Assessment of the impact of load shedding on the households of Alexandra, Johannesburg, South Africa.

by

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Master's Research Report

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Declaration

I declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

____C.MBATHA_____

(Signature of candidate)

__30th _day of ____April____2024_____in____Johannesburg___

Abstract

In South Africa, persistent challenges in the electricity sector have been noted. This study emphasizes that having access to electricity is insufficient; the reliability of its supply is crucial, especially given prolonged power outages faced by a significant portion of the population. In Alexandra Township at two residential areas, 16th Avenue and East Bank, the research used a mixed-method approach, involving questionnaires for 100 households and 20 local businesses, and semi-structured interviews with representatives from the local city authority. Results indicated substantial disruptions to daily lives and operations. These disruptions adversely affected critical social services, hindering operations in essential infrastructures like water supply systems, hospitals, education institutions, and telecommunication systems. The study identifies illegal electricity connections, infrastructure loss, and political interference as perceived major causes of successive power outages in Alexandra. It highlights the worsening nature of load shedding, making it a significant political issue in South Africa, reflecting hardships households and businesses face. The paper recommends governmental subsidies for alternative energy appliances and more favorable electricity tariff rates for households and small businesses to alleviate demand during peak periods. The findings offer valuable insights for policymakers and the South African electricity utility in analyzing trade-offs between negative welfare effects and costs of reducing power outages.

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List of Acronyms

SSA- Sub Saharan Africa

ANC- African National Congress

CBD- Central Business District

Chapter 1:

General Introduction

1.1. Background to the study

South Africa is currently facing its most severe energy crisis in history, leading to extensive daily power outages in its communities (Amadi, 2015). Load shedding affects the social, economic, and psychological well-being of poor urban residents and small-scale business enterprises that frequently rely on steady power access (Buscher, 2009). Access to clean and reliable electrical energy is critical to human welfare such that the inability of a household to afford sufficient access to energy affects the quality of life and welfare of individuals (Kesselring, 2017; Hoika, 2023). Continuous access to electricity fosters economic growth, encourages higher investment, and reduces operational costs for businesses (Amadi, 2015). The absence of reliable electricity access has long been acknowledged as a critical obstacle to development (Umar and Kunda-Wamuwi, 2019). Both developing and developed countries have prioritized expanding access to electricity in their policy agendas (Inglesi and Pouris, 2010; Tanaka *et al.,* 2022). Nonetheless, the issue of electricity supply reliability has received comparatively less attention, even though many individuals with access to electricity continue to experience recurrent power outages that are expected to hinder the benefits of being connected to the electricity grid (Meles, 2020).

Electricity access in developing countries has received limited attention while developed countries are generally subjected to a higher degree of reliable electricity supply due to substantive investment in power generation capacity (Umar and Kunda-Wamuwi, 2019). Nonetheless, developing countries are navigating significant restructuring to bridge the immense gap between electricity demand and supply (Gaunt, 2008). This is linked with investments in electricity security

that have failed to sustain the rapid demand growth caused by the increase in population growth and industrialization (Steenkamp *et al.,* 2016; Eguiguren-Cosmelli, 2018).

Considering the large scale, extended timeframes, and thorough groundwork needed for electricity infrastructure development, meticulous planning and maintenance of this infrastructure are of utmost importance (Smit *et al.,* 2019). Nevertheless, numerous Sub-Saharan Africa (SSA) countries face a challenge in terms of their government authorities lacking the capacity for long-term planning in the power sector. Kaseke and Hosking, (2013), argued that the current power shortages were largely predictable, but proactive measures were not implemented promptly to prevent them. However, the high expenses associated with extending the power grid, the unreliability of existing infrastructure, a lack of political commitment, and institutional weaknesses all pose significant challenges to these initiatives (Banza *et al.,* 2022; Chidembo *et al.,* 2022). Electricity shortages are proven to exacerbate political tensions within a country (Bowman, 2020; Kaseke and Hosking, 2013). Many business enterprises and households have opted for private power generation due to the inadequacy of public grid electricity supply (Nduhuura *et al.,* 2021; Muhihi and Paschal, 2022). On the other side of the debate, there are arguments suggesting that privatization is driven by profit motives, potentially leading to the exclusion of the poorest individuals. Prior studies emphasized that load shedding and its impacts are strongly associated with households' socio-economic classification (Musango, 2014; Umar *et al.,* 2022). As the economy grows, the increasing electricity demand has revealed inadequate progress in expanding power generation and transmission infrastructure, eliminating any previous surplus capacity cushion (Ndaguba, 2018).

In many African countries including South Africa, there are numerous challenges associated with electricity supply, primarily stemming from factors such as natural occurrences (such as drought),

fluctuations in oil prices, disruptions in the energy systems due to conflicts, and insufficient investments in electricity generation (Kambule *et al.,* 2019; Garba and Bellingham, 2021).

The increasing energy demand poses a global environmental challenge (Chakamera and Alagidede, 2018; Li *et al.,* 2023). The consumption of energy derived from fossil fuels has concerning consequences for public health indicators (Laher *et al.,* 2019; Mutumbi *et al.,* 2021). Alternative power sources such as generators are reported to have serious health complications for individuals (Punt, 2008). Research conducted in the past has indicated that the utilization of non-renewable energy sources is a significant contributor to environmental pollution in developing countries as they pursue economic development (Jonaitis *et al.,* 2018). Therefore, it is against the above background that the current research aims to understand how the electricity crisis in South Africa significantly affects low socio-economic households. If electricity supply interruptions persist, they will likely trigger a development crisis (Inglesi-Lotz, 2011).

1.2. The significance of the study

South Africa suffers significant infrastructure problems, with the power sector's problems possibly being the worst (Umar and Kunda-Wamuwi, 2019). Households exposed to greater hours of load shedding are most likely to be systematically different from households with fewer hours of load shedding for a variety of reasons (Chidembo *et al.,* 2022). For instance, the grid networks might benefit from routine maintenance, and communities with greater political and economic clout are likely to receive energy services of a higher caliber than poor surroundings (Meles, 2020).

The research identified a deficiency in understanding the infrequent investigation of electricity outages in households. Consequently, this study seeks to address this gap in knowledge by evaluating the consequences of electricity disruptions in impoverished urban households and small-scale enterprises. Additionally, the research identifies certain societal factors that play a significant role in influencing the impact of electricity outages. Following the research development on the electricity crisis, the current research contributes to information on the energy crisis and is useful for policymakers to evaluate all the challenges associated with load shedding when making recommendations on how to obtain a reliable power supply in the future (Lawson, 2022).

1.3. Problem statement

The significantly high electricity crises associated with uneven power distribution and unreliable power supply have collectively resulted in deeper social injustices for poor households and widespread protests in many South African communities, especially in Alexandra township (Pillay, 2021; Fisher *et al.,* 2022). Eskom, South Africa's state-owned power utility, has faced interconnected obstacles, such as inadequate maintenance and insufficient coal supply for its power stations (Monyei and Adawumi, 2017). Delays in the upgrade of the Koeberg nuclear power station, along with notable setbacks at other key facilities like Medupi and Kusile power stations, have collectively contributed to excessive power interruptions (Sehlapelo and Inglesi-Lotz, 2022). These interruptions have had devastating repercussions on the local economy of Alexandra as well as the well-being of households (Nkosi and Govender, 2022).

Business establishments in Alexandra were reported to be struggling to remain open and some had to let employees go because of continual load shedding (Uhunamure *et al.,* 2019). On top of the reduced power supply in Alexandra, Eskom started implementing revenue collection in households, which resulted in cutting off the electricity supply to non-paying customers (Williams *et al.,* 2020). The local municipality funding system relies on revenue collected from basic service providers such as water, electricity, and garbage, this is done to fund the mandated activities (Qeqe *et al.,* 2022). Escalating levels of indebtedness have caused a considerable number of households to lag in their payments, prompting the implementation of assertive revenue collection methods (Chakamera and Alagidede, 2018). As part of these measures, overdue municipal arrears are now being subtracted as a portion of prepaid electricity token acquisitions by domestic users. This action is exacerbating the financial strain on working-class users, diminishing the number of electricity units they receive for each rand spent. A significant portion of this demographic has

already found themselves in debt due to previous instances of non-payment. (Ateba and Prinslo, 2019; Chakamera and Alagidede, 2018).

This situation arises from the electric utility sector's efforts to adapt to substantial transformations, which encompass deregulation, a surge in electricity consumption, expanding customer numbers, industry reorganization, consumer preferences, and the rising costs associated with net generation capacity. The key focus of load management, including load shedding, is to align consumer electricity demand effectively and cost-effectively with the available capacity to ensure reliable supply (Sehlapelo and Inglesi-Lotz, 2022).

The City of Johannesburg also carries a significant weight of socio-economic inequalities characterized by lopsided access to basic infrastructure provision, which is compounded by rapid urban growth (Williams *et al.,* 2020; Mawasha and Britz, 2021). On top of being under-resourced, municipalities are still facing the challenge of electricity theft and self-organized illegal power connections that are routinely used by residents (Nel *et al.,* 2016; Banza *et al.,* 2022). As a result, affluent households are capitalizing on the affordable costs of solar photovoltaic technology, acquiring rooftop systems that significantly reduce their reliance on the national grid (Burke and Stephens, 2018). Several efforts to reform the power industry in South Africa have been put into action, but they have not yielded the desired results. The option of privatizing electricity has been discussed as a potential solution to the crisis, although concerns have been raised about limited accessibility for disadvantaged communities and the undesirable consequence of tariff hikes.

This draws attention to the assessment of the impact of electricity supply interruptions in Alexandra. Because of the above observations, this study will be guided by the following research questions.

Main research question:

What are the impacts of load shedding on households and small-scale businesses in Alexandra, City of Johannesburg, and how does it affect their daily lives and operations?

Specific research questions:

i. What is the impact of load shedding on households in Alexandra?

ii. What is the impact of load shedding on small business enterprises in Alexandra?

iii. What are some of the challenges faced by City Power to adequately supply electricity in Alexandra?

1.4. Aim and objectives of the research.

The study aims to assess the effects of load shedding on households and businesses in Alexandra.

The specific objectives of the study are:

i. To identify and examine the impact of load shedding on households in Alexandra.

ii. To identify and examine the impact of load shedding on small business enterprises in Alexandra.

iii. To keep track of how City Power addresses various load-shedding challenges affecting households and businesses in Alexandra taking into consideration the past and present status of South Africa's electricity crisis.

Chapter 2:

Conceptual framework and literature review

Electricity is a prerequisite for human welfare and economic growth (Chidembo *et al.,* 2022). The South African electricity grid is predominantly supplied by Eskom, which is the state-owned, monopoly supplier of electricity (Mabugu and Inglesi-Lotz,2022). Obstacles faced by Eskom, brought on by the rapidly deteriorating power generation facilities and the decreasing South African government bailouts, prevented Eskom from providing enough electricity to satisfy total demand (Williams *et al.,* 2020). This has led to the implementation of electricity blackouts also known as load-shedding in South Africa. This section starts by defining the key concept of the study for clarity. Followed by reviewing existing literature on the impact of load shedding on households from global, regional, and local contexts.

2.1. Defining the concepts of the study.

2.1.1. Energy

The concept of energy has been incorporated into the field of physical science, serving as a metric for the net force exerted on an object or by an object, and this is further calculated by multiplying the force by the distance over which it is applied. This measure is referred to as potential energy. (Mehling, 2017). Due to inadequate energy infrastructure, poor management, and a lack of sufficient national resources, energy shortages result in incidents of electricity load-shedding (Akpeji *et al.,* 2020). Energy poverty refers to the inadequate availability or restricted access to essential energy sources such as electricity, gas, fuel, kerosene, and diesel. It characterizes a circumstance in which the provision of energy-related products and services fails to meet the

anticipated demand or requirements. This persistent issue is a widespread challenge across numerous developing countries, including South Africa (Amadi, 2015; Chidembo *et al.,* 2022).

2.1.2. Electricity

Electricity is the conveyance of electrical power or charge. Classified as a secondary energy source, it is generated by transforming primary energy sources like coal, natural gas, oil, nuclear power, and various natural resources into usable forms. Electricity, as a standalone entity, is neither renewable nor non-renewable. However, the energy sources utilized in its production can be categorized as such, depending on whether they are replenished naturally over time or are finite resources (Wabukala *et al.,* 2023).

2.1.3. Load shedding

This phenomenon can also be referred to as power outages, power blackouts, and power cuts (Koirala and Acharya, 2022). Electricity load shedding is described as a shortage of electricity to maintain a lower level of energy and supply electricity to customers by the total megawatts produced by the energy-generating resources (Jamil *et al.,* 2018). When Eskom's power plants are unable to meet their share of the country's demand for electricity, load shedding is undertaken. Eskom chooses to sporadically switch regions of its national electricity supply network to disperse the limited electrical supply that it has (Mabugu and Inglesi-Lotz, 2022).

Lawson, (2022), contended that the process of load shedding is to intentionally turn down some of the electrical supply to reduce the pressure on the national electrical system. Load shedding is not a deliberate choice or tactic; instead, it is viewed as an emergency measure that policymakers are actively seeking to minimize or avoid whenever possible (Nkosi and Dikgang, 2018). When the electricity grid is in danger of collapsing entirely, Eskom considers load shedding to be required.

The pressure on the electric system is not necessarily the root cause of the outages; other factors include outdated infrastructure, illegal electricity connections, and wire theft (Steenkamp *et al.,* 2016).

2.1.4. Theoretical perspective of load shedding

To complement the research methodology, load shedding theory from the existing literature sources argues that South Africa faces a complex electricity problem with three interrelated dimensions. The capacity challenge stems from a disparity between operational generating capacity and peak demand (Drian and Mart-Mari, 2016). To address this, a recommended solution involves increasing capacity through new investments and urging consumers to reduce peak electricity demand (Nel *et al.,* 2016). The supply problem, on the other hand, arises from a gap between consumer consumption levels and Eskom's ability to supply power, influenced by technical maintenance requirements and constraints on coal production (Ateba and Prinsloo, 2019). The proposed remedy involves augmenting operational capacity and ensuring a sustained supply of power. The reserve margin problem emerges because of high demand surpassing ESKOM's operational capacity, leading to shorter equipment lifespans and disruptions in supply (Ingles and Pouris, 2010; Sinwell *et al.,* 2022). This issue can be mitigated by increasing overall capacity, allowing more time for maintenance, and ensuring a longer equipment lifespan (Drian and Mart-Mari, 2016).

A critical aspect is the dependency on coal for electrical energy output, with stocks needing replenishment through coal purchases exceeding usage. This, in part, can be achieved by reducing electricity consumption (Monyei and Adewumi, 2017). Overall, the long-term solutions emphasize increasing capacity, addressing technical and resource-related challenges, and effectively managing coal supplies to enhance the resilience of South Africa's electricity system.

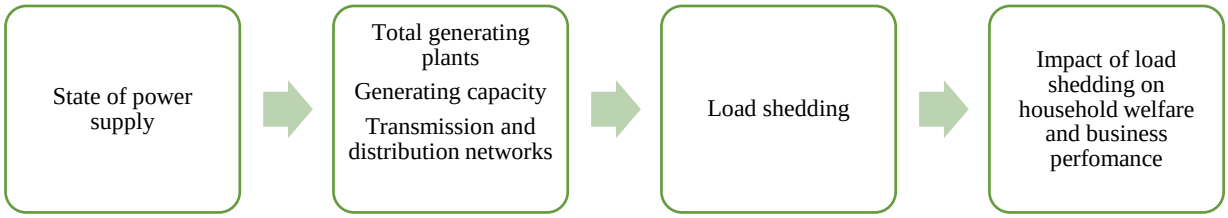

Figure 1: Model for the conceptual framework of the study.

2.2. The impact of load shedding on households in developing countries

Disruption in power supply places a significant strain on households although electricity access in developing countries has received considerable attention the lack of reliability in power supply is still a challenge (Mabunda, 2021). Meles (2020), argued that there is insufficient evidence on the impact of load shedding at the household level in developing countries due to a limited scope of the literature addressing energy poverty. Most of the studies conducted on the impact of frequent power outages in developing countries indicate that the effects are more pronounced on the economic development of both households and enterprises. Therefore, this section delves into the various ways in which frequent power outages disrupt business operations, hinder economic growth, and impede the development of these enterprises.

Mutambo *et al.,* (2023) revealed that load shedding leads to either a shortage of electricity for industries or higher electricity costs for developing industries including Pakistan, Bangladesh, India, Nepal, Senegal, Cameroon, Ethiopia, etc. Consequently, this results in either reduced or increased prices for the products of those industries. This, in turn, causes price increases for the products of other industries that rely on inputs from the affected industry (Adhikari *et al.,* 2017; Oluwasuji *et al.,* 2023). This ripple effect continues, ultimately reducing the overall output of the economy and driving up prices for most goods and services produced domestically (Mutambo *et al.,* 2023). In addition to experiencing discomfort from irregular electricity supply, households also face higher prices for goods and services. Furthermore, domestic production becomes more expensive compared to international counterparts, leading domestic industries to lose competitiveness (Cloete *et al.,* 2023).

Kessides, (2013), indicated that in Pakistan, persistent load shedding has emerged as a long-standing problem, greatly affecting the business activities of small-scale enterprises across the

country. Since 2007, Pakistan has faced a severe energy crisis marked by a substantial decrease in production, leading to a shortfall of 6000 Megawatts and widespread power outages. The research indicates that load shedding has had a considerable impact on business operations, causing issues in customer management, reduced sales, damage to products, and increased expenses (Kessides, 2013).

In India, the recurrence of power blackouts has been used as a crucial indicator of facility-based deliveries and skilled birth attendance. In contrast, the duration of load shedding is a significant predictor of skilled birth attendance. Because of approximately 8.5 electrical outages that occurred in India, the number of home births increased by 18% in a typical month (Koroglu *et al.,* 2019).

Power outages reduce the amount of income earned by households as well as employment in general (Kaseke and Hosking, 2013). A study in Pakistan revealed that the well-being of industrial workers was negatively impacted by rising power crises that resulted in power and gas load-shedding hence, their financial status was characterized by low earnings, and because of the economic imbalance, their social well-being suffered from pessimistic effects and mental unrest (Jamil *et al.,* 2018). A study in Ghana indicated that power outages also have adverse effects on social and sustainability matters, including health, employment, education, population growth, and poverty reduction (Nduhuura *et al.,* 2020). The reliance on backup diesel generators to lessen the impact of power outages often leads to higher consumer spending on electricity and worsens air quality due to increased local emissions. Additionally, power outages can deter entrepreneurship and decrease the demand for labor, thus limiting employment opportunities (Booysen *et al.,* 2023). Kaseke and Hosking, (2013), found a positive link between the use of electricity and improvements in productivity, health, and life expectancy.

2.3. The impact of load shedding on households in Sub-Saharan Africa

Africa has a lot of issues with energy supply, and the main causes include conflict, oil and gas price shocks, natural disasters such as drought, and insufficient investment in electricity generation (Kaseke and Hosking, 2013). Prior studies in Sub-Saharan Africa revealed that urban households are more prone to the impact of power outages than rural households because most activities are electricity-dependent, unlike rural areas which rely on traditional fuel (Nduhuura *et al.,* 2021, Muhihi and Paschal, 2022). However, a study in Zambia linked charcoal usage to igniting fires for cooking in households with the increased risk of carbon monoxide poisoning (Umar and Kunda-Wamuwi, 2019). The urban poor are particularly affected by energy insecurity because of their low asset base, which makes them more susceptible to environmental shocks (Reid and Simatele, 2021).

The impact of load shedding is associated with a lack of access to critical social services provision in African countries (Meles, 2020). Disruption in electricity supply limits the optimal delivery of vital infrastructure such as medical facilities, water systems, telecommunication, systems, and education institutions (Koroglu *et al.,* 2019; Casey *et al.,* 2020). Basic services were shut down in Zambia due to power disruptions. Industries, farms, and households were compelled to turn to other energy sources (Kaseke and Hosking, 2013). Umar *et al.,* (2022), located the impact of load shedding on the lack of water supply and sanitation at the household level. Load shedding affects the water system because of the combined effect of heat waves, intermittent pumping of water because of electricity interruptions, and failure of infrastructure (Smit *et al.,* 2019). In Uganda, power outages have resulted in significant harm, including consequences such as the loss of 150 lives in healthcare facilities, compromised sanitation, and disruptions in water supply. Uninterrupted electricity supply in healthcare facilities is of utmost importance, as any power

disruption could result in a deterioration of patients' health, potential fatalities, and the jeopardizing of surgical procedures (Ndaguba, 2018).

The strain of the electricity crisis in Nigeria is deeply affecting rural households. The Niger Delta's rural households' frequent power outages were found to have several negative effects, including slowed economic growth, reduced leisure time, increased criminality, and increased insecurity (Amadi, 2015). It was also demonstrated that people's social and economic lives are severely affected by power interruptions. In modern civilization, a reliable power supply adds value to leisure time makes life worthwhile, and reduces stress. In Nigeria, Extended and uncertain power disruptions have a detrimental impact on the well-being of rural households, leading to feelings of weariness, frustration, and drowsiness during daylight hours. This, in turn, results in reduced productivity, and a propensity to nod off at work, and even while operating vehicles (Amadi, 2015).

In Ghana, there were reports of intense public concern about the increased crime associated with the power supply crisis (Danso-Wiredu *et al.,* 2016). The power outages were also associated with several fire outbreaks which emerged from the high voltage surges when the power supply is reconnected and from the usage of alternative energy sources (Umar *et al.,* 2022). Besides the fire outbreak effect, high voltage surges also lead to direct damage to household electrical appliances (Amadi, 2015). It is also important to consider the additional costs of household expenditure on purchasing backup power alternatives (Schmidthales and Reichl, 2016).

In Zimbabwe, the impact of the electricity crisis was underlined by gender inequality (Musademba *et al.,* 2012). Power outages hinder women's attempts to generate money to help most households overcome their financial difficulties. Businesses' relationships with customers were strained because of load shedding since they were unable to accomplish objectives or render a service (Li *et al.,* 2023, Musademba *et al.,* 2012). Since it takes time to develop connections with consumers,

the loss of customers in an oversaturated market is likely to have made things worse for most businesses (Mukoni, 2012). Loss of merchandise was also terrible because many goods were ruined or destroyed, especially those that needed refrigeration during power outages. These interruptions may cause reduced profit, loss of employment, and increased business costs, loss of business (Reid and Simatele, 2021; Umar *et al.,* 2022).

It is important to highlight the presumptions found in research in Zimbabwe, which suggested that providing broader access to energy services will empower women by enabling them to participate in literacy and numeracy programs, granting them additional leisure time, improving access to information through radio and television, and thereby enhancing their awareness and empowerment. Additionally, the assumption is that improved energy services will lead to a shift in the traditional gender-based division of household labor, with men taking on more domestic responsibilities (Mukoni, 2012). The impact of load shedding varies for individual households depending on the household's power supply and usage plan (Longe *et al.,* 2017; Nduhuura *et al.,* 2021).

2.4. The impact of load shedding in households in South Africa

The ability of South African households to do or take advantage of activities and services that require electricity is limited (Chidembo *et al.,* 2022). A study in rural areas of the Vhembe district highlighted the impact of alternative energy mostly used in rural areas which are paraffin, candles, and firewood as unclean energy sources (dangerous and risky) that are detrimental to both human health and the environment (Li *et al.,* 2023). The impact of load shedding reflects a household's electricity use behavioral patterns and attitudes (Williams *et al.,* 2020). Socio-psychological ideals such as universalism, goodness, hedonism, and power all have an impact on how people use electricity (Mutumbi *et al.,* 2021). For instance, urban poor households use solid waste to generate energy during scheduled power blackouts (Lawson, 2022).

Residential fires in Cape Town caused by load shedding led to hundreds of people dying and many are injured because of open-flame fires, which are costly and extremely dangerous. The increased risk of fire prevalence in households during power surges (caused by appliances switching on and off tremendously increasing the electric system voltage) is caused by poorly-insulated wiring in appliance connections and electrical faults (Lawson, 2022). The fire outbreaks not only cause death and injury, but they also damage the environment, cause psychological damage, and increase hospital admissions, especially for pediatrics and the elderly (Koroglu *et al.,* 2019; Casey *et al.,* 2020). The adverse impacts of load shedding in South Africa have also been witnessed in a scenario whereby load shedding tragically resulted in the loss of four premature infants' lives at Cecilia Makiwane Hospital in East London in 2015 (Ndaguba, 2018). Gehringer *et al.,* (2018), also indicated that load-shedding implementation in South Africa was associated with a substantial rise in hospital admissions of pediatrics, on the same day and up to two days after the power load shedding. The increased admissions were associated with cases of impairment of eyes, ears, lungs,

and digestive system complications stimulated by external noxious influences such as the combustion of fuels used as alternative energy sources during periods of load shedding, as a possible trigger (Casey *et al.,* 2020, Lawson, 2022; Li *et al.,* 2023).

In South Africa, some electricity blackouts are caused by social-political tensions within the country (Gaunt, 2008). The electricity crisis has swiftly evolved into a significant political dilemma, symbolizing the government's struggles to enact meaningful reforms (Muller, 2023). This is evident through the proliferation of oversight bodies for Eskom, the establishment of a new Ministry of Electricity, and the controversial declaration of a national state of disaster (Baker and Phillips, 2019). This stagnation is significantly diminishing public support for the ANC, which had already reached its lowest historical level during the 2021 local elections. Recent polls indicate a substantial exodus of voters from the ANC due to persistent load shedding. Consequently, the ruling party may struggle to secure a majority in the upcoming 2024 general elections based on its current level of popularity (Muller, 2023).

The political crisis of load shedding was also felt by the residents of Sun Valley in Pimville, Soweto, who endured in the dark in August 2020 because of a malfunctioning power transformer, frequently lacking the means to warm their homes or prepare meals. The study demonstrated the psychological costs of being forced to live without electricity (Sinwell *et al.,* 2022). This also demonstrates how the ANC's electoral success or growing electoral failure at the local government level is related to the electrical issue. This expressed not only the despair with the power of the vote (Tanaka *et al.,* 2022). The author argues that electrifying Sun Valley is a cornerstone of the "energy racism" agenda since it depends on and implies that the black middle class will continue to be tormented by the power crisis (Todd and McCauley, 2021).

Therefore, South African individuals experience a loss in welfare because of decreasing household earnings accompanied by the high inflation rate (Punt, 2008; Bohlman and Inglesi-Lotz, 2016). The load-shedding outbreak in 2008 also took a toll on gold mine workers in Johannesburg. As a result of power failures, the mining industry had to stop its operations to avoid the risk of mine workers being trapped underground (Kaseke and Hosking, 2013). The train industry was also affected by the frequent power blackouts. The impact of load shedding is one of the major socio-economic inequalities.

Chapter 3:

Research Methodology

3.1. Research Approach

The study used mixed-method research approaches to address the aim and the specific objectives of the study. The quantitative method (closed questions) was used to gain a general perception of the prevalence of load shedding and the socioeconomic effects of load shedding in Alexandra households. A qualitative method (open-ended questions) was used to extract in-depth knowledge on the causes and associated implications of load shedding on households' welfare in residential areas of Alexandra from the local authorities. Qualitative research questions primarily focus on ensuring the trustworthiness of the study by establishing the credibility, transferability, confirmability, and dependability of the findings. Unlike quantitative research, which emphasizes generalizability to the broader population based on sample size, the key distinction in qualitative studies lies in their concern for the extent to which the results can be applied to the specific context from which the sample is drawn (Olajuyin and Mago, 2022).

In questionnaire design, closed-ended questions are most effective when the topic is clearly defined, and responses can be easily categorized into a few pre-defined options. On the other hand, open-ended questions are better suited for exploring complex or ambiguous topics where a variety of responses are expected and cannot be easily captured in a closed-ended format (Rouder *et al.,* 2021). Open-ended questions can be used alongside closed-ended questions to encourage respondents to elaborate on a topic or provide their perspectives in an unstructured manner. They can also be used as standalone questions to gather detailed information that closed-ended questions may not capture. Unlike closed-ended questions, open-ended questions can prompt respondents to

share unexpected details or personal experiences, making them particularly useful for sensitive topics. By allowing for diverse responses, open-ended questions can provide a more refined understanding of the data, complementing quantitative results and revealing the underlying reasons behind certain trends (Rouder *et al.,* 2021).

3.2. Research design

This section briefly describes the overall strategy for how the study was conducted logically. The study was designed in a context that addresses the research problem and constitutes the blueprint for study site selection, data collection, and data analysis.

3.2.1. Study site description

Alexandra, also known as Alex or Gomora, is a township situated in Gauteng province in South Africa. The Alexandra is a low-income township under the geographic region of the City of Johannesburg Metropolitan Municipality. Alexandra has positioned 12 km from the northeastern hub of Johannesburg Central Business District (CBD) and it is also located in closer proximity to the affluent suburbs of Sandton which is made up of high-value property, commercial and retail (Mawasha and Britz, 2021). Shapurjee and Chalton, (2013), argued that it is unusual for a low-income settlement like Alexandra to be located near a high residential and economic area like Sandton in South Africa. Alexandra covers a total area of 6.91 km^2 and has a total population of approximately 179,624 residents (Census, 2011). The research study consists of two study locations namely, 16^{th} Avenue and East Bank Avenue, Alexandra. East Bank Avenue is geographically located at 26º 10′ 0.9″ S 28º 11′ 0.5″ E. The 16^{th} Avenue extension is geographically located at 26º 10′ 46.7″ S 28º 10′ 26.4″ E. The study sites are geographically separated by the

Jukskei River which is one of the largest river basins in the country and it runs through Alexandra township covering a total length of 390 km. The Jukskei River poses a threat to residents who are adamant about living on the banks as there are frequent reported incidences of flooding which affect the informal settlements/shacks along the London Road and leave the households destroyed and people's lives at risk (Mawasha and Britz, 2021). East Bank and 16th Avenue are characterized by formal extensions of the original township 'Old Alexandra' (Shapurjee and Charlton, 2013).

Gauteng province is the smallest province in South Africa but has the highest population of approximately 12.3 million people (Census, 2011). Although Gauteng has the largest urban economy, Gauteng has the highest standard of socio-economic inequalities including rapid urbanization, migration, unemployment, poverty, racial segregation, gender-based discrimination, unequal political influence as well as income and wealth inequality (Dzikiti and Leonard, 2016; Musango, 2014). As a result of the challenges that date back, Alexandra's establishment in 1912 was influenced by apartheid pass laws and policies. Historically Alexandra was the only place where black people could secure freehold land during the apartheid era until the residential area was subjected to oppression and inequality when black communities were exploited by greedy white landlords into paying overpriced rentals in 1924 (Richards *et al.,* 2007; Dzikiti and Leonard, 2016).

As a result of the inherited apartheid scars, the population of Alexandra constitutes a majority of black people from various ethnic groups. The effect of apartheid persists in Alexandra households as they are characterized by state-subsidized low-income housing units also known as RDP, that constitute additional rental units commonly called backyard sharks/dwellings and informal housing (Shapurjee and Charlton, 2013; Mawasha and Britz, 2021). Alexandra is facing deeper socio-economic issues such as rapid population growth, poor access to basic service provision,

lack of infrastructure, overloaded sewerage systems, dangerous electricity connections, environmental pollution, crime, unemployment, etc. (Pillay, 2021; Fisher *et al.,* 2022). The social injustices draw attention to developing a research study that will explore how the community of Alexandra is affected by the recent succession of electricity load shedding in the country. The environmental setting of Alexandra makes it an easy target for research study sites because of the underdeveloped and informal settlements. The infrastructure has been overburdened by the enormous, unplanned population, resulting in power disruptions, low water pressure, and frequent sewerage blockages and overflows (Dzikiti and Leonard, 2016). Due to the backyard shack development's high density and cramped character, maintenance access can be extremely challenging or even impossible in most residential areas (Ndakuba, 2018).

Alexandra residents engage in a variety of economic activities, often characterized by a mix of formal and informal sectors. The specific economic activities can vary, but some common livelihood strategies include informal trade and entrepreneurship (spaza shops and street vending), craftsmanship and handiwork, services (transportation, information technology, beauty services,) education and training, arts, and culture (artists and performers), community services and some residents may commute to work in formal employment sectors outside the township, such as offices, factories, or service industries.

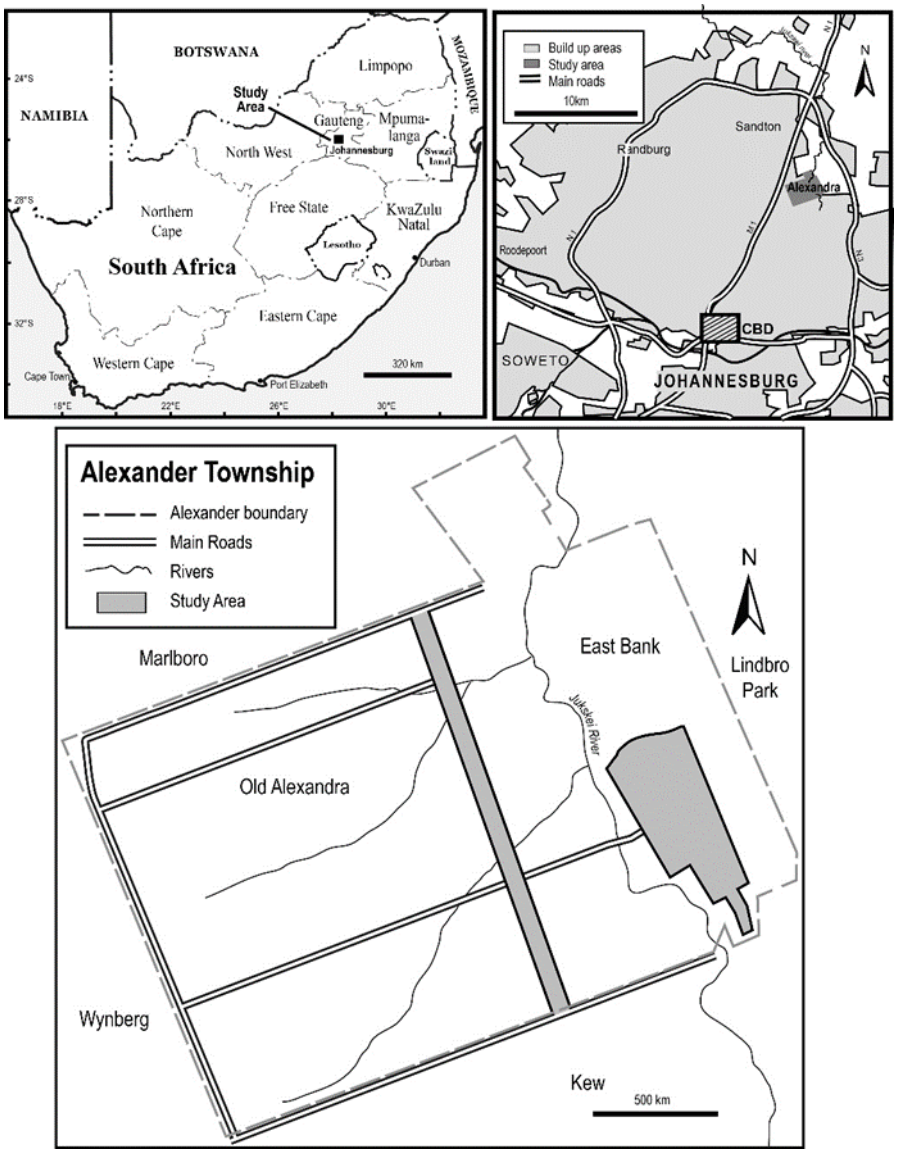

Figure 2: The map representing the research study locations namely, East Bank Avenue and 16th Avenue, Alexandra. The map was created by Cebolenkosi Mbatha, with aid from the GAES cartographer, Miss Wendy Phillips.

3.2.2. Study population and sampling procedure

All the residents of the community of Alexandra are affected by the persistent electricity sector challenges characterized by the erratic power supply. Thus, the targeted population of the study was 100 households and 20 small-scale businesses selected from communities of the two study sites namely, 16th Avenue and East Bank Avenue, Alexandra. The study population comprised adult household heads that were above 18 years of age from all gender groups. A total of 20 small business enterprises were also selected for data collection. These included bakeries, butcheries, taverns, spaza shops, boutiques, internet cafes, welders, workshops, tailors, and salons.

The researcher applied simple random sampling to collect data for the study. The participants were chosen based on specific characteristics or features relevant to the study or their expertise in the subject matter. The researcher walked towards households and local businesses distributing questionnaires in person and only households that were volunteering to engage in the study were given questionnaires. Qualitative data was purposively gathered through key informant interviews involving four representatives from the local city authority. The researcher cannot disclose the local city entities that were interviewed due to ethical considerations, but the participants willingly agreed to take part in the interviews.

The household samples for questionnaire administration were selected using simple random sampling in the two designated study sites located in Alexandra namely, East Bank and 16th Avenue. The quantitative data of the study was collected by administering a total of 120 questionnaires face-to-face to adult members of households and small business enterprises in Alexandra. The questionnaires were divided into equal parts between the two study locations; therefore, fifty questionnaires were administered to 16th Avenue households and 10 small business enterprises, and the remaining portion of hardcopy questionnaires were administered to East Bank

Avenue households and its small business enterprises. The questionnaire technique was useful in this scenario because it allowed participants to respond to questions precisely meanwhile maximizing the response rate, given that the researcher framed the questions in a manner that was clear, concise, and lacked bias (Jones *et al.,* 2013). Moreover, face-to-face interviews enable the researcher to obtain responses that intend to address complex questions, therefore eliminating confusion from participants, and the responses can easily be entered manually and directly into a computer database (Jones *et al.,* 2013).

The questionnaire comprised questions that identified the household's demographic information, outage characteristics, socioeconomic impacts of load shedding, and household electricity usage plans. (Amadi, 2015; Mutumbi *et al.,* 2021). The questionnaires were printed on A4 paper, and they were also written in English. A minimum of 10 minutes was allocated for each questionnaire in a single household.

Qualitative data was collected through a series of semi-structured interviews which were conducted with the relevant stakeholders involved in the provision of electricity such as City power representatives. The interviews were conducted face-to-face, depending on the availability of the respondents. The reason for selecting semi-structured interviews was that they allowed respondents to present an in-depth understanding or experience of the research phenomenon without deviating from the context of the topic areas/question (Ritchie *et al.,* 2003). The semi-structured interviews also allow respondents to articulate themselves beyond what the researcher asked. The total samples of the questionnaires and interview responses administered were successfully retrieved in safe storage by the researcher and were then used for data analysis.

3.2.3. Research technique and instruments of data collection

This section describes which research techniques were used to achieve specific research objectives.

Table 1: Study objectives and their complementary research technique for data collection.

Research objective	Research technique of data collection
1. To identify and examine the impact of load shedding on households in Alexandra.	To achieve this objective, 100 questionnaires were conducted with the local community members in Alexandra focusing on the negative impact of load shedding in their households. The questionnaire highlighted the effects of load shedding based on household welfare including the social, psychological, and economic aspects.
2. To identify and examine the impact of load shedding on small business enterprises in Alexandra.	To achieve this objective, 20 questionnaires were conducted with small-scale entrepreneurs in Alexandra. The questionnaires sought to understand the impact of the power disruptions on business' performance particularly the income and expenditure as well as the flexibility to adopt alternative energy sources.
3. To keep track of how City Power addresses various load-shedding challenges affecting households and businesses in Alexandra taking into consideration the past and present status of South Africa's electricity crisis.	To achieve this objective, once-off, in-person semi-structured interviews were conducted with four local authorities focusing on various concerns aligned with the research questions. The respondents were City Power experts and the City of Johannesburg council.

3.2.3.1.Researcher's observations

The researcher also made personal observations on participants to gain some insight into the characteristics of the households how the overall functioning of the settlement is and how the community is affected by the recent electricity issues. The observations were then captured during the times of data collection as well as special visits to the study locations, particularly the small business enterprises. The observations were made purposeful by identifying an accurate target group to be used as a study sample. This step was useful in narrowing down your focus and determining the scope of your research. This was followed by observing the target sample in their natural environment. This is important to ensure that the observations are unbiased and accurately capture the relevant behaviors of participants and areas of concern. Throughout the process, it was integral to maintain ethical regulations such as obtaining informed consent when necessary and ensuring the confidentiality of participants' information (Jones *et al.,* 2013).

3.2.4. Data analysis

The researcher used Microsoft Excel as the software tool to analyze the characteristics of the quantitative study population as well results obtained from the open-minded questions. Thematic method of data analysis was used to analyze the responses obtained from questionnaires and semi-structured interviews. Responses to each open-ended question were thoroughly read multiple times, and patterns or themes were identified. Exhaustive and mutually exclusive categories were established, each assigned a specific name. Subsequently, each response was analyzed and categorized accordingly. Following the categorization process, frequencies for each category were calculated.

Thematic analysis is a widely used qualitative method that involves organizing data using a coding system to draw meaningful conclusions (Rouder *et al.,* 2021). However, in quantitative research, the inclusion of open-ended responses is sometimes not fully utilized due to a lack of explicit analytical strategies, limited resources, or a lack of expertise in qualitative analysis. When open-ended data is presented alongside quantitative results, the approaches can be superficial, such as showcasing a few quotes or using word clouds, which may not fully capture the depth of the information provided by respondents. This issue is partly because techniques for visualizing qualitative data are less developed compared to those for quantitative analysis (Decorte *et al.,* 2019).

After the frequencies for every category were added up, they were then converted into percentages. The descriptive statistical results were displayed in both bar graph and table format (Umar *et al.,* 2019). The qualitative data responses were thoroughly read and revised several times to get a clear context and critical understanding of the information presented. Concepts that emerged from the semi-structured interview were covered and discussed in a brief empirical framework in a South African context while reflecting on the overview of the study (Pillay, 2021). The data collected from observations of the participants and their interactions regarding the electricity crisis in the community was analyzed by generating a hypothesis that assumes that the environmental setting of Alexandra has a significant contribution to the impact of load shedding faced by the households. This theory was then linked to the themes drawn from the major findings of the study.

3.2.5. Limitations of the Research

The study sample was a relatively small sample size, only a total of 100 households and 20 small business enterprises were sampled altogether with a minimum of 4 stakeholders including City Power experts and other local authorities. In case of adequate funds located to research the sample

size would be increased beyond the selected sample size to increase the reliability and validity of the results. To mitigate the lack of resources to execute the research successfully, the research had to ensure that research aligns with local needs and priorities, it's crucial to engage with residents to assess various factors. This includes understanding the specific focus of the project, the geographical context, the preparedness of community members to participate, and how the research ties into existing efforts (Baumann, 2011). However, there is no predetermined minimum number of participants required for quality in both quantitative and qualitative studies. Instead, the emphasis lies on collecting a sufficient amount of information to gain a comprehensive understanding of the phenomenon being investigated (Olajuyin and Mago, 2022). However, there was a small level of uncertainty that the researcher would be able to get all the potential respondents to respond precisely to the questionnaires. Fortunately, the study achieved saturation using data from half of the study sample; however, the researcher continued gathering additional data to enhance the depth and richness of the information.

To ensure the validity of data, consistency in data collection, storage, and analysis was fundamental (Gardner, 1999, Jones *et al.,* 2013). Following best practices for data management, such as using standardized formats, naming conventions, and documenting processes, helped in maintaining data integrity. Documenting any inconsistencies in the data is crucial. This includes noting any outliers, missing values, or discrepancies in the data that could affect its quality or interpretation (Rouder *et al.,* 2021; Jones *et al.,* 2013).

The language was most likely to be a barrier between the researcher and the respondent since the researcher is only fluent in two languages including IsiZulu and English whereas the study was conducted in a settlement with people from different backgrounds and the researcher is not multilingual. The issue of safety was also a huge concern for the researcher because Alexandra is

allegedly one of South Africa's crime hotspots (Fisher *et al.,* 2022). To minimize the issue of language barrier and safety during data collection, the researcher had to ask for assistance from one of the members of the community forum to assist with questionnaire administration. The disadvantage of using questionnaires is that they tend to be information-biased as they are not 100% accurate, thus they misclassify people. The disadvantages of collecting research data in person are that it is expensive, requires more time allocation, and requires a lot of training for the researcher to avoid biases or unethical behaviors (Jones *et al.,* 2013).

3.3. Ethical considerations

The researcher applied for ethics clearance with all the relevant documentation required. Ethical consent (Protocol number: gaes_2023_07_013) for the research study was constituted by Human Research Ethics at the University of Witwatersrand. The potential participants were required to sign an informed Consent form and Participant information sheet presented in simple language that guaranteed them anonymity in the current research study. The researcher was strongly determined to show research integrity during data collection for the study. The researcher also showed strong dedication to research principles such as accountability, honesty, good steward as well as professional courtesy and fairness to the participants. The researcher used the plagiarism software tool available on the Wits Canvas for student's assignments to determine the extent to which the research report may had any instances of plagiarism. To counteract plagiarism detected, the student had to paraphrase the plagiarised content and acknowledge the source of work by citing it correctly in the research writing using both in-text citations and adding the original authors to the list of references (Gardner, 1999).

Chapter 4:

Results and Discussion

4.1. Results

This section shows the results of the data collected using the questionnaires from both households and small businesses in Alexandra that assessed the impact of load shedding. This chapter is organized into 3 sections respectively. The first section provides descriptive data on the household's socio-economic characteristics (**Table 2**). The second section presents the impact of load shedding on both households and small-scale entrepreneurs in Alexandra (**Figure 3** to **Figure 9**). The last section presents the responses of the local authorities as well as the researcher's observations.

4.1.1. Socio-demographic information of respondents.

Table 2. The table below represents the respondents' descriptive results of household characteristics.

Household socio-economic characteristics	**Percentage of respondents (%)**
Gender of household's head	n=100
Female	63
Male	37
Homeownership	
RDP	47
Rent	27
Stand-alone (repossessed property)	26
Number of household occupants	
0-3 people	44
4-6 people	45
6+ people	11
Monthly household income	
Less than R 5000	38
Between R 5000 and R 10 000	37
More than R 10 000	25
Employment status	
Employed	53.33
Self-employed	24.76
Not employed	21.90
Willingness of households to pay for improved and reliable power supply	
Yes	65
No	34
Not sure	1

The results from **Table 2** indicated that 63% of households are headed by females while respondents from male-headed households were only 37% of the sample population. The study showed that a majority of 47% of households in the study site are RDP-owned houses, however, other types of household ownership are common in Alexandra namely, rentals which constitute 27% of households, and stand-alone properties which make up 26% of the total sample population. The results showed that 45% of households inhabit an average number of 4-6 occupants and a minimum of 11% of households accommodate more than 6 occupants. Within the sample population, only 25% of households receive more than R10 000 of monthly income while a majority survive with only R 5 000. This is in alignment with the employment status results that show that 21.9% of respondents are unemployed while 53.3% are employed and 24.7% are self-employed. Lastly, only 65% of respondents are willing to pay for improved and reliable power supply if there is a proposed project to tackle the electricity crisis in Alexandra.

4.1.2. Effects of load shedding on households in Alexandra township.

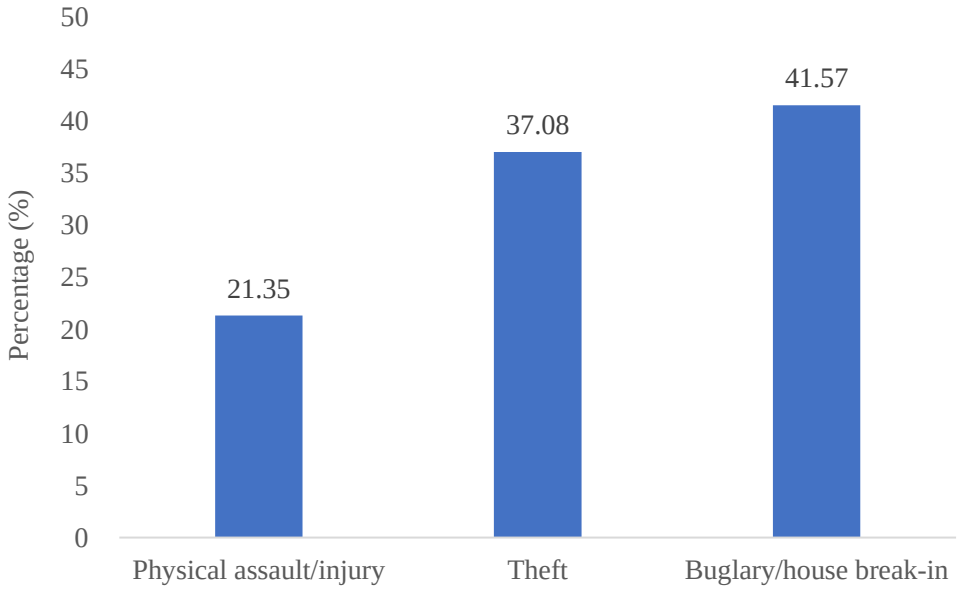

Figure 3: The impact of load shedding on households in safety and security.

The above illustration **(Figure 3)** shows the implications of load shedding on the safety and security of households in Alexandra. **Figure 3** shows that 41.57% of households have been faced with incidents of burglary and 37.08% of households became hotspots of theft in their properties because of the prolonged hours of darkness caused by lack of power supply. Meanwhile, 21.35% of respondents experienced attempts of physical assaults or injuries during periods of load shedding.

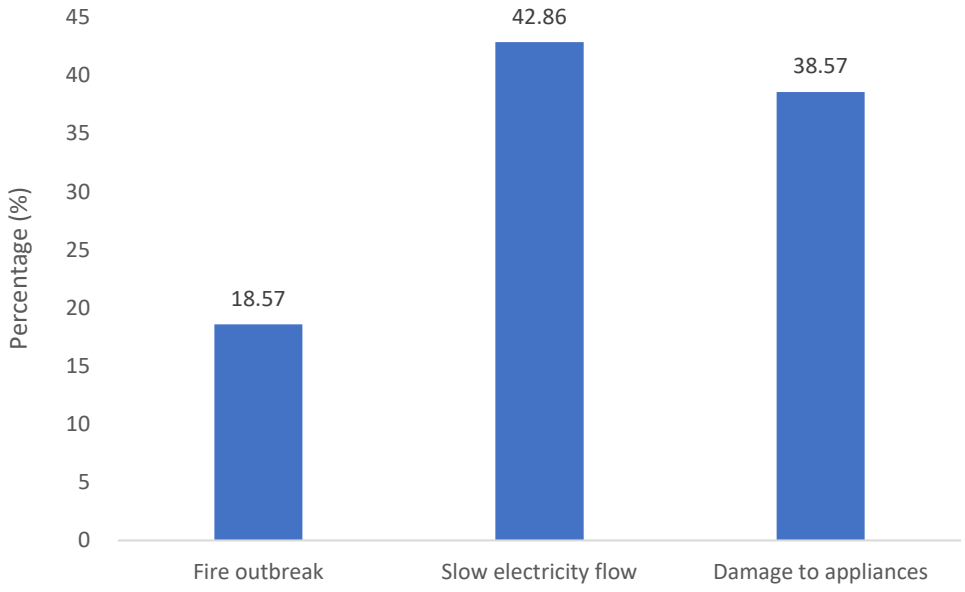

Figure 4: The impact of load shedding on households regarding damage to property valuables.

The bar chart above assesses the effects of load shedding on a household's property/valuables. **Figure 4** shows that 18.57% of respondents have experienced fire outbreaks in their homes while 42.86% of respondents noticed that their electric devices work slowly after power interruptions. Additionally, 38.57% of respondents argued that their electrical appliances have been damaged because of load shedding.

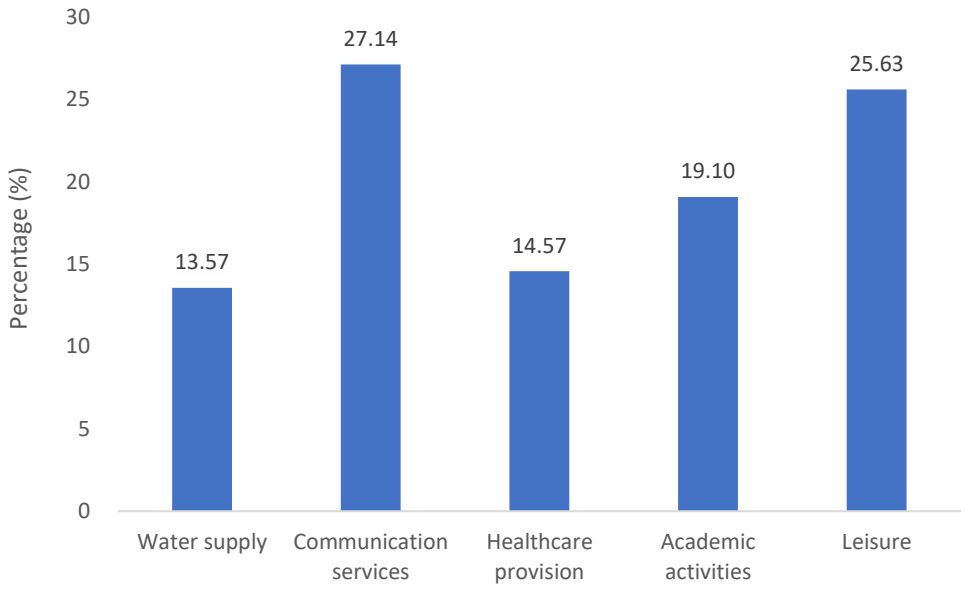

Figure 5: Impact of load shedding on households in disruption of social services.

The above graph **(Figure 5)** illustrates the effect of power interruptions on the provision of essential social services at the household level. **Figure 5** indicates that respondents reported a huge disruption in both communication services from network service providers (27.14%) and leisure activities (25.63%) during periods of load shedding. Load shedding also severely affected 19.1% of households in effectively engaging with their academic activities, while 13.57% of households reported experiencing challenges with water supply during power disruptions. Lastly, **Figure 5** also indicated that 14.57% of respondents argued that they have been subjected to limited medical attention because of load shedding which causes a decline in healthcare/medical provisioning at crucial times.

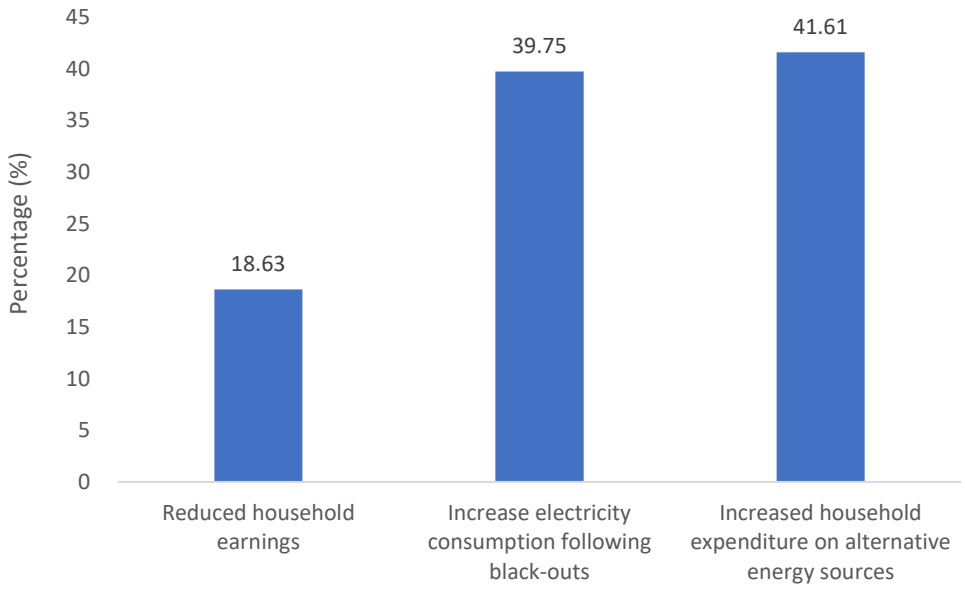

Figure 6: Impact of load shedding on households' income and expenditure.

The above figure assesses the impact of load shedding on household income and expenditure. **Figure 6** shows that 41.61% of households have adopted alternative energy sources that they implement during load-shedding periods, however, the implementation of alternative power sources is associated with increased additional costs in running the households. **Figure 6** also demonstrates that 39.75% of households argued that electricity consumption from their power meters increased significantly after blackouts. Additionally, 18.63% of respondents reported that they experienced a reduction in their monthly earnings and believe that it is associated with progressive power interruptions in the country. The effect of reduced household earnings is perceived by respondents to affect the psychological well-being of the working class.

Table 3. Alternative energy sources used by households during load-shedding periods.

Alternative energy sources	Frequency expresses in terms of number of respondents	Percentage (%)
Rechargeable lamps	46	28.05
Candles	44	26.83
Paraffin	27	16.46
Gas	23	14.02
Charcoal/firewood	16	9.76
Generators	6	3.66
Solar panels	2	1.22
Total	164	100.00

Table 3 displays the alternative energy sources adopted by households during load shedding in descending order according to household preference and affordability. Rechargeable lamps (28.05%), candles (26.83%), and paraffin (16.46%) are the most preferred power sources by the sampled households in Alexandra. Only a minimum of 1.22% of respondents could afford solar panels and 3.66% of households could afford generators.

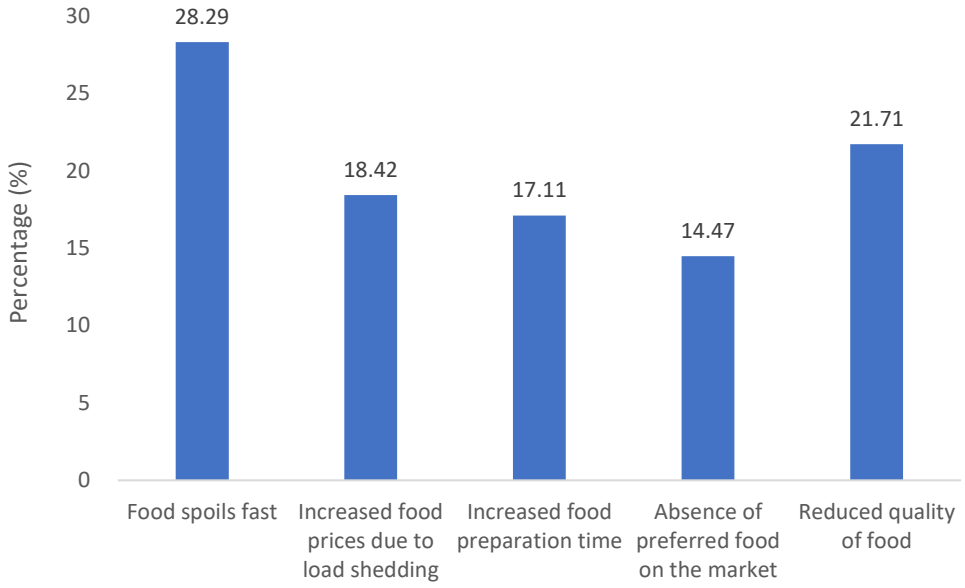

Figure 7: Impact of load shedding on households' access to food security.

The above figure represents the challenges faced by households to access clean and high-quality food from both households and the market because of load shedding. **Figure 7** shows that food spoils fast in 28.29% of households due to incessant power interruptions. **Figure 7** indicates that 21.75% of households argued that with the progressive load-shedding schedule, the retail shops are now selling food that has compromised quality and significantly reduced shelf life. In addition, **Figure 7** also shows that 14.47% of households are struggling to access their preferred food items from the market because of load shedding, meanwhile, 18.42% of households complained about the increased price of food on the market. Lastly, 17.11% of respondents are struggling to prepare meals for their families in record time due to power interruption which has messed up the routines in many households, some respondents reported that they struggle to adapt to the current electricity crisis.

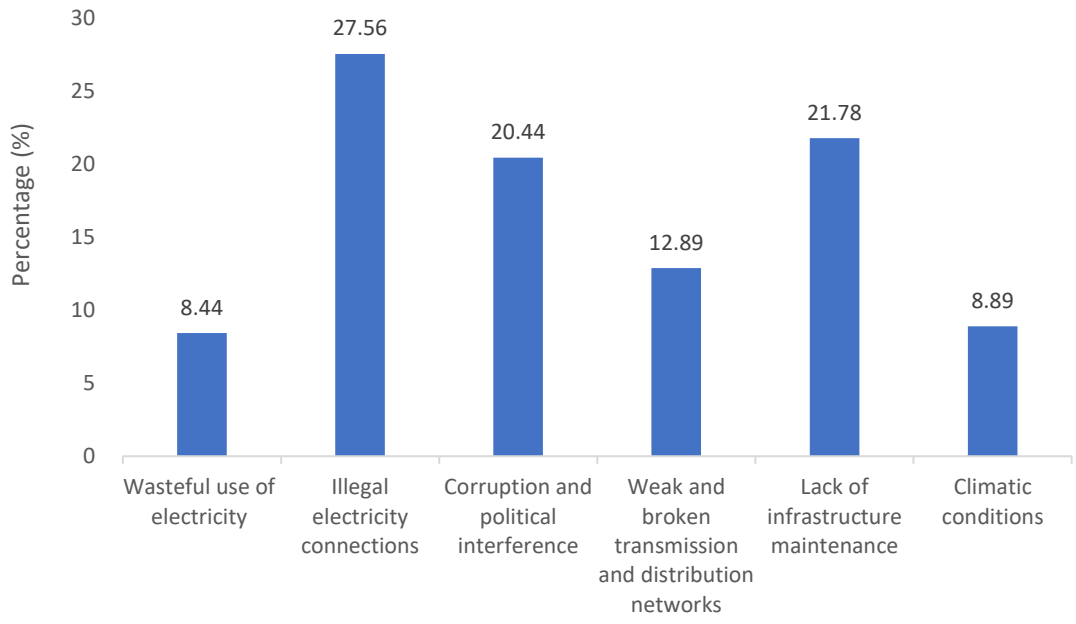

Figure 8: Household's perception of the challenges associated with unreliable electricity supply in Alexandra.

The above bar chart (see **Figure 8**) represents the respondent's perception of what might be the cause of the prolonged power load shedding in Alexandra. **Figure 8** shows that 27.56% of respondents perceived the prevalence of illegal electricity connections as a cause of load shedding and 21.78% of respondents assume that lack of electricity infrastructure and maintenance greatly contributes to load shedding. **Figure 8** also shows that only a few respondents agree that wasteful use of electricity (8.44%) and climatic conditions (8.89%) are associated with successive power disruptions.

4.1.3. The effects of load shedding on the operations of small-scale enterprises in Alexandra

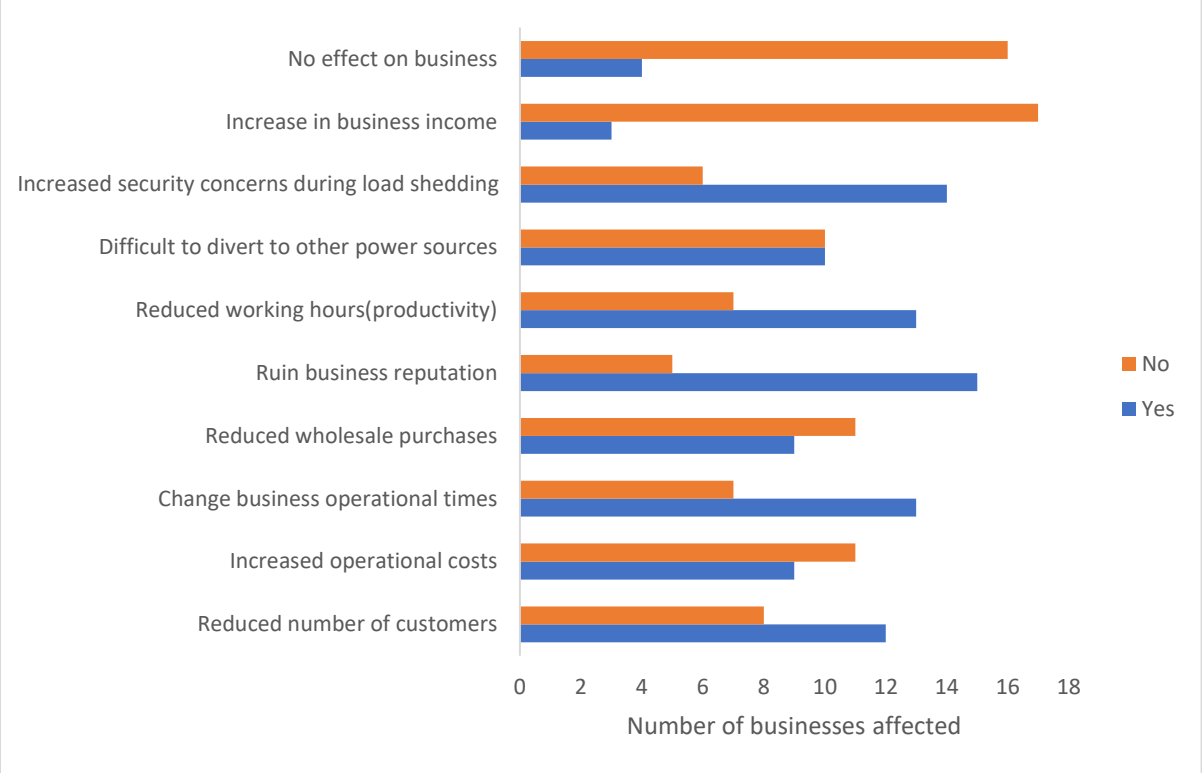

Figure 9: Impact of load shedding on small-scale enterprises in Alexandra

The above illustration **(Figure 9)** assesses the effects of load shedding on small-scale businesses in Alexandra. A total of 20 local businesses were interviewed using a questionnaire with both closed and open-ended questions. Most respondents are facing a loss in profitability which is directly proportional to the reduced number of customers, wholesale purchases as well and working hours(productivity). Many businesses are struggling to secure alternative power sources to use during periods of load shedding as a result, their businesses have become mostly vulnerable to crime, and this greatly affects the business reputation.

Table 4: Challenges faced by local businesses in Alexandra during periods of load shedding.

Type of business	Challenges faced by local businesses
Internet café	• The devices and servers are down during load shedding, and we cannot operate so we close till the electricity comes back. • Securing the new technologically advanced power sources to be used as alternatives are costly and we are currently not making much profit.
Food business e.g., Bakery, fast foods, taverns	• Dough spoils fast while waiting for power to return. • Since we have no power backup plan, we struggle with lighting in the afternoons therefore we now close earlier because of security concerns. • Diverting to alternative energy sources is difficult because of the sudden inflation in gas prices. • Customers complain about the smell of paraffin and firewood on their food, especially on the fast foods. • Female-owned businesses must pay extra money for gas delivery at the doorstep since the gas cylinder is quite heavy and requires manpower. The gas cylinder is a hazardous power alternative. • Taverns complain of warm beverages that upset their customers.
Butchery	• Food from the fridge spoils fast. • Generators and fuel are expensive, they add to the unplanned operational costs.
Clothing e.g., Tailors, clothing shops	• Cannot take bulk orders. • Takes longer to deliver orders and that reduces customer reliability in our business and ultimately ruins the business reputation. • Increased competition with fellow businesses that have alternative power sources.

	• Substituting an electronic sewing machine with an old manual one is a demanding process. The manual machine's weight necessitates tailors to transport it between their homes and workplaces. Moreover, regular servicing and the application of essential oils are required to maintain the machine's effective functionality. • Customers steal from the shops during power disruption periods since the shops are dark during load shedding and cameras are off. Also, trying to monitor walk-ins is quite difficult because it makes customers uncomfortable.
Hardware e.g., repairs	• We take limited bulk orders. • We work diligently to meet customer satisfaction, which means we must test the appliances that we are fixing several times including the time the customer comes to collection and because of power interruptions we fail to do such. Therefore, sometimes customers must come to our workshop continuously to check on their stuff and that is both frustrating and time-consuming.
Salon	• Sometimes we take customers to the nearest salon to finish their hairstyle and must pay the competitor. That increases the business's operational costs while the business already has marginalized profit. • Business reputation is ruined when customers lose patience and trust in us when we keep them waiting for long hours and sometimes turn them back with unfinished products because of prolonged load-shedding periods.

Responses from local authorities and the researcher's observations

The response from the members that are in authority in Alexandra and the electricity providers, City Power regarding the impact of load shedding was that there is a schedule that residents are urged to follow so that they can plan accordingly and prepare for the power cut. A City Power representative argued,

"We are advised by ESKOM to switch electricity for a specific area within the City of Johannesburg region to reduce the load on the strained grid and they schedule a power cut during hours that they think are conducive for communities. The schedule also assists the residents to avoid the devastating impact of power interruptions such as fire outbreaks, damage

to household/business valuables as well as to minimize the costs associated with load shedding"

(City Power, 2023).

Load shedding has caused households to shift their dependence on alternative energy sources and access to alternative electricity has increased over time (Koriala and Acharya, 2022). Load shedding has increased the use of fossil fuels which contribute to air pollution and has other environmental and health implications.

The unscheduled power interruptions are a huge concern for City Power utility because they often result from the resident's negligence with the electricity supply system and the technicians usually struggle to restore power in the households. This then leads to widespread protests from the residents demanding service delivery from the city authorities. There are frequent cases of residents connecting electricity illegally to avoid paying electricity tariffs to the local municipality. The local authorities urged that urban poor cities such as Alexandra have limited planning capacity and rapid population growth and therefore, they are obliged to adhere to the municipal regulation which also includes paying revenue for basic service provision such as water, electricity, and waste tariffs. This is important for households to pay electricity tariffs because the collected revenue is used by the municipality to fund the maintenance of electricity infrastructure and other services which are necessary for the effective running of the city. The uncontrolled urban sprawl facilitated by the increase in the number of informal free-standing residential buildings also known as stand-alone properties which do not adhere to the urban planning regulations plays a crucial role in the power supply crisis because they have implemented their unregulated methods to access electricity to their households. The informal stand-alone settlements propel electricity theft and ultimately influence electricity security (Wabukala *et al.,* 2023).

4.2. Discussion

Load shedding has significant social, economic, and environmental implications across many regions and South Africa. In Alexandra, low-income households and small-scale enterprises are particularly vulnerable to the adverse effects of load shedding. This section provides a brief assessment of the impact of load shedding in Alexandra.

Power interruptions in Alexandra were observed to have wide-ranging effects on the safety and security of households and business establishments, damage to household appliances, disruption of access to social services, influence on food availability and security, and a reduction in household income, among various other consequences. The most common impacts highlighted in this research encompassed food spoilage, residential break-ins, harm to business equipment such as refrigerators and stoves, interruptions in communication services, disruptions to educational activities, and increased household expenditure on alternative energy sources. Similar concerns related to power supply interruptions in residential settings were also identified in other countries such as Ethiopia, Ghana, Zambia, and Nigeria (Amadi, 2015; Umar *et al.,* 2019; Meles, 2020; and Nduhuura *et al.,* 2021).

Power outages directly affect households financially, dictating their income and expenditure rate (see **Figure 6**). However, measuring the economic worth of intangible, non-material advantages of electricity at home, such as well-being, leisure, comfort, and general social welfare, is challenging and subjective because the actual economic value of these intangible benefits is not well-established (Nduhuura *et al.,* 2021). Access to electricity, which leads to increased opportunities for home-based production and job creation, can diminish when the electricity supply is unreliable (Williams *et al.,* 2020). Moreover, households may have to spend significantly on measures to cope with or adapt to power outages, like purchasing backup electricity systems, and

this expense can surpass their regular electricity costs (Oluwasuji *et al.,* 2020). This, in turn, can have a detrimental effect on the overall economic situation of the household (Musademba *et al.,* 2012). Power outages not only disrupt economic activities and business operations but also result in increased costs for households and impact the overall cost of living (Booysen *et al.,* 2023, Cloete *et al.,* 2023). Both industries and households have come to accept prolonged periods without electricity as commonplace. Many households have endured living without power and have witnessed damage to their electrical appliances because of load shedding (Mabunda *et al.,* 2023). Failing to address this electricity crisis could lead South Africa into a decline, potentially jeopardizing its status as a food-secure nation in Africa (Masinga and Madzivhandla, 2023; Bhorat, 2024).

The study found a strong association between frequent exposure to power outages and socio-economic hardship, and the likelihood of reporting attempts of robbery or assaults because of the prolonged electricity outages in households (Amadi, 2015; Williams *et al.,* 2020). The discovery that individuals with lower socio-economic status are less likely to report safety concerns, such as assault or burglary, as outcomes of power outages, can be explained by two main factors. Firstly, socio-economically disadvantaged individuals may tend to reside in neighborhoods characterized by worsened socioeconomic challenges. According to social disorganization theory, these areas often have a high prevalence of crime. As a result, they may not necessarily associate uninterrupted electricity with an enhancement of personal or household safety. Secondly, because they live in places with a heightened risk of criminal activities, socio-economically disadvantaged individuals may have already developed coping mechanisms to address potential threats to their safety (Inglesi-Lotz, 2011; Musango, 2014). While South Africa already contends with a high crime rate, prolonged load shedding has exacerbated this issue, leading to heightened levels of fear among the

populace who are forced to live in a state of constant apprehension (Erero, 2023). Households with lower socio-economic status, residing in impoverished urban communities, might depend on community-based protection forums within their neighborhoods to safeguard their property during periods of electricity outages (Chidembo *et al.,* 2022). The results of the current study are consistent with the findings of a study conducted by Nduhuura *et al.,* (2021), where they discovered that in Ghana, there was a significant rise in public apprehension regarding the heightened risks of physical violence, residential burglaries, and theft that coincided with the recent electricity supply crisis.

Disrupted access to electricity not only impacts households but also undermines the efficient delivery of crucial social services to communities (see **Figure 5**). Essential infrastructures, including water supply systems, healthcare facilities, educational institutions, and telecommunication networks, heavily rely on a stable and dependable electricity supply to function at their best and provide necessary services to the public (Gehringer *et al.,* 2018). Instances of power outages have been observed to impede the provision and accessibility of high-quality healthcare services in many developing countries (Nduhuura *et al.,* 20121). There have been limited research studies examining the influence of electricity on the accessibility and provision of healthcare services. For instance, a study conducted in Ghana discovered that the likelihood of mortality rate surged by 43% on days when healthcare facilities endured power outages lasting two or more hours (Koroglu *et al.,* 2019).

Nonetheless, it remains uncertain whether these findings can be broadly applied to different situations or regions. Healthcare establishments facing electricity disruptions may deliver substandard services, such as insufficient lighting or the inability to operate specific medical devices (Gehringer *et al.,* 2018). Additionally, they may struggle to admit new patients, thereby

increasing the likelihood of women being denied access to healthcare (Koroglu *et al.,* 2019). Concerning the current study, respondents reported that they have been turned away from the clinics and hospitals whenever there is a power disturbance due to a lack of electricity alternatives in the public health facilities.

Access to electricity is also closely linked to effective educational performance, leading to a reduction in illiteracy rates and an increase in academic validation which is an important aspect in modern societies. When households have electricity access, a greater number of pupils actively engage in academic pursuits, such as enrolling in and attending school, utilizing advanced educational devices, and engaging in personal study at home-based activities (Umar *et al.,* 2019). However, if the electricity provision is inconsistent, it can undermine the learning environment by restricting learning opportunities. As a result, this compromises the provision of high-quality education and impacts the motivation and academic achievements of students (Kaygusuz, 2011).

Prolonged power outages can also disturb the provision of water to residences as all components of a contemporary water supply system, including extraction, treatment, transmission, and distribution, rely on electricity (Ateba and Prinsloo, 2019). In densely populated areas such as Alexandra, particularly in many developing urban areas, the loss of water supply can have detrimental effects on public health, leading to an increased risk of disease outbreaks such as cholera. Very often water distribution systems managed by utility companies depend on electricity for the treatment, pumping, and distribution of water across extensive geographical regions (Umar *et al.,* 2019). Consequently, these systems are vulnerable to interruptions during prolonged power outages. Since individuals with lower socio-economic status often have restricted access to piped water, they may be somewhat restricted from the water supply disruptions that could result from power outages (Kaygusuz, 2011; Nel *et al.,* 2016).

Furthermore, interruptions in electricity supply also disrupt communication and leisure activities, such as watching television or attending pubs, thereby complicating access to information and home-based recreational opportunities (Umar *et al.,* 2022). Recurrent power disruptions are also reported to cause direct harm to household electrical devices such as heating, cooling, lighting appliances, gadgets, and various other appliances (Akpeji *et al.,* 2020). The lack of a reliable electricity supply also renders electrical appliances ineffective and incapable of serving their intended functions as desired by the end-users (Ateba and Prinsloo, 2019).

One significant challenge posed by load shedding for emerging businesses is the disruption of network connection services. The study discovered that 27.14% of households struggle with network connectivity which is essential for communication, business operation as well as learning among other things. Given the widespread reliance on the Internet across various industries, including those operating entirely online, the loss of network connectivity can force businesses to halt operations for several hours or more (Mabunda *et al.,* 2023; Wentik, 2023). This issue has become increasingly critical with the growing trend of remote work, as individuals working from home may encounter power outages even if certain offices and commercial areas have electricity during load shedding (Mutambo *et al.,* 2023). Additionally, during load shedding, many ATMs become inoperative, and credit card machines frequently fail to function, posing significant obstacles for small businesses that rely on these payment methods. Load shedding also impacts cellular networks in South Africa, leading to the loss of cell phone signals (Oluwasuji *et al.,* 2020). This disruption can have severe implications for young enterprises, as many businesses heavily rely on cell phones for daily operations, potentially resulting in communication breakdowns or the inability to conduct business during load-shedding periods (Mabunda *et al.,* 2023).

Due to the inconsistent condition of public electricity supply in South Africa, numerous major enterprises and affluent individuals have resorted to obtaining and relying predominantly on private electricity generators to sustain their operations and lifestyles (see **Table 3**). This shift has substantially inflated business operational expenses, and production costs of goods and services, and ultimately raised the prices for consumers to access essential commodities and services (Wabakula *et al.,* 2023). The most significantly affected are the underprivileged residents and small-scale businesses that can rarely afford their electricity supply (Umar *et al.,* 2019). South African cities particularly the peri-urban areas such as Alexandra are deeply affected by deficiencies in power generation, transmission, and distribution, resulting in a significant deficit in energy provision (Nkosi and Dikgang, 2018; Tanaka *et al.,* 2022). Because of this substantial electrical energy shortfall, the city grapples with recurrent power interruptions, compelling numerous industries, and businesses to invest in and utilize their private generators to meet their essential electricity supply requirements without disruption (Ateba and Prinsloo, 2019; Todd and McCauley, 2021). As mentioned earlier, the concept of load shedding is closely intertwined with the complex challenges within the electricity sector, such as the ongoing private investments in electricity infrastructure (Wentik, 2023). The municipality then considered using revenue from commercial industries and wealthy consumers to cross-subsidize for the poor. Does this promote equity? Well, this model can be criticized as unstable and most likely to perverse incentives for municipalities to increase tariffs. Another critique of this model is that it would encourage high consumers which are the poor communities to keep consuming electricity without care. However, the positive review is that at least everyone would have access to reliable electricity supply and other basic services as promoted by the sustainable development goals.

Currently, several businesses, particularly small-scale enterprises, have shut down, and many others are on the brink of closure, while social activities have diminished compared to the past (refer to **Table 4**). Consequently, it is imperative to take immediate proactive measures to prevent an imminent critical energy shortage among business operators and to avert the potential collapse of social life in this rapidly expanding city of South Africa (Meles, 2020). Economic and social functions in the region are increasingly reliant on electricity, with no indication that the potential repercussions of power outages on industries will diminish in the foreseeable future (Smit *et al.,* 2019). The presence of feeble and deteriorating transmission and distribution networks is one of the primary reasons for the recurrent power disruptions in South Africa, particularly around Alexandra. Contemporary power systems are functioning near their maximum capacity limits, prompted by rising energy consumption, industrial expansion, and various environmental and economic factors (Musademba *et al.,* 2012). This circumstance has made the establishment of new transmission lines and power plants considerably challenging. Consequently, a significant portion of the networks have become fragile, burdened by heavy loads, and susceptible to voltage instability. Certain segments also remain antiquated and require upgrades to meet current energy demands (Amadi, 2015).

The results of the current study were consistent with the study conducted by (Amadi, 2015), which indicated that household power outages in Nigeria contribute to a range of significant challenges, including unemployment, inflation, food wastage, increased crime rates, heightened household inconveniences, reduced leisure time, augmented spending on alternative fuels, added responsibilities, particularly for women and children, and avoidable fatalities linked to the inhalation of fumes from biomass and private electricity generators.

The respondents perceived the cause of load shedding in South Africa, mostly as the consequence of illegal electricity connections (electricity theft), lack of infrastructure maintenance as well as corruption and political interference in the country (see **Figure 8**). In Alexandra, the primary reasons behind frequent power outages stem from the presence of weak and deteriorating power networks. Currently, Eskom power systems operate near their stability thresholds due to rising demands for electricity, industrial growth, as well as environmental and economic considerations (Kambule *et al.,* 2019). (Schmidthaler and Reichl, 2016). These factors collectively pose challenges for the establishment of new transmission lines and power generation stations (Mabunda, 2021). As a result, multiple power distribution networks have weakened, carrying heavy loads, and becoming susceptible to voltage instability (Amadi, 2015). Neilson, (2017), highlighted that as electrical infrastructure in developed countries ages and many regions in developing countries frequently face inconsistent electricity supplies, the broader socio-political significance of blackouts warrants increased interdisciplinary focus. Load shedding has become ingrained in the everyday language of South Africans, symbolizing the economic, social, and political instability resulting from infrastructure shortcomings (Neilson, 2017). As climate change and heightened geopolitical tensions persist, challenges with global and local energy infrastructure and supply chains are expected to intensify. Hence, South Africa's energy crisis serves as an indicator of what may become more prevalent in other regions (Baker and Phillips, 2019; Bhorat, 2024).

This research suggests that various spatial processes, including socioeconomic, political, demographic, and other factors, influenced the distribution of load-shedding outages in the area under study. As a result, the findings can only be understood within the specific context of the study area and may not necessarily reflect the experiences throughout the entire city of

Johannesburg. A comprehensive analysis of load-shedding experiences across all neighborhoods in Johannesburg could provide a more complete understanding of city-wide experiences.

Chapter 5:

Conclusion and Recommendations

5.1. Conclusion

It is imperative to note that this study focused specifically on the impact of load shedding on households and small business establishments in Alexandra which is located within the city of Johannesburg in Gauteng. The research used mixed-methods techniques to gather insights from households, small-scale enterprises, and relevant respondents in city authorities. Due to financial, transportation, and time limitations, the study included only 124 participants. As a result, the findings cannot be generalized to all municipalities in South Africa regarding households and small business development. However, these findings may apply to similar economic environments and load-shedding challenges in other municipalities, contributing to the effectiveness of addressing this issue.

The ongoing energy crisis is not caused by environmental or external factors beyond Eskom and the state's control; it is entirely self-inflicted. Corruption, looting, and fraudulent activities have played a significant role in Eskom's deterioration (Wentink, 2023). Load shedding has expanded the scope of energy poverty to incorporate urban areas. This practice effectively deprives people in cities of reliable and high-quality energy services (Smit *et al.,* 2019). Urban residents are left with limited, cost-effective options for alternative energy sources. The shortage of sufficient power supply has significantly hindered the economic and social progress of the population of Alexandra. An examination of energy consumption patterns has uncovered disparities in energy costs between residents in low-density and high-density areas (Nel *et al.,* 2016).

Individuals with fewer financial resources often find themselves paying a higher cost or investing more time to access energy services in comparison to those in more favorable economic situations (Koirala and Acharya, 2022). This has profound implications for the well-being of households and businesses. The economic challenges experienced by impoverished households are frequently overlooked when assessing their income based on the capacity to acquire a standard array of goods and services, as is commonly done for households with average income or consumption expenditures (Bohlmann and Inglesi-Lotz, 2021). The notion of neglecting the impoverished fails to acknowledge that despite their limited contributions, they remain significant participants in various aspects of society. This narrative presents a potential risk and vulnerability, which could escalate to the extent that these individuals cease to contribute entirely if they are not granted priority access to essential services like electricity (Masinga and Madzivhandla, 2023). When a substantial portion of their income is allocated to acquiring alternative energy sources and fuels, it signifies that the utility company's strategy in handling load shedding is contributing to the deepening of the poverty cycle. This research also offers preliminary empirical data in South Africa regarding the influence of power interruptions on households' precautionary spending, which includes costs associated with alternative energy sources (Muhihi and Paschal, 2022). Dependence on traditional fuels such as charcoal, firewood, gas, and paraffin as substitutes during power outages implies that unreliable electricity supply may be linked to indoor air pollution, deforestation, and global warming (Ateba and Prinsloo, 2019; Meles, 2020). Additionally, this situation could complicate the progress of energy transition efforts which is the future for many developing countries including South Africa (Li *et al.,* 2023). The hurdles created by substantial load shedding that ultimately influence households' well-being and business operations stem from

the country's socioeconomic disparities, racial inequalities, and its strong reliance on coal-based electricity generation (Baker and Phillips, 2019).

5.2. Recommendations

The study advocates for collaborative efforts involving the government, Eskom, and electricity consumers to address the challenges that contribute to the ongoing electricity crisis. These challenges encompass issues such as aging infrastructure, governance concerns, and financial constraints. By addressing these challenges collectively, there is a potential to pave the way for a more sustainable and inclusive power system that aligns with the country's developmental objectives. The current state of the electrical energy crisis in South Africa is greatly inflicted by socio-economic inequalities which deepens the social injustice for the poor. To tackle the situation, it is important to note that households in poor urban regions cannot afford alternative power supply. Therefore, the government can offer backup power to businesses enterprises that cannot afford generators and solar panels, and, alternatively, households that have residents with special health conditions so that no one is marginalized. Looking at how access to alternative energy sources has increased over time, should reflect on the justice implications of electricity distribution because of private power investments. The government should accelerate the implementation of the use of renewable energy and enforce justice principles in energy policies.

Additional research is imperative to explore the adoption of cost-effective and health-conscious alternative energy sources tailored for economically disadvantaged communities in South Africa. This research could pave the way for sustainable and accessible energy solutions that not only address the pressing needs of these communities but also contribute to overall social and economic development. By identifying and implementing such alternatives, there is an opportunity to alleviate the electricity supply challenges faced by vulnerable populations while promoting environmental sustainability and public health.

The limited access to modern energy in South Africa is detrimentally impacting the continent's development objectives and its capacity to enhance climate resilience. Addressing the issue of load shedding and preventing its cascading impacts necessitates collaboration among businesses, industries, and the government. The local government must establish a conducive environment, including a robust regulatory framework, incentives for investing in renewable energy, and access to affordable capital (Cloete *et al.,* 2023).

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