion aligns with the findings of Goldberg (2015), who examined the effects of power outages on South African retail businesses.

The results also show a positive but insignificant relationship between sales and Tobin's Q. This result implies that an increase in sales might lead to an increase in company value. The Retention Rate exhibits a coefficient of 0.0028 with a p-value of 0.046, indicating that a higher retention rate positively influences Tobin's Q. Additionally, the coefficient of the risk variable highlights a negative and significant relationship between risk and Tobin's Q. This finding suggests that reducing risk levels could lead to an increase in company value. This view is consistent with the conclusions of Abebe and Abera (2019), who found that risk negatively impacts Tobin's Q. The implication of this finding is that manufacturing companies experience better financial performance at lower risk levels.

The size variable, with a coefficient of -0.00092 and a p-value greater than 0.05, demonstrates a negative but insignificant relationship between company size and value. These findings align with Zuhroh (2019), who reported a similar negative and insignificant association. This suggests that a decrease in total assets does not substantially affect company value. Similarly, the age of the manufacturing company shows a positive and significant coefficient. Manufacturing companies should consider investing in reliable infrastructure and alternative energy sources to mitigate the effects of load shedding. This could help stabilise production and protect company value. The post-estimation test results confirm to the model's and the variables' reliability. The R^2 for the regression model is 0.9018, indicating that the independent variables are responsible for about 90.18% of the variance in the value of the manufacturing companies. The model is significant and valid at 0.000 according to the F-statistics test, which has a value of 107.29.

The study's findings reveal a negative and statistically significant relationship between load shedding and financial performance, measured by ROA and Tobin's Q. This aligns with existing literature that demonstrates how energy instability disrupts business operations and erodes financial sustainability (Grainger & Zhang 2019, Mabunda et al. 2023). However, the degree of financial impact varies across firms, suggesting differences in strategic responses.

The random effects model revealed a statistically significant negative relationship between total load shedding hours (TLH) and ROA but an insignificant effect on Tobin's Q. This discrepancy can be explained by the nature of these two financial measures:

ROA measures internal profitability and is directly affected by operational disruptions. Load shedding increases production costs (e.g., generator fuel, downtime losses), which immediately reduce profitability, leading to a significant decline in ROA. Tobin's Q, however, is a market-based measure influenced by investor expectations and broader market conditions. Investors may already price in energy instability risks,

meaning load shedding does not cause immediate valuation fluctuations. This aligns with prior studies showing that long-term investor sentiment may be less reactive to short-term operational inefficiencies (Salehi et al. 2022).

Additionally, some firms mitigate the impact of load shedding by raising product prices or investing in alternative energy sources, offsetting short-term profitability losses. Investors may perceive these adaptive strategies as neutralizing the financial impact of load shedding, explaining why Tobin's Q remains statistically insignificant despite significant ROA effects.

The positive and significant relationship between retention rate (RR) and ROA suggests that firms with higher retained earnings reinvest in operational efficiency and alternative energy solutions, improving short-term profitability. This is consistent with research highlighting retention-driven reinvestment as a key factor in firm resilience (Sasidharan et al. 2022).

However, the insignificance of RR in Tobin's Q indicates that retained earnings do not immediately influence market valuation. Investors may not view high retention rates as a decisive factor in stock valuation unless there is clear evidence that retained earnings translate into long-term growth and competitive advantage. This suggests that while internal financial performance improves through retained earnings, investor sentiment remains unaffected in the short run.

A critical question arising from the findings is whether firms' financial responses to load shedding reflect short-term coping mechanisms or long-term strategic adjustments. The high retention rate (85.16%) observed in the dataset suggests that many companies prioritized reinvestment over dividend payouts, aligning with long-term adaptation strategies (Sasidharan et al. 2022). This trend indicates that companies did not merely absorb costs or transfer them to consumers but actively restructured financial resources to enhance energy resilience. Moreover, the negative correlation between risk and financial performance highlights the financial pressures imposed by load shedding. This suggests that companies that fail to mitigate energy risks experience declining returns, which reinforces the argument that energy security is a critical component of financial sustainability (Salehi et al. 2022).

The findings suggest that firm-level strategies alone may not be sufficient to mitigate the financial risks of load shedding. Policymakers must play an active role in developing energy infrastructure and regulatory frameworks that support private sector investment in alternative energy sources. Lessons from other energy-intensive economies suggest that government incentives for renewable energy adoption can significantly reduce financial strain on businesses (Akadırı et al. 2021). For corporate managers, the results highlight the importance of energy risk management as part of financial planning. Firms with higher energy dependency must integrate energy cost forecasting into their financial models, ensuring that investment in alternative energy solutions is factored into long-term growth strategies.

The findings contradict Fakih et al. (2020), who argued that firms could adapt to frequent power outages and improve financial performance. One possible explanation for this discrepancy is the predictability of power outages in different regions. While firms in the MENA region may have leveraged predictable outages for strategic planning, South African firms face highly erratic load shedding schedules, making long-term planning more difficult (Bowman 2020).

This inconsistency underscores the need to differentiate between adaptive efficiency and financial resilience. While some firms may implement short-term cost-cutting measures, long-term financial sustainability requires structural investments in energy resilience. The significant negative relationship between load shedding and Tobin's Q suggests that investors perceive energy instability as a long-term risk, potentially reducing firm valuation.

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Conclusion

South Africa has experienced persistent challenges with its electricity supply in the past decade. As a result of this challenge, load shedding has become a frequent occurrence in the country. Companies have adopted several strategies and coping mechanisms including reduction in operation, shutting down plants during load shedding hours, investment in alternative power supply and pushing the cost to consumers. The study examined how load-shedding has affected the financial sustainability of manufacturing companies listed on the Johannesburg Stock Exchange. The study relied on secondary data from 2013 to 2022 and employed a multiple regression to examine how power outages influenced the financial performance and value of these companies between.

The findings revealed a negative relationship between load shedding and financial sustainability, implying that as load-shedding hours increased, key financial indicators like return on assets (ROA) and Tobin's Q decreased. This result indicates that frequent power outages negatively impact the ability of manufacturing companies to generate profits and increase their market value. The findings further imply that the companies should invest in alternative energy sources to reduce the financial impact associated with load-shedding. Additionally, the negative relationship between ROA and retention rate indicates that some companies have responded to the negative impact of load shedding by reducing dividend and reinvesting profits into energy solutions. This move may help ensure their long-term sustainability.

The broader implications of the study highlight serious economic and policy concerns for South Africa. First, without significant improvements in the country's energy supply, the manufacturing sector will continue to struggle and the economy will suffer. Moreover, the department of energy need to focus on developing energy infrastructure and alternative green energy sources such as solar and wind energy to stabilize the power supply, which is essential for maintaining the growth and

competitiveness of South Africa's manufacturing sector. The findings of the study would enable informed investment decisions based on firms' energy resilience strategies. In addition, it highlights risk factors associated with power outages and financial performance. The study offers empirical evidence for energy policy formulation and infrastructure investment. It further supports government intervention programs to enhance industrial energy security. In summary, while load shedding has been a major issue in South Africa, this study sheds light on its practical effects on the financial performance of manufacturing companies. It underscores the need for both businesses and the government to take proactive steps in resolving this challenge. By understanding and mitigating the impact of load shedding, manufacturing firms can better navigate the current environment and strengthen their sustainability.

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