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The impact of electrical energy theft on revenue collection at Eskom in KwaZulu-Natal Province.

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A dissertation submitted in fulfillment of the requirements for the degree of Master of Business Administration

Graduate School of Business and Leadership

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DECLARATION

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DEDICATION

I dedicate the dissertation to my family, my husband Toro, and our two children Tlotlo and Moeketsi.

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ABSTRACT

South Africa's state-owned company, Eskom has been experiencing a decline in revenue and an increase in non-technical energy losses(NTL). Research has shown that most utilities including those from first-world countries are struggling with non-technical energy losses and have employed advanced technological solutions which are aimed at reducing losses . In this study, the researcher investigates the motives behind energy theft from Eskom KwaZulu-Natal Operating Unit electricity consumers and recommends solutions to eradicate or reduce the NTL . Increase revenue collection by reducing customers that engage in energy theft activities in Eskom KwaZulu-Natal Operating Unit. In the context of this study the perception that electricity is a right, refers to the phenomenon that all energy consumers must be supplied with exceptional power quality, irrespective of whether they are from affluent or less affluent communities. Non-probability sampling technique was employed to select 60 participants that are directly supplied by Eskom or are Eskom employees based in KwaZulu-Natal. A quantitative research approach was used to investigate the probable cause of increasing non-technical energy losses, and an online survey questionnaire was distributed to the potential participants. The results were divided into three sections section A, section B, and section C. The results were analyzed utilizing the Chi-square test. The results suggest that the increase in non-technical energy losses is attributed to consumers having easy access to the Eskom infrastructure. Most socio-economic groups find electricity tariffs unaffordable and consequently decreasing Eskom's ability to collect revenue. The result of this study ensuing past research has proven that technological solutions applied in isolation will not address the increasing non-technical losses in utilities. The increase in NTL experienced by Eskom affects the larger masses of South Africa as energy access has a direct correlation to GDP growth and the livelihoods of households. A collaborative approach is needed between Eskom and the government to address the rising pressures induced by NTL, the use of theoretical knowledge in new technologies, reviewing tariff structures, new policies to help reduce energy theft, and joint partnerships between Eskom and the community leaders and strengthening law enforcement.

Keywords: Eskom, electricity services, non-technical losses,

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LIST ACRONYMS

COVID-19	SARS-CoV-2 Corona Virus
DME	Department of Minerals and Energy
DOE	Department of Energy
ECT	Expectation Confirmation Theory
EEDSM	Energy Efficiency Demand Side Management
FBE	Free Basic Electricity
GDP	Gross Domestic Product
IBT	Inclined Block Tariff
KZN	Kwa-Zulu Natal
NERSA	National Energy Regulator of South Africa
NTL	Non-Technical Losses
OU	Operating Unit
SA	South Africa
UKZN	University of Kwa-Zulu Natal
USA	United State of America
ZSC	Zero Sequence Current

CHAPTER 1- INTRODUCTION

Eskom Distribution has experienced a decline in revenue and increased Non-Technical Energy Losses (NTL) (Bowman, 2020:398). Non-technical losses are losses experienced in an electrical distribution system due to either defective hardware in the electrical system, inefficiencies in business processes, or energy theft (Jenkins and Pe´rez-Arriaga, 2017:64). Energy theft remains a constant risk in power utilities and requires that utilities formulate strategic solutions to manage and reduce energy theft (Mahani, Nazem, Jamali and Jafari, 2020:30). Energy theft not only deteriorates the life span of assets but also imposes revenue reduction on utilities (Dagnachew, de Boer, Gernaat and van Vuuren, 2017:185).

NTL poses an immense problem for power utilities, and South African utilities are no exception to this challenge (Baker and Phillips, 2019:176). A reduction in NTL will mean that utilities can collect revenue for most of the electrical energy distributed to the end-user, and the deterioration of the line hardware infrastructure be minimized (Dzansi, Puller, and Yebuah-Dwamena, 2018:5).

Jack and Smith (2017) conducted a study in Eskom Distribution they discovered that Eskom largest installed meter type was electromechanical meters installed in customers' homes. These meters are susceptible to tampering, have high failure rates, and do not have any remote access tamper detection functionalities. The maintenance of line hardware can enable utilities to manage the failure rate of the infrastructure (Jack and Smith, 2017:19).

The study focuses on investigating the motives behind the increasing NTL energy losses in Eskom Kwa-Zulu Natal Operating Unit (KZNOU). In concluding the investigation, the researcher aims to recommend strategies to reduce the losses in Eskom KZNOU. The research project examined the existing adopted strategies and validated their effectiveness in reducing NTL. Addressing NTL losses in Eskom Kwa-Zulu Natal Operating Unit would improve the quality of the supply rendered to customers, and they would have minimal supply interruptions induced by NTL. Customer confidence would be significantly increased and result in higher revenue collection.

Revenue collection has been a big focus area for the Power Utility Eskom, and the utility had projected a net R26.2 billion loss for 2020/21 (White, 2020:4). The utility company needs a significant financial boost to remain sustainable, and addressing NTL is a good starting point to address the financial constraints. The resultant net effect of reduced NTL is that revenue collection will be increased, thus making Eskom more financially viable for potential investors (Bowman, 2020:404).

1.1 Background of the study

Eskom has experienced a significant reduction in revenue collection and a drastic increase in NTL over the last decade. As a result, revenue collection has been a big focus area for the utility company. And yet, Eskom had already projected a net R26.2 billion loss for 2020/21 (White, 2020:3). One of the biggest contributors to this loss in revenue is NTL. Therefore, the utility company needs a significant financial boost to remain sustainable, and addressing NTL is a good starting point to address the financial constraints. The resultant net effect of reduced NTL is that revenue collection will be increased, thus making Eskom more financially viable for potential investors (Bowman, 2020:404). Factors contributing to NTL include energy theft, no-payment payment for services rendered, and malfunctioning of the line hardware in a distribution network (Bowman, 2020:427).

A large customer base in Eskom still has electromechanical meters installed in their households. Electromechanical meters are installed in their homes, where energy is paid after consumption, which is also deemed post-paid. These post-paid meters are read manually on three months cycles. Another more significant portion of customers is electrified via prepaid meters, where consumers purchase the energy token units upfront for consumption (Jack and Smith, 2017:19). Both the electromechanical and prepaid meters are installed at consumers' homes and are easily accessible to the consumers. After three months, the customer's electricity consumption is physically validated in post-paid meters. The physical validation is on three-month intervals due to resource constraints, and thus the utility cannot meet the total customer base every month (Jacome and Ray, 2018:250).

1.2 Purpose of Study

The research objective is to find motives behind energy theft from Eskom Kwa-Zulu Natal Operating Unit electricity consumers. Investigation into factors contributing to the increase of NTL will assist the power utility in formulating mitigation plans to increase revenue collection and thus decreasing striving to decrease SA's fiscal deficit (Anh, Duc, Hung, On, Tien and Vu, 2021:45). In understanding the reasons behind energy theft, the utility can explore innovative solutions to reduce or eliminate NTL on power distribution networks. Increase revenue collection by reducing customers that engage in energy theft activities in the Kwa-Zulu Natal Operating Unit.

1.3 Scope of the study

Research and recent literature have proven that socio-economic factors affect revenue collection in utilities and are discussed in the literature review chapter in greater detail. The study aimed to address the gaps in the literature for NTL in developing countries.

This research was cross-sectional and has covered the investigation into the reasons behind the increasing NTL in developing countries. The research aims to understand the rationale behind energy theft and recommend methods to mitigate energy theft. The study uses key informants to provide an in-depth understanding of the problem. Additionally, the research uses secondary research to support the collective narrative and contextualize the results reported.

1.4 Research objectives

a. To identify the critical reasons for electrical energy theft in Eskom.
b. To identify electrification process gaps and suggest methods to improve identified gaps.
c. To recommend strategies that will improve revenue collection.

1.5 Research questions

a. What are the causes of electrical energy theft in Eskom?
b. What are the electrification gaps in Eskom and how can they be improved?
c. What can be done to improve revenue collection at Eskom?

1.6 Significance of the study

There has been a drastic increase in energy theft, resulting in poor network performance. Over the years, more and more South Africans have resorted to energy theft, which has put the highly financially indebted utility Eskom into further distress (Baker and Philiphs 2019:180).

There is scarce research about NTL losses in non-developed countries with installed classic(old) meter technologies (Alshammari, Hamadneh, Jumani, Khalid, Khan, Saeed and Sheikh, 2020:219). This research has bridged the knowledge gap identified by the literature. Additionally, the study contributes to scientific research in that the chosen geographical area was South Africa a country that is still underdeveloped. Moreover, Eskom Holding, municipalities, and educational institutions will benefit from this study as there has not been any recent research investigating the probable cause for energy theft in third-world countries.

The power utility requires innovative solutions to reduce the NTL and improve revenue collections. Eskom employees will also benefit from this research to better equip the utility to invest in innovative technology solutions or improve existing processes for customer service delivery. The power utility needs innovative solutions to reduce the NTL and improve revenue collections. Eskom customers will also benefit from improved service delivery and the overall improved quality of electrical energy supplied.

Eskom's financial performance has affected the SA, the country's credit ratings have been reduced and the SA sovereign debt has increased in the last decade. Eskom like other state-owned enterprises has been relying on government bailouts to stay in business. In the 2021/22 financial year, Eskom KZNOU attained a net deficit of R 2 billion in their financial statements. The net loss was attributed to declining revenue collection and increasing municipality debt levels. Addressing the revenue deficit will enable the government to redirect the government bailout it has been funding to the state-owned enterprise to other socio-economic projects that require funding (Baker and Phillips, 2019:180).

1.7 Overview of methodology

The selected research study area was Eskom in KZNOU. The target population was 110 which consisted of zero buyers greater than 12 months and Eskom employees employed in KZNOU. The convenience sampling technique was employed to select 60participants to represent the target population from Eskom KZN customers and employees.

The methodology utilized in the study was a quantitative research method approach to explore the problem statement. The researcher used quantitative data to gather the psychological constructs of the participants (Taherdoost, 2019:7).

In the study, the NTL was the dependent variable objective of the research, the function of this variable was to understand the changeability that causes the variability of the research. The research study has three independent variables, which can influence the variability of the NTL. The first identified independent variable is electrification projects, which can positively or negatively impact the NTLs in distribution.

The second identified independent variable is access to Eskom metering infrastructure, NTL can be increased when customers have access to tamper with the Eskom infrastructure. Socio-economic inclusive tariffs are also another independent variable that can adversely impact the revenue collection and then result in increasing NTLs.

The researcher fielded an online survey questionnaire which consisted of closed-ended questions and two open-ended questions.

The research instrument employed to collect data was an online survey questionnaire. The researcher opted to employ this instrument as it is cost-effective, to limit themselves to the exposure of contracting COVID-19, and the online survey questionnaire offered the researcher the convenience to collect the data with ease to meet the time frames specified by UKZN to complete the research study. Interviews were not the selected tool to collect research data as this tool has high running costs when compared to the survey questionnaire and responses require to be transcribed which is time-consuming (Afolayan and Oniyinde, 2019:52).

Two open-ended questions were employed to get an in-depth view from the participants on how to address the research problem.

Data analysis was performed using SPSS and Excel to analyze and interpret the collected data

1.8 Limitation of the study

The limitation of this study was that it is only limited to Eskom employees from KZN and consumers that have their electricity directly supplied by Eskom in KZN. Electricity consumers supplied electricity by municipalities were excluded from participating in the research. The time frame constraints set out by the university limited the researcher from doing longitudinal research.

Eskom KZN has over 1 million customers and just over 4000 employees, therefore the researcher had to select a small sample size to represent the population.

The time frame to submit the dissertation posed a limitation to the study as there was a slow willingness to participate in the survey from the Eskom customers, and therefore attaining the required number of participants for the survey posed a challenge for the researcher.

Coronavirus, formally known as COVID-19, has impacted and shaped the landscape of human interaction. COVID-19 has imposed new socially accepted norms and behaviors (Wu, Ye, and Zhou, 2020:2).

The government introduced regulations and legislation to limit the spread of the virus (Ramaphosa, 2020). The researcher had to adjust to the new normal by adapting and finding innovative methods to collect the data from the participants.

1.9 Dissertation outline

The Dissertation paper comprises five chapters.

Chapter 1 introduced the research study by highlighting the study's background information, the purpose, the research objectives, and its significance.

Chapter 2 examined the existing literature on NTL concerning revenue collection in power utilities. The discussion refers to the aspects and theories, models, and legal frameworks underpinning revenue collection in electricity distribution, the correlation between non-payment and expenditure ratios, and customer satisfaction.

Chapter 3 outlined the research methodology, which includes: the research design, the research method, the target population, sampling, data collection, data analysis, ethical considerations, and the limitations of the study.

Chapter 4 reported on the presentation and analysis of the research findings.

Chapter 5 summarizes the main research findings and recommendations and emphasizes areas for additional research.

1.10 Summary

This chapter introduces the research study by highlighting the study's background information, purpose, research objectives, and significance.

CHAPTER 2- THEORY AND RESEARCH REVIEW/THEORETICAL BACKGROUND

2.1 Introduction

Studies have shown that the electrical energy sector has experienced numerous problems worldwide; the most common problem has been electrical energy losses. These electrical energy losses are classified into two categories: technical and non-technical energy losses (NTL). Technical losses occur due to energy dissipation during the generation, transmission, and distribution process in electrical systems. Non-technical losses are losses resulting from energy theft, faulty measuring devices, and human error in reading measurements in meters (Alshammari, Hamadneh, Jumani, Khalid, Khan, Saeed, and Sheikh, 2020:216).

Studies have shown that highly industrialized countries with advanced technological infrastructure, are not as highly impacted by NTL, this is because the utilities can monitor and apply advanced analytics to manage their infrastructure. The advanced analytics and built intelligence also enable the utilities to limit their customers from accessing their infrastructure illegally (Alshammari et al., 2020:215).

Scott(2015) conducted a study, where it was identified that 40 % of the NTL experienced by the power utility Eskom was due to energy theft from businesses (Nhamo, Nhemachena. Mjimba, and Savić, 2020:123).

Figure 2-1 below is a graphical representation of Eskom KZNOU Technical and Non-Technical losses. The graph below shows NTL averages 75% from February 2020 to November 2021, and the TL average 25% for the same period. In the winter months, NTL averages at 77%, which is an indication that the electricity grid is under constrain during these months.

Non-technical losses in SA are extremely high and could further cause detrimental effects to the Eskom infrastructure. The effects on infrastructure could place SA in a compromised position as Eskom's quality of supply would affect the larger masses of the SA economy. The majority of SA's industrial sector depends on receiving supply from Eskom, supply reliability is crucial for business operations to function optimally.

Compromised quality of supply could negatively impact the SA's Gross Domestic Product (GDP) resulting in a contraction of GDP and job losses. SA's socio-economic status will be greatly impacted as a larger population of SA will be relying on government grants. Eskom KZNOU needs to investigate probable solutions to decrease the NTL losses detrimental to the utility infrastructure and quality of supply.

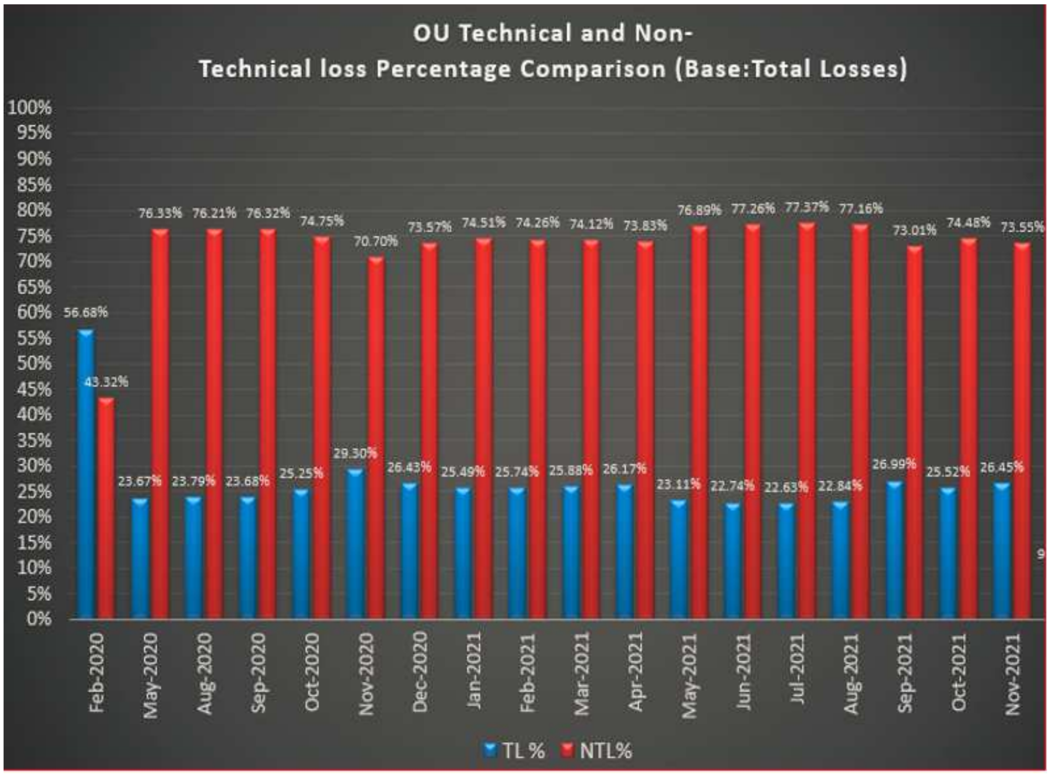

Figure 2- 1 Graphical presentation of Kwa-Zulu Natal Operating Operating Unit Technical and Non-Technical Losses

Source (Eskom , 2021)

2.2 Universal access to electricity in South Africa

More than half of Africa's population does not have access to electricity. Two in every three people have no access to electricity in Sub-Saharan Africa. Sub-Saharan Africa has a total generating capacity of 90GW, the same installed capacity as the United Kingdom, which has less than 7% of the population size of Sub-Saharan. The electricity utilities in Africa have adequate energy resources, but even with adequate resources, the generated energy capacity is insufficient to meet the energy demand (Burgess, Greenstone, Rynan, and Sudarshan, 2019:146).

Eskom has a total installed generation capacity of 51.7GW with an approximate population size of 60 million people. In the 1990s, projections were made that 80% of SA’s households would be electrified by 2012, in 2004 President Thabo Mbeki committed that each household in SA would have access to electricity. However, the rate of this commitment has not been accomplished. The number of new developments and projects such as the Reconstruction and

Development Plan (RDP) increased the number of households in SA. The obligation to electrify all households is unattainable with the increasing basic cost per connection charge.

The Department of Minerals and Energy (DME) had estimated that the basic connection cost would be at R6500 in 2013, which excluded the bulk infrastructure costs such as upgrading of the line hardware however, Eskom estimated that the nominal costs would be around R10 000 per connection in 2013. The cost of electrification would not only increase SA's fiscal expenditure but further, decrease SA's GDP (Scharfetter and Van Dijk, 2017:17).

The Sub-Saharan electricity infrastructure has aged and has high generating costs with low efficiency (Baker and Phillips, 2019:180). Most of the Eskom power stations were built in the 1970 and late 1980 and thus the infrastructure has decayed over the years. Due to rapid economic growth and technological change, Eskom decided to build two additional power stations Kusile and Medupi to increase generating capacity for the utility. The building of these two power stations has increased the Eskom debt level drastically, the debt level is currently sitting at R500billion. Eskom is required to achieve an R20 billion saving per annum to assist the utility financially. The Eskom income levels do not meet the organizational operational needs (De Vos, 2019:2). Eskom needs to expand the grid to be to increase generating capacity. Smaller and remote communities will be provided electricity through off-the-grid electrification systems and standalone systems to attain access to electricity (De Fatima, Arthur and Cockerill, 2019:107).

Through Sustainable Development Goals (SDGs) and The National Development Plan (NDP), the global community has envisaged that by 2030, all South Africans will have access to electricity and Eskom will supply energy at affordable and competitive rates. Eskom will provide improved quality of supply for SA consumers and efficient power for businesses with reduced carbon emissions. Eskom has an installed generation capacity of 58095 Mega Watts (MW); 80% of this installed capacity is from fossil-fueled plants that have aged and will be decommissioned within the next 10 to 30 years. SA's generation capacity has declined yearly, and the energy consumption need has increased by 0.1 % in September 2021compared to September 2020 (Statistics South Africa 2021). Eskom's generating capacity is supplied by 2.7 GW pump storage, 1.7 GW from hydro, 1.8 GW from nuclear, 3.7 GW from renewable energy, 3.8 GW from diesel, and the largest installed capacity with 38 GW from coal. The generated power is transmitted at high voltages through transmission lines and converted to usable energy for distribution to the end-users (Nhamo et al., 2020:34, De Fatima et al., 2019:107, Department of Energy South Africa, 2020).

In 2003 the Department of Minerals and Energy (DME)took over the responsibility of the electrification data from the National Energy Regulator. DME identified significant data discrepancies in the annual connections data during this period. DME needed to adjust its strategy to cater to growth. After 2003, most DME reports omitted the cost per connection total capital expenditure on electrification.

Clarity was needed on the reallocations towards bulk infra-structure on the total spending. Illegal connections and disconnections contributed to the data discrepancies. DME needs to consider SA projected household growth when strategizing and budgeting for electrification targets. In 2004 the South African president had predicted that by 2012 universal access to electricity would be reached. The government meant that the annual electrification budgets needed to be adjusted to cater to this growth. However, in 2005 the electrification budgets were drastically cut. For 2019/20, the DME intended to electrify 195 000 households in the National Electrification Plan. DME over exceeded the target by the electrification of 19 517 additional households (Department of Energy South Africa, 2020).

The electrification rate is paltry in many Sub-Saharan African countries due to the high connection charges, thus making it difficult for universal access to electricity to be achieved. Strategies to address electricity access and lower connection charges need to be formulated. Methods such as loans, subsidizing the connections, and spreading the payments over a period can lower connection costs. However Blimpo and Stein (2018:13) argue that utilities cannot recover the cost of servicing the rural areas through cost recovery tariffs, this is due to the socio-economic status of communities living in rural areas their first need is to provide food for their families; therefore the progression to improve the quality of life in low-income households is gradually very slow (Blimpo and Stein, 2018:13). The distance between houses in rural areas is considerable; thus, electrification projects can be costly. Most people cannot afford to connect to the electricity grids (Nhamo et al., 2020:34). Utilities can explore renewable energy solutions to reduce the cost per connection and make it affordable to electrify rural areas. Renewable energy methods such as photovoltaics can benefit households' energy-efficient appliances such as gas stoves and LED lights in rural areas where the houses are decentralized (Blimpo and Stein, 2018:15).

Post the apartheid era SA has undergone massive developments, the SA economy has received a boost from external investors building large companies in the business sector. In addition to the developments in the business sector, SA has been impacted by urbanization increasing the demand for energy in SA. Irrespective of the budget constraints, the Eskom network capacity was insufficient to cater to the projected growth (De Fatima et al., 2019:156).

Most utilities have given urban areas a preference for electrification. The rural areas have been left un-serviced. Electrification has been a subject left to external political pressure, which causes utilities to be under pressure to meet political demands (Blimpo and Stein, 2018:13). Utilities need to carefully consider the choices of the electrification systems to align with the levels of consumption and the rural population density. Long-term investments are required to cater to future energy planning systems and expansions (Dagnachew et al., 2017:187).

Eskom the state-owned entity owns a bulk of SAs electricity, fossil-fueled power stations generally supply the largest electricity generated in SA. Eskom is responsible for 95% of generation and 60% of the distribution. The municipalities are responsible for 40% of the energy distribution (Mbanda et al., 2021:3). Coal-powered plants are accountable for 90% of the generated supply, and independent power producers account for 10% of the generation capacity (Baker and Phillips 2019:178).

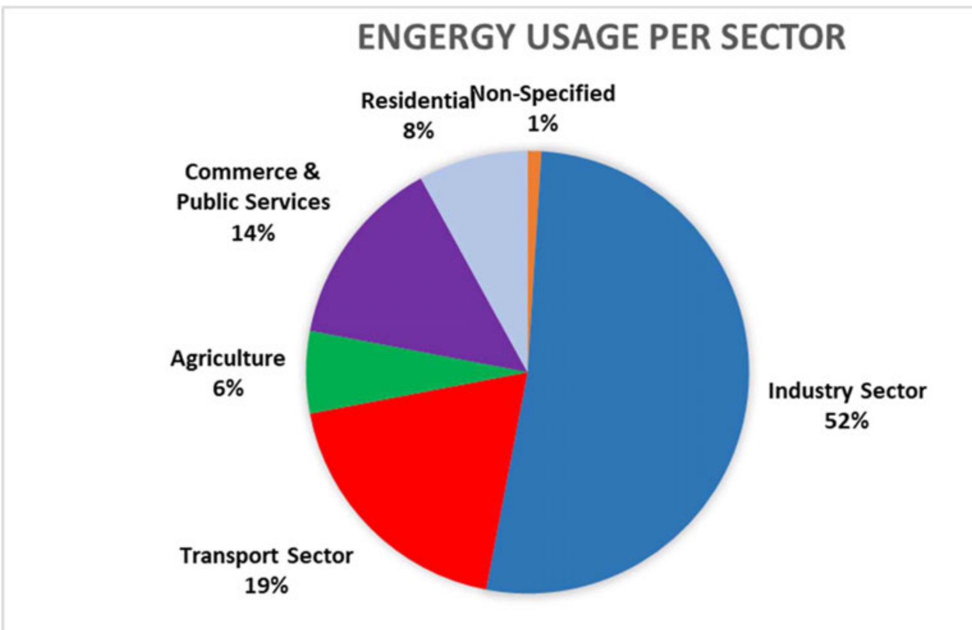

Figure 2- 2 Department of Minerals and Energy Sectorial Breakdown of energy usage for 2016.

Source (The Department of Mineral Resources and Energy 2019)

Figure 2-2 above represents the 2016 energy consumption trends per sector. The industry sector consumed 52% of the generated electricity capacity in 2016 and was the leading sector out of the six sectors. 19 % of the total produced energy is consumed by the transport sector and 14% by the commerce and public services sectors. Residential consumption made up the third lowest energy consumption at 8% and agriculture the second lowest.

The graph depicts the areas of priority for the power utility based on the energy demand in 2016 (The Department of Mineral Resources and Energy 2019).

Industries and commercial consumers consume the bulk of the generated energy capacity. In 2030, commercial and industrial consumers will increase consumption to 68% of the generated energy capacity (De Fatima et al., 2019:156).

2.3 Methods of collecting revenue

2.3.1 The meter as the utilities cash register.

The energy meter is the cash register for the utility. The meter must accurately measure the consumed energy which then, results in potential revenue for the utility. Historically energy meters were purely utilized for correct revenue collection. Modern-day electronic meters have a built-in memory capacity to store summated energy usage data. The data obtained from the meters can be used in structuring tariffs and demand-side management (Mahani, Nazemi, Jamali and Jafari, 2020: 121).

2.3.2 Importance of meter accuracy

Electricity is widely used for different purposes such as industrial, agricultural, and domestic use. A meter is a device that measures the energy usage for any electrically powered device, household, and business. The accumulated meter readings are used to generate the customers' bills payable to the utilities. Energy consumers need to be conscious of their energy consumption (Mahani et al., 2020:121).

2.3.3 Post-paid metering technology

Electricity metering can be measured utilizing two methods, conventional and prepaid metering. Traditional metering allows the customer to consume energy and only pay after usage. Prepaid electricity metering enables consumers to purchase the energy usage upfront before consuming energy. Most utilities prefer prepaid electricity usage as it offers many benefits. Some benefits include upfront revenue collection and reduction in labor costs as no meter readers are required (Mahani et al., 2020:121, Ogunjuyigbe, Temitope, Mosetlhe, and Yusuff, 2021:13).

Historically induction types, also known as electromechanical meters, were used for post-paid service level agreements. These meters worked on the principle of induction, which rotated the metal disc at the same speed as the transient power through the meter, resulting in advancing dials. The induction meters with dials have since been replaced with digital meters with LCD or LED screens which also work on the same principle of induction.

Electronic meters also measure reactive energy, power factor, and instantaneous power. Some disadvantages are associated with post-paid meters, including the risk of incorrect bills resulting from inaccurate readings taken from the meter (Mahani et al., 2020:14).

Also, there are high costs related to the generation of accounts, and revenue is only recognized once the consumer has paid for the energy consumed. Most utilities including Eskom suffer from delayed payments or no payments from consumers, resulting in negative cash flow (Mahani et al., 2020:9).

If the consumers are unable to pay for the consumed energy, Eskom can disconnect the customers for non-payment and charge them a reconnection fee to reconnect them; however, most utilities experience problems as consumers often do not pay the reconnection fee and opt to reconnect themselves illegally onto the electricity grids (Kelsey and Smith, 2017:8).

2.3.4 Prepaid meters

Prepaid meters operate similarly to electronic meters; however, these meters have a relay inside the meter that is programmed to open the contact inside the meter, disconnecting the supply after all the credit on the meter is depleted. Prepaid meters force the consumer to purchase the energy tokens before the energy consumption. Smaller consumers from disadvantaged households yield better returns as they are more willing to pay for electricity services. Prepaid metering may be essential to poor, low-income household consumers (Kelsey and Smith 2017:5).

This feature is beneficial for both the consumer and the Eskom. Consumers can monitor their consumption, pay for their consumption upfront, and can pay consumption upfront and be exposed to the cost of energy. There is some transactional cost associated with prepaid metering; these include establishing a vending system that enables vendors to earn commission on the sale of energy tokens (Ogunjuyigbe et al., 2020:13).

For Eskom, the added benefit is that the revenue is collected upfront and results in better cash flow when compared to post-paid metering. There is also no cost associated with the generation of the bill with prepaid metering. The only additional charges that need to be absorbed by the utility are generating the energy tokens (Ogunjuyigbe et al., 2020:5).

Prepaid meters enable customers to control their daily patterns and maintain their usage. The prepaid meters can be utilized as a disciplining mechanism; however, some consumers still prefer the post-paid meters because they provide more security in disconnections (Jacome and Ray, 2018:265). Low-income users can benefit from prepaid meters in that they consume their energy to meet their cash flow (Jacome and Ray, 2018:265).

Prepaid metering has provided a cheaper technology. The energy solution offers more utilities an opportunity to electrify even consumers from disadvantaged households (Kelsey and Smith 2017:37). In 2019, 85 % of SA's population had access to electricity to a study conducted by Statistics SA (Statistics South Africa, 2021).

Jack and Smith, 2016, conducted a study in the City of Cape Town, and it was discovered that the installation of prepaid meters reduced the consumer's energy consumption by 13%. However, the reduction in revenue was offset by the drastic decrease in the cost associated with the revenue recovery costs (Kelsey and Smith, 2017:5).

Contemporary literature has proven that prepaid metering increases revenue collection as the revenue is collected upfront before the energy is consumed (Ogunjuyigbe et al., 2020:5).

2.3.5 Smart meters

Post-paid meters and prepaid meters are susceptible to energy theft as in most cases both these types of meters are installed within the consumers' boundaries and are easily accessible to the consumers. Both the post-paid and pre-paid meters technologies do not have any built-in intelligence that would enable the utility to be able to monitor the meters remotely and attend to any anomalies within a reasonable time. Accessibility creates an undesirable situation for Eskom as this gives rise to energy theft, a big utility problem. Electromechanical and prepaid meters will be replaced by smart meters used in smart grids as part of the advanced metering infrastructure. Smart meters have built-in intelligence to detect tampers over and under voltages (Arafat, Hassan, and Alam, 2022:564).

Smart meters can be connected to smart grids to curb energy theft. Smart meters can be remotely monitored and provided with a two-way communication system between the consumer and the utility. Eskom can have live updates on the activities that are taking place on the meters. The live updates and monitoring system may include alarms for tamper detection, which Eskom can attend to in real-time as and when it happens. Smart meters can provide utilities with additional benefits, including performing remote disconnections and disconnections (Stagnaro and Leoni, 2019:7).

Eskom can significantly reduce operational costs associated with bill generation. Technicians can reduce the travel time and time spent fault find technicians on the system. Data from the meters can be collected using data concentrators. Data can be temporally stored on the data concentrator for shorter time intervals, Eskom is a large organisation and data collected can be store on the cloud. More permanent storage data can be relayed using GPRS to the meter master station to analyze and interrogate.

Metering errors can be easily found and resolved when the meter master station is activated to detect faults on the meter networks and flag these as alarms in the back office (Arafat et al., 2022:563).

The full smart metering solution requires that the meters be connected to the GPRS systems and interphase back to a headend system that is connected to the internet, and if Eskom do not have adequate firewalls in place, they could be susceptible to cyber vulnerabilities. Eskom should cater for additional security modules to prevent intruders from hacking onto the metering system.

With all these added benefits for Eskom to install smart meters, significant capital investments to migrate to smart grids is required (Chakraborty, Das, Sidhu and Siva, 2021:127, Radhakrishnan and Das, 2018: 1039).

2.4 Motives behind the increasing non-technical energy losses

2.4.1 The right to electricity

All energy consumers must be supplied with excellent power quality, regardless of whether they are from developed or underdeveloped countries. Energy justice can be disseminated in two common ways, temporal infrastructure, and permanent infrastructure to provide access to energy. There are two types of energy injustice within the energy sector, energy insecurity and energy burden (Baker and Phillips, 2019, Löfquist, 2020:720).

The unstable energy or low-income consumers' failure to pay for services is known as energy insecurity and expensive energy tariffs for financially disadvantaged communities are commonly known as energy burden. Energy insecurity and energy burden are regularly associated with food shortages, house insecurities, and overall stress (Löfquist, 2020: 713).

The energy burden often results in households sacrificing to pay for their utility services and living in unsafe, unhealthy conditions that add to the dimension of poor health in communities (Hoody, Robertson, Richard, Frankowski, Hallinan, Owens, and Pohl, 2021:14).

Technological constraints make it difficult for utilities to supply electricity to only the paying and legal customers. Higher levels of supply quality are difficult to attain, as there is one electricity grid that provides both paying and non-paying customers. The high levels of theft are resultant of social and political constraints. Utilities in developing countries resort to privatization to avoid the social norms of electricity being treated as a right.

Households are also encouraged to seek alternative energy means by using renewable energy solutions (Burgess, Greenstone and Sudarshan, 2019:110).

In developing countries, the right to electricity impacts electrification programs. Considering electricity as a right has significant impacts on utilities. Consumers may perceive electricity as a right that increases non-payment, energy theft, and widely tolerated electricity subsidies. The electricity subsidies cause utilities to miss an opportunity to make revenue with each unit of electricity not sold (Burgess et al., 2019:112).

SA has been faced with rising sovereign debts which have contributed to 69.90% of SA's GDP in 2021. The GDP can be used by potential investors to weigh SA's potential of being able to repay loans (Trading Economics, 2022).In the last three years, it has become increasingly difficult for the government to continue to avail bailouts to state-owned enterprises including Eskom.

Due to budget constraints, Eskom has limited access to electricity supply and restricted the number of hours when electricity is supplied in some areas. Eskom is not able to meet the electricity market demand. Reduction in electricity supply makes matters very difficult for Eskom as they must make decisions that may impact their paying customers. The increasing energy theft and high production costs of energy call for utilities to adequately strategies to boost the declining revenue (Burgess et al., 2020:156).

Electricity grids are constrained, and the electricity supply from Eskom is unreliable, even consumers willing to pay are affected by the poor service delivery. More and more customers are resorting to renewable energy such as photovoltaics, solar lamps, and wind turbines, as an alternative source of energy supply (Burgess, Greenstone, and Sudarshan, 2020:154).

2.4.2 Electricity disconnections.

Eskom disconnect consumers who cannot pay for electricity services rendered to them, the consumers are disconnected as Eskom is losing revenue due to the unsettled debt (Cicala, 2021:14).

Electricity availability plays an essential role in the economy, both in households and industries electricity is consumed for essential fundamental functions such as cooking and illumination (Kelsey and Smith, 2017:35).

In a recent study conducted in the United States of America(USA), it was discovered that there was an increase in the number of households disconnected due to non-payment and homes that had entered into payment arrangements during the Covid-19 pandemic (Cicala, 2021:17).

2.4.3 Impact of COVID-19 in SA

The COVID-19 pandemic adversely impacted the South African economy and society. The South African Government declared a state of emergency, and a national lockdown was announced on 27 March 2020. The decision to place South Africa (SA) under a nationwide lockdown was to help minimize the spread of the virus, resulting in the closure of many businesses (Ramaphosa, 2020). In SA, there are over 5 million Small, Micro, and Medium Enterprises (SMMEs) SA, and the majority of these entrepreneurs are in the informal sector.

When the government offered relief aid to assist SMMEs,micro-businesses with a turnover of less than 2 million did not qualify for the government aid as most do not comply with legislation (Zeidy, 2020:145).

In a business impact survey of the COVID-19 pandemic in SA, 84,5% of businesses indicated a turnover below the average rate, and 54% indicated that they could survive between one and three months without a turnover. The effect of COVID-19 cost the already struggling SMMEs business sustainability, which further resulted in massive reductions in manpower and ultimately closed down most businesses (Statistics South Africa, 2021).

Unemployment has drastically increased due to the COVID-19 pandemic. Due to the increased scarcity of resources, most households face increased debt levels (Alenda-Demoutiez and Mügge, 2020:597).

2.4.4 The ripple effect of decoupling and demand-side management on revenue

Driving up demand and selling considerable volumes of electricity at a cost that exceeds marginal costs has always been the traditional way energy providers and markets maximize their profits. This conventional method of achieving marginal revenue inhibits Eskom from investing in energy efficiency to reduce greenhouse gas emissions.

In the late 1970s, there was a change in focus from increasing supply availability to reducing the amount of energy and water consumed by the consumers in the United States. Incentives have been introduced to encourage utilities to reduce the demand required by consumers (Michelfelder, Ahernb, and D’Ascendis, 2019:310).

Decoupling was introduced into the energy sector in 2007, which promoted the theory of separating the total energy delivered by the utility and profits, thereby separating revenue from fluctuating sales. Decoupling was aimed to break the historical norms of operating energy markets, thereby encouraging Eskom to invest in energy efficiency incentives to promote green energy (Wetzel and von Loessl , 2019:145).

In 2006, the Electricity Regulation Act was introduced in SA as a new regulatory framework for the electricity industry. The act aimed to balance regulation policy incentives and market-based mechanisms (Baker and Phillips, 2019:8).

The act includes the introduction of Energy Efficiency Demand Side Management (EEDSM) which requires that Eskom conforms with energy-efficient standards, methodologies, and demand-side management. As the most significant power utility in SA, Eskom had to ensure compliance with the EEDSM initiatives.

The EEDSM initiatives endeavored to reduce the environmental impacts and the carbon footprint in energy production in SA (Baker and Phillips, 2019:180).

Decoupling reduces the investment risk to Eskom in that sales volumes are separated from revenue. Some investors can view decoupling as an investment risk due to the changing regulatory regimes. There are three types of decoupling methods, the lost revenue recovery from reduction of sales, fixed and variable mechanism, and the fixed revenue true-up mechanism's categories. The fixed and variable mechanism may or may not include a set volume of sales or the fixed rate of expected sales. Rarely used in electricity utilities is the fixed rate intended to cover all or most fixed costs. The lost revenue recovery category enables utilities to recover lost revenue due to specific sales reduction programs (Michelfelder et al., 2019:315).

In some literature, it is arguable that there is a positive relationship between energy consumption and GDP growth; other research perceives that energy consumption has no impact on economic growth(Dinçer, Yüksel, and Zafer, 2017:76). Studies have also indicated that energy consumption contributed positively to growing economies in countries that consume a large volume of energy. On the other hand, the energy consumption of countries with low consumption did not affect economic growth (Ambrose and James, 2017: 1565).

Utilities can promote energy efficiency by employing various methods to manage the energy consumed by customers, including the utilization of time-of-use tariffs to discourage consumers from using less electricity during peak times when most consumers require using electricity. Critics argue that decoupled utilities have no incentive to encourage energy efficiency, while others say that decoupling discourages the overconsumption of energy (Ambrose and James, 2017: 1565).

2.4.5 Non-payment culture

The history of non-payment for services in SA dates to the apartheid regime in the 1980s. Segregation in service delivery between affluent white and black communities gave rise to dissatisfaction with services and resulted in non-payment. More than 20 years after the first democratic election, the culture of non-payment remains a risk for utilities (Kambule and Nwulu, 2021:56).

2.4.5.1 Tariff structures

Eskom can use two tariff pricing models, a tariff pricing model that encourages the consumer to increase their demand or a pricing tariff model that discourages the consumer from driving up their energy consumption. Due to the forever-changing environment, Eskom is designing their tariffs to cater to the changing climate. Tariff structure designs in the modern-day consider various factors (Ye, Koch, and Zhang, 2018:124).

The tariff design considers the time when the energy is consumed, season, and fixed costs such as line charges. The type of load the consumer will be using the energy for must be considered in the tariff design structure for industrial consumers. Renewable energy and the introduction of independent power producers require that Eskom designs special tariffs to cater to the wheeling arrangement (Castro and Callaway, 2020:560).

The household's income significantly contributes a part to each household's energy demand. The type of electrical appliances that the home can afford can positively contribute to their energy consumption patterns. The socio-economic factors can negatively impact the consumer's ability to afford electricity (Ye et al., 2018:125).

The National Energy Regulator of South Africa (NERSA) has granted Eskom an 8.61% tariff increase for the local authorities and a 9.16% tariff increase for Eskom directly fed customers, and these tariff increases are effective from 1 July 2022 to 30 July 2023. This price increase will further impose stress on households that are struggling to make payments (NERSA, 2022).

2.4.6 Energy consumption in low-income households versus high-income households

The price of electricity and energy consumption rate has increased drastically over the last decade. The electricity prices have resulted in energy expenditure of between 5 -15% of their household income for lower-income households compared to middle-income households due to lower-income households not having energy-efficient appliances (Ambrose and James, 2017: 1560).

High-income households spend less time at home and thus consume lower average energy when compared to low-income families who spend more time at home (van den Brom, Meijer, and Visscher, 2018:131)

Consumers from highly developed countries often do not view electricity access as a privilege. However, consumers from developing countries perceive electricity access as a privilege (Burgess et al., 2020:147).

2.4.6.1 Correlation between non-payment and expenditure ratios

In a recent study conducted in Soweto, one of SA's biggest townships, prepaid meters resulted in 48% reduced energy consumption. Observation noted that 60% of the households' income was spent on electricity bills. In other studies, researched worldwide, the introduction of prepaid meters resulted in a significant NTL reduction in utilities. The survey conducted by Kambule (2014) called for a socially inclusive energy policy that protects lower-income households and for a subsidy from the government that enables lower-income families to utilize renewable (Kambule, Yessoufou, Nwulu and Mbohwa, 2019:46).

2.4.6.2 Behavioral tendencies

The constrained electricity grids make it crucial for Eskom to understand which sector consumes the most demand for energy. Understanding the energy consumption demands can enable Eskom to prioritize and segregate the maintenance intervals and priorities the network upgrades. Households consume up to 20% of overall electricity consumption globally; hence, they are important role players in promoting sustainable consumption. In SA, residential accounts consume a marginal amount of the generated capacity. Research on electricity use behavior is essential for informing the sustainability of electricity utilities (Mutumbi, Thondhlana, and Ruwanza, 2021:16).
Consumer education on energy-saving tips positively influences energy consumption in households. There are various methods to improve energy inefficiencies in low-income households. It is always arguable which way is most effective between educating the consumers, introducing new energy-efficient appliances, or combining the two methods (Ambrose and James,2017:1560). Technological solutions such as installing in-home displays and programmable thermostats that keep the water geysers at a set temperature and purchasing energy-saving appliances can reduce the amount of energy consumed by consumers monthly (Zhang, Xiao, and Zhou, 2020: 1278).

A study was conducted in the United States of America (USA) to research the behavior and attitudes of customers in low-income households. Behaviors of those who pay for electricity and those who do not pay for electricity were examined to introduce energy cost-saving measures. Behavioral factors such as using energy-efficient appliances in households and adopting energy-efficient measures for example cooling food before placing it in the fridge, installing geyser blankets, and setting geyser thermostats at lower temperatures to save energy. Behavioral factors such as using alternative methods of cooling and heating the household are best recommended for consumers.

Behavioral factors that promote consumers to drive up the energy demand are discouraged as these create future constraints on the electricity grid to meet the growing energy demand. Eskom should discourage consumers from purchasing appliances that are not energy efficient. It was observed that the behavioral factors attributed to 30% of the energy utilized for heating households and 50% of the power attributed to cooling measures in homes. The behavioral change in consumer behavior depends on the consumers' willingness to change their behavior (Hafner, Pahl, Jones, and Fuertes, 2020:11).

2.4.6.3 Free basic electricity

The government introduced the Free Basic Electricity (FBE) program to fulfill the ANCs' free essential services. During their manifesto, the African National Congress promised free crucial services to low-income households in the year 2000. The free essential services included 6000litres of free water and 50kilo Watts hours(kWh) to all qualifying households. The FBE amount will not meet the basic household needs for a month, consumers are still required to purchase electricity. A larger population of low-income households that do not have access to electricity and homes with access to electricity infrastructure has increased over the years, increasing the qualifying household's marginal drastically (Mutumbi, Thondhlana, and Ruwanza, 2021:19).

At the initial rollout of the FBE project, the local government could not successfully implement the FBE project. The government did not adequately define the roles and responsibilities of the role players. Municipalities were under the impression that the government was exclusively responsible for the project. DME consumers who could not afford to come forward and pay were included in the FBE project. Most communities still do not understand how FBE works because they think it is free for everyone. Communities need to be better educated on how the FBE project would be operated (Mutumbi et al., 2021:17).

Socio-economic growth and development are highly dependent on clean, safe, and affordable energy availability. Some researchers argue that the lack of access to cheap energy supply in SA has contributed to sluggish social growth and development. FBE is provided at no cost to consumers from disadvantaged backgrounds to bridge the socio-economic challenges. However, a specific qualification needs to be met by applications to qualify for FBE (Baker and Phillips, 2019:399).

The minimum required qualification criteria are that the property value must not exceed R150 000, the household's gross income must not exceed two state pensions values, and the applicant converted to prepaid metering. Observations have indicated a backlog in the system due to the high demand for applicants that meet these criteria (Baker and Phillips, 2019:410).

2.4.7.1 Consumer satisfaction

Poor electricity supply and slow electricity connection services are regular in SA. The loss of supply has negatively impacted the Gross Domestic Product (GDP) and has impacted productivity for most industries. Eskom is drowning in debt and constantly rely on government bailouts to service SA's growing demand for electricity (Conway, Robinson, Mudimu, Chitekwe, Koranteng, and Swilling, 2019:2).

There is a negative feedback loop between the interruption of electricity supply and revenue collection. Blackouts negatively affect the Eskom's potential revenue collection and tarnish consumer confidence in the missed opportunity to render services (Dzansi et al., 2018:5).

The availability of free online knowledge and information has made it increasingly difficult for companies to manage market knowledge or information available to consumers. The available online information can affect consumer satisfaction and behaviors. It has become increasingly imperative for Eskom to create consumer satisfaction for online knowledge products for long-term consumer relationships. In literature, consumer satisfaction is traditionally associated with the expectation-confirmation theory(ECT), which explains how consumers perceive satisfaction through expectation confirmation. According to the ECT, consumers derive satisfaction from pre-usage expectations and the perceived service performance (Fu, Lui, Luo and Cai, 2020:14).

Eskom needs to ensure that the customers are satisfied to purchase more services; if customers are not satisfied with services rendered, they will be reluctant to buy services. Notably, not every happy customer can yield or result in Eskom attaining revenue. Customer satisfaction is dependent on good customer service; good customer service can provide many benefits for Eskom. These benefits include customer loyalty, improved business reputation, and employee satisfaction (Uzir, Hlabusi, Thurasamy, Hock, Aljaberi, Hasan, and Hamid, 2021:134).

Loyal customers are guaranteed to purchase more services and are not easily influenced to take their business elsewhere. Thus, Eskom can retain their revenue, and competitors do not quickly poach consumers. Satisfied customers can refer new customers into a business, thus increasing the market share for the company; also, the satisfied customers are less likely to complain, thus reducing time spent attending to queries for Eskom. There is also an added benefit for Eskom areas with fewer customer complaints, which is that these utilities attract employees of a higher caliber. Employees with higher caliber can result in utilities becoming highly efficient (Uzir et al., 2021:122).

The converse is true for poor customer satisfaction, resulting in a reduced market segment, low employee morale, loss of competitive edge, and declining revenue.

Eskom can reduce poor consumer satisfaction by investing in conducting market research, staff training, customer education, quality service, and efficient platforms to attend to customer complaints (Uzir et al., 2021:123).

It is pertinent for revenue growth that all levels of the organization are aligned and ready for the change. If the business units are aligned, it could impede revenue growth in an organization (Bowman, 2020:420).

2.4.7.2 Customer service

Each industry is different. Thus, it is not easy to have a benchmark to evaluate good customer service. The quality of customer service can be distinguished by two main factors, speedy service delivery and professionalism (Tien, Annh, Diem, Thanhvu, Dung, Bien and VanOn, 2021:42).

The swift services refer to resolving queries quickly from delivery of services, warranty, and creating quality customer services. Professionalism satisfies the customer by putting their needs first and knowing about the business operations and industry trades. Customers' expectations need to be met, and customers evaluate the perceived service against their obtained service. If the received service meets the customers' perceived expectations, customers are said to be satisfied. Service providers need to be attentive to customers' needs and strive to exceed these needs (Tien et al., 2021:46).

2.5 Initiatives to reduce non-technical energy losses

2.5.1 Energy planning

Electricity provides convenience for consumers, and the service of electricity rendered gives an accurate indication of development in a country. Energy planning requires that utilities carefully strategize between the energy supply choices. Eskom has limited energy choices to centralized supply energy technologies such as fossil fuel, gas-based, hydroelectric, and nuclear power plants (Akom, Shongwe and Joseph, 2021:69). These centralized energy technologies have presented Eskom with two significant challenges: environmental impacts that lead to global warming and high operating costs associated with generating electricity. Thus, it has become crucial for Eskom to explore alternative energy supply mixes to remain sustainable. Eskom need to consider decentralized technologies such as renewable technologies to be sustainable (Akom et al., 2021:72).

2.5.2 Tariff designs

The macroeconomics, demand growth, and fuel price increase make it extremely difficult for Eskom to plan strategically. Eskom has come up with innovative ways to reduce the demand cost. These include demand-side options such as encouraging consumer behavioral patterns such as co-generation and private generation (Michelfeldera et al., 2019:314).

In most utilities, the electricity tariffs do not reflect the marginal costs of electricity production. Eskom is subsidized by the government to ensure that the marginal costs of electricity is covered. The current average essential tariff cost of R20 per kWh covers the energy costs and has other fixed operating expenses, competing for which cost can be covered by the tariff (Kambule and Nwulu, 2021:40).

The Inclined Block Tariff (IBT) was implemented for residential customers in 2010 as per the directive from NERSA for all Eskom customers and municipality customers. Eskom introduced the IBT to provide a subsidy for all disadvantaged customers with low consumption to benefit from the low tariff rates on block 1 of the tariff model. However, for high-energy consumers, the IBT proved to be non-beneficial due to the higher cost of energy per unit (Kambule and Nwulu, 2021:36).

IBT is not popular with electricity consumers as it can easily distort the consumers' budgets and inhibits consumers from pre-buying electricity units for upcoming months. The IBT also introduced a new element of revenue risk for Eskom in that it excluded the fixed costs from the tariff (Kambule and Nwulu, 2021:37).

The IBT structure encourages electricity consumers to use electricity sparingly. The electricity pricing model is designed into two blocks. The first block is from zero to six-hundred kilowatts, which charges consumers the lowest price per unit of electricity. The last block is greater than six hundred kilowatts charging the highest per-unit price of electricity. When customers purchase electricity for the first time in a month, they are charged using block one, and when they buy more electricity units, they progressively move into block two. When consumers purchase more units in a month for the same amount, they receive fewer units. Moving consumers from one block to the next is an automatic, systematic process, and there is no manual intervention required from utilities (Langeberg Municipality, 2020:3191).

2.5.3 Revenue collection improvement methods

Predictive revenue analytics can predict the fraud probability and the financial implication imposed by energy theft. Eskom can employ analytics to understand and analyze consumer behavior, thus selecting better methods to reduce energy losses and improve revenue collection. Predictive analytics can assist Eskom in making informed decisions on feeders and networks to install smart technology systems (Hammerschmitt, Rosa Abaide, Lucchese, Martins, da Silveira, Rigodanzo, Castro, and Rohr, 2020:64).

2.5.3.1 Energy balancing techniques

Statistical meters can be installed at all critical feeders and down to the transformer zone level for analytical energy calculation purposes. The energy analytics calculation can enable them to gain insights into which areas of their network to prioritize and intensify their efforts to reduce their NTL (Chakraborty, Das, Sidhu, and Siva, 2021:67).

Eskom must provide a safe electricity supply to their consumers as prescribed by the South African OHS. Act 85 of 1993. In a study conducted by Bokoro and Louw(2019), Zero-Sequence Current (ZSC) philosophy was proposed, which considers the safety aspects imposed by the NTL. The ZSC philosophy is a theory that measures the resistivity of the soil by installing a measuring device on the neutral of the low voltage transformer. Suppose there is an increase in soil's resistivity, and alarms are flagged on the utility system to notify them of the abnormality. The utility can then dispatch technicians to remove the illegal connections.

The ZSC philosophy is highly dependent on the network data's accuracy and demand management. The adoption of zero-sequence current to network configurations will require that the distribution infrastructure be redesigned. Furthermore, the ZSC philosophy cannot isolate the primary supply from the network when illegal activities are detected, Eskom will still require to dispatch technicians to attend to faults (Bokoro and Louw, 2019:32).

2.5.3.2 Improvement of metering infrastructure

Smart grids are the recent world trend for efficient and reliable energy transmission and distribution. Smart grids have built-in intelligence that can predict, manage the electricity demand, and manage energy during peak periods. Accuracy in energy measurement is an integral part of a smart grid system, and utilities can obtain it by installing smart meters. Smart meters can enable Eskom to manage customer interactions by effectively notifying them of upcoming power outages (Bokoro and Louw, 2019: 121).

Eskom can install smart meters to enable built-in intelligence into the metering system. The employment of smart meters requires other auxiliary equipment to be attached to the electrical system to enable Eskom to monitor the customers' consumption trends and detect tampers. Early tamper detection will allow Eskom to react quickly to energy theft and any other intrusion into the metering system. Additional functions such as remote connection and disconnection of customers are another benefit that smart meters provide, which the traditional metering systems perform. When post-paid customers default on payment, Eskom can remotely disconnect the supply and reconnect the supply remotely on receipt of payment. Eskom can change customers from post-paid to prepaid metering by sending a command remotely to change the encryption from post-paid to prepaid metering (Jenkins and Pe'rez-Arriaga, 2017:58).

However, while smart metering systems offers Eskom with additional benefits of improving their inefficiencies, it must be noted that some additional considerations must be considered for installing smart metering systems (Chakraborty et al., 2021:12).

Smart meters require adequate business change management to properly integrate existing and new processes to align with the newly employed technology infrastructure (Arafat et al., 2022:560). Substantial capital investments are needed to invest in the metering assets and human resources by ensuring that resources are adequately trained and have suitable working tools to align with the upgraded infrastructure (Arafat et al., 2022: 562).

In some literature, it can be argued that smart metering systems are better suited for well-developed countries with well-maintained distribution networks and consumers who can afford to pay for the services rendered by utilities (Makarand et al., 2020:121).

In developing countries such as SA, Eskom ought to consider innovative strategies to cater to the health of the existing infrastructure. Eskom should consider feeders where minimal upgrading of line hardware infrastructure will be required to implement smart metering systems initially. The prioritization of available CAPEX funds should be strategically assigned to areas where quick gains in reduction of NTL and increase in revenue collection will be attained (Arafat et al., 2022:560).

2.5.3.3 Culture change

Energy behavior is often not the focal point in energy reduction initiatives. Eskom can introduce energy behavior in energy reduction initiatives. Customers can be educated on energy-saving techniques and in turn, the utility will benefit from reducing the demand of the constrained electricity grid (Hoody et al., 2021:16).

Low-income households who cannot upgrade their homes into energy-efficient households could significantly benefit from energy-saving tips and behaviors (Mutumbi et al., 2021:6).

Behavioral changes include switching off lights when you are not occupying the room or allowing food to cool totally before placing it into the fridge are small incremental behavior changes that promote energy saving in households.

2.5.3.4 SA projects for low-income households

Recent research has shown that socio-economic development has a dependency on energy access. Energy access is required for job security and to improve the livelihoods in rural households. Developing countries, including SA, have targeted the electrification of rural households to promote socio-economic development in low-income families (Conway et al., 2019:3).

The government has strategically decided to offer micro grid electricity access to low-income households to relieve pressure on the main electricity grid constraints and still reach their objective. Most developing countries, including SA, have opted to use Solar Home Systems (SHS) to improve access to rural households. SHS is said to be cost-effective in unelectrified households (Burgess et al., 2019:12).

The National Energy Efficiency Strategy (NEES) was introduced in SA through the DoE to increase energy demand and reduce SA's carbon footprint. Eskom-sponsored projects were raised to enable residential customers to improve energy efficiency, such as the installation of solar panels on top of the new RDP houses that were being built in 2015, distribution of energy-efficient lightbulbs, and geyser blankets to prevent water in households from cooling rapidly (Bowman, 2020:420).

2.6 Conclusion

Non-technical Energy losses create a serious risk to the sustainability of electrical power utilities worldwide. Energy theft is the most significant contributor to NTL. Energy theft can result in overloaded distribution networks and threatens the overall lifespan of the distribution network. The resultant net effect is poor quality supply and declining revenue. Eskom as a result,experiences declining revenue which compromises Eskom's sustainability.

Various literature studies have expressed three leading research solutions to address NTL losses, policy changes, data-based analytics, and hardware-based solutions. For the policy changes to be motivated, the researcher would need to investigate socio-economic factors in a geographical area that could lead to energy theft. The second solution is the data-based analytical method which would require no additional line hardware, however, the utility would require skilled resources to conduct the analytics. The non-hardware solution is most preferred by utilities in the modern-day era as it requires minimal capital injection. Lastly, the commonly used hardware solution requires that the utilities upgrade their existing infrastructure to include devices with built-in intelligence for remote monitoring and analytics to detect NTL (Alshammari et al., 2020:217).

SA has one of the largest disparity problems in the world, where socio-economic problems affect a significant part of the population to sustain a living, and affordability of basic needs is a concern. While this problem may be vastly known, Eskom needs to employ technology strategies to manage the energy theft crisis. Collaborative efforts are required between customers and Eskom are crucial for business survival. Customers need to be sensitized and introduced to a new culture of paying for services rendered.

CHAPTER 3- METHODOLOGY

3.1 Introduction

NTL has induced a going concern for Eskom Kwa-Zulu Natal. Revenue collection has significantly decreased and conversely, NTL has increased. The high NTL has compromised the asset health of the distribution networks due to overloading posing an intermittent danger to the quality of supply, resulting in the utility experiencing numerous breakdowns. The declining revenue collection increases the going concern for Eskom KZN and threatens the future job security of Eskom employees.

The problem needed to be urgently addressed as Eskom has rising debt and relies on government bailouts to continue business operations and service the sovereign debt (Bowman, 2020:406). SA's economy has been struggling with the ever-rising fiscal and sovereign debt**.** Addressing the problem would mean that government funding can be used for other needs to improve SA's socio-economic position.

The researcher explored a quantitative approach to investigate what causes the energy theft rate to increase and propose solutions to increase revenue collection in Eskom. Primary data was collected by using a survey questionnaire. Secondary data from existing literature was also employed to equip the research with an in-depth understanding of the problem. Survey monkey software was used to collect the data, and the researcher had aimed that it would take 15mins for the participants to complete the survey. The data preparation and the statistical analysis were performed with the survey monkey software. The data was then analyzed graphically using survey monkey and SSP software.

3.2 Research design

A quantitative research approach was utilized to explore the problem statement. The quantitative research approach enabled the researcher to understand the opinion trends of electricity consumers (Hanslo, Vahed and Mnkandla, 2019:90).

The researcher will seek to accurately measure the targeted concept of NTL in distribution power and the targeted idea of NTL in distribution power systems. The researcher will use the quantitative research method framework (Hanslo et al., 2019:90).

The researcher explored a convergent parallel research design where the numeric and test data were collected and analyzed separately. This method is also known as the concurrent triangulation design method. After that quantitative data were then integrated, merged, and displayed (Hanslo et al., 2019:121).

Quantitative research is an objective, systematic and practical investigation of observable occurrences through computational techniques. The researcher selected quantitative for data collection because it would enable the researcher to collect the data systematically and sequentially, thus enabling rapid data to collect data to meet the UKZN's timelines.

The research study followed a cross-sectional approach according to time, and the data was collected in a single period time interval of 49 days and analyzed.

The researcher selected this cross-sectional approach to align with the university's specified time frame to complete the research.

3.3 Target population

The target population was 110 which included, zero buyers greater than 12 months and Eskom KZNOU employees of all ages and gender. A sample of 60 participants was selected to participate in the research study. The researcher requested approval from senior management to perform research at Eskom. Permission was granted, and the Eskom electricity zero buyer list was obtained enabling the researcher to start the investigation. The researcher requested authorization in line with the POPI Act to get a contact list of Eskom customers who are zero electricity buyers or customers who have defaulted in paying for the electricity.

The researcher narrowed down the study's participation, to participants who had access to email and or WhatsApp from the list of Eskom KZNOU participants. Furthermore, to narrow down the list of Eskom employee participants, the researcher targeted the participants involved in KZNOU NTL reduction initiatives for participation in the research to gather any process-related input data.

Participants that are Eskom customers will give insights into the intended research problem. The participants from the KZNOU NLT reduction initiatives will provide insights into organizational processes. Participants not involved in KZNOU NTL reduction initiatives will not be selected as they could give negative results.

3.3.1 Informed consent

The researcher sent an email to email to the internal Eskom participants with the informed consent form noting their rights to participate or not to participate in the research. The research included informed consent as a paragraph in the survey questionnaire for participants external to Eskom. The research informed the participants that they could withdraw from participating in the study at any given time. To remove participation, the participants would have to contact the researcher. The informed consent also mentioned that each participant's response would be treated with confidentiality and used only for the intended research purpose.

3.4 Sample and sampling strategy

The research was aimed at advancing the larger population of SA. As much as the investigation was said to benefit the larger population of SA, it was not feasible for the researcher to target a larger population of SA. Due to resource constraints, the researcher had to limit the research to Eskom KZN customers. A smaller sample of Eskom KZN's customer base was chosen to represent the bigger size of the Eskom KZN customer base. Convenience sampling employs readily available participants to take part in a survey (Naderifar and Goli, 2017:196). Convenience sampling was used to select participants that would not give the researcher great difficulty responding to the survey questionnaire.

3.5 Sample size

Eskom KZN has a total number of 110 customers on the zero-buyer list greater than 12 months. For research purposes, the population size was 110, and the confidence level was 95%. The population was vast, so Solvin's was adopted for the research.

The researcher assumed that the large population does not know the variability in the proportion that will partake in the NTL energy survey questionnaire due to the large population. The researcher desired a 90% confidence level and a margin error of 5%

$$n = \frac{N}{(1 + N e^2)}$$

Where:

n is the sample size, N the population size, and *e* the margin of error.

$$n = \frac{110}{(1 + 1\ 10 * 0.1^2)}$$

n = 99

The non-probability, convenience sampling technique was selected as this method offered the researcher the flexibility to select elements that were interested in the subject topic NTL and elements that would respond to the research instrument within the specified time frames.

3.6 Data collection

3.6.1 Primary data

In the study, the NTL was the dependent variable, the objective of this variable in the research was to understand the unpredictability that causes the variability of the research. The research questionnaire aims to answer the question, “What are the causes of electrical energy theft in Eskom?”

The research study has two independent variables, which can influence the variability of the NTL. The first identified independent variable electrification projects, which can positively or negatively impact the NTLs in distribution. The question” What are the electrification gaps in Eskom and how can they be improved?” aims to quantify the impact contributed by delayed electrification projects on energy losses.

The second independent variable is affordable tariffs that can adversely impact the revenue collection and then result in increasing NTLs. The survey question, “What can be done to improve revenue collection at Eskom?” aims to compute whether the existing pricing tariffs would contribute to the increase in energy losses.

The researcher utilized primary data collection to investigate the research objectives. An online survey questionnaire was used as means to collect data from participants. The online survey questionnaire will enable the researcher to test the dependents variable’s variability by varying the independent variables.

The researcher opted to employ an online survey questionnaire as a data collection tool for the study. Cost analysis benefit was conducted and evaluated to select the cost-effective option. It was a more affordable option than other methods of collecting primary data. It employs the survey questionnaire to reach a more extensive geographical size of the Eskom KZN customer base.
It aimed to provide respondents with sufficient time to respond to the questionnaire. The informed consent clarified the possibility of misunderstanding to let the respondents understand the study. The survey comprised 22 closed questions using the Likert scale and two open-ended questions. The survey monkey software was used to collect the data, and the researcher had aimed that it would take 15mins for the participants to complete the survey.

3.6.2 Likert scale

The research incorporated the use of a close-end questionnaire using the Likert scale. The Likert scale enabled the researcher to gather feedback from the participants. The Likert scale questionnaire will allow the researcher to collect the psychological constructs of the participants. The researcher combined the Likert-scale questionnaire with two open-end questions for the researcher to understand the phenomena better (Taherdoost, 2019:8).

3.6.3 Research instrument

The research instrument utilized is an online survey questionnaire designed using a survey monkey database. The research survey is being used as the research instrument perceived that it would be more efficient to collect the data from the participants to align with the UKZNs timelines. The research survey comprised 24 questions which were 22 closed-ended questions and two open-end questions.

Close-ended questions allow the respondent to respond from a predefined set of answers and enable the researcher to measure the respondent's attitudes. Open-ended questions allow respondents to respond freely using their own words and may or may not, in some instances, measure the respondent's academic capability of the subject and not necessarily their attitude towards a specific topic.

Open-ended questions also impose an additional responsibility on respondents in that they need to use their own words to respond (Schmidt, Gummer and Robmann, 2020:5).

Most respondents do not respond to open-end questions as they try to avoid the politics associated with giving their own opinions (Zhou, Wang, Zhang, and Guo, 2017:2).

3.6.4 The survey questionnaire

The researcher designed the survey questionnaire to comprise three sections. Section A relates to the respondents' profile and association with Eskom, and section B addresses the problem statement of what is triggering NTL to increase. Lastly, in section C, two open-ended questions seek to obtain the respondents' views on NTL.

See appendix B for the survey questionnaire.

The survey question’s purpose is to answer the following questions in sections B and section C.

a. What are the causes of electrical energy theft in Eskom?

b. What are the electrification gaps in Eskom and how can they be improved?

c. What can be done to improve revenue collection at Eskom?

3.6.5 Survey questionnaire administration

The survey questionnaire link was sent to the participants via email. The participants were requested to complete the survey questionnaire via the survey monkey database. The survey was opened for a cross-sectional period aligned with the university's timelines and was later closed to conclude data collection. The data was then further analyzed using the survey monkey database and PSS.

3.6.6 Secondary data collection

The researcher used recent academic literature, such as journals and articles, to collect secondary data and better understand the research problem. The purpose of the research secondary data was to adequately understand the reasons and rationale behind consumer behavior. The researcher performed data analysis by triangulating primary and secondary data, which enabled the researcher to get a better perspective from different sources.

3.7 Data analysis

A survey questionnaire was sent to participants via email and WhatsApp. The research gathered participants' opinions, knowledge, attitudes, and values on NTL distribution networks.
The variables were not manipulated, and no interference was done. The researcher waited for the participants to respond to the questionnaire. Descriptive statics was used to analyze the data from the survey monkey. The researcher recorded the total number of responses via survey monkey. The researcher analyzed the collected data utilizing the SPSS to get an in-depth understanding of the responses from respondents.

3.8 Ethical considerations

Researchers need to take careful consideration when conducting surveys. Researchers need to ensure that the respondents do not respond subjectively. In a recent study, researchers have found an increase in the response rate of participants, and respondents are less subjective. Researchers need to ensure that the promises made to the participants have been adhered to. Respondents need to create an equal chance of gains for the research and not compromise the participants' opportunities to gain from the study (Nunan, 2021:272).
The research conditions were clearly stated upfront in informed consent, stating the researcher's intent and what the participants stood to gain see appendix B.

The researcher indicated to the participants that participation was voluntary and could be re-traced at any given time should the participants do so. Participants were also drawn to the attention that their responses would be used for the intended research, and there was no further incentive that would be gained in part taking in the study.

In line with the South African Constitution (Act 108 of 1996) Section 16(1) (d), the researcher ensured that all ethical considerations were adhered to and that no infringements of rights were done by the researcher (Klug, 2019:709).

The researcher ensured that ethical clearance was obtained through the UKZN Ethical Clearance Committee. The research that would not infringe the South African Constitution (Act 108 of 1996) Section 16(1) (d); please see appendix D, the approval letter attained to perform the research study, which included the period of validity.

3.9 Research reliability and validity

3.9.1 Research reliability

The reliability in research refers to how the data collection technique measures the same way used under the same conditions with the same subjects. Or if the analysis were performed by another researcher using the same instruments, the results would be replicated. This component looks at the study's replicability, and it is not measured by estimated (Almanasreh, Moles and Chen, 2019:217). The survey monkey will keep the measurement scale constant throughout the survey.

The participant's error was avoided because the participants were all sent the survey using, survey monkey simultaneously in the afternoon. Participant bias was avoided because all participants' responses were kept anonymous, and only the researchers had access to the responses from the respondents.

The researcher error and researcher bias were avoided by using survey monkey to create the survey and collect the respondent's data; therefore, the research could not manipulate the responses. The survey monkey used the data analysis to stop the subjective investigation and distort the results.

3.9.2 Research validity

Construct validity was performed to ensure that the measurement tool measures what it is supposed to measure and can be generalized (Almanasreh et al., 2019:217). The researcher wanted to investigate the reasons that gave rise to electrical energy theft in Eskom KZN and thus decreased revenue collection. The researcher opted to conduct this research topic as there is a growing demand for Eskom to attend to the problems posed by the energy theft crisis. Therefore, an inductive approach was utilized to perform the research.
The researcher reviewed recent literature and extracted relevant tops in the survey instrument.

The researcher then selected four knowledgeable members of NTL to help with content validity. The content was validated using the Lawshe method to validate the Content Validity Ratio (CVR) (Almanasreh et al., 2019:220).
The formula below was utilized to compute the CVR.

$$CVR = \frac{\eta e - \frac{N}{2}}{\frac{N}{2}}$$

Where:
CVR is the content validity ratio, ηe the number of panel members that would have agreed that a specific particular item is essential, and N denotes the number of expected panel members
Using the Lawshe method to compute the CVR is dependent on the researcher obtaining several skilled panelists in the chosen that are available to assess the instrument (Almanasreh et al., 2019)
The survey ensured high content validity and constructed validity to measure the participants' opinions.

3.9.3 Research pilot

The research survey questionnaire was piloted by sending the survey first to six employees at Eskom KZN. The arbitrary number of six was chosen for the ease of managing the sample. The pilot aimed to test how easily the survey could be completed for the researcher to obtain feedback on the following surveys. All recommendations were corrected from the feedback received from the six participants.

3.10 Justification of methods employed

An online survey questionnaire was constructed using survey monkey to collect the data as the manually printed survey questionnaire posed a risk of contracting SARS-CoV-2(COVID-19) for the researcher and participants. Interviews were not a suitable method to collect data as they are time-consuming.

Still, it also required that both the participants and the researcher were available at the same time to conduct the interview. The population size was large, and KZNs geographical landscape was too vast, making it impossible for the researcher to reach the participants within the specified time frame for UKZN, making the survey questionnaire a better research tool for the study.
Performing purely qualitative research was going to be time-consuming and restrict the researcher from adhering to the timelines specified by UKZN.

3. 11 Research limitations

The research was limited to a cross-sectional time frame, and all the data needed to be within the specified time frame to meet UKZN's timelines. Only participants supplied electricity by Eskom and Eskom employees who resided in Kwa-Zulu Natal were selected for participation in the study. Participants that had their electricity supply provided by the municipality and were not Eskom employees were exempted from participating in the research. Eskom employees that resided in other provinces were excluded from participating in the study.

3.12 Conclusion

This chapter discussed the rationale behind the methodology selected to conduct the research. Researchers must select the correct research design to enable the researcher to collect the desired type of data. Careful consideration needs to be taken to select a research instrument that will allow data collection to be performed with ease.

CHAPTER 4 –PRESENTATION AND ANALYSIS OF FINDINGS

4.1 Introduction

In this chapter, findings from the survey questionnaire are presented. Descriptive statistics in the form of graphs and tables were used to present the results obtained from the study. Inferential techniques include the use of correlations and chi-square test values, which are interpreted using the p-values.

The presentation is done in three sections section A, which screens the respondent's profile, section B presents the triggers of NTL, and section C a presentation of the two open-end questions. The data were analyzed utilizing SSP software.

4.2 Section A, respondents' profile

The results in Table 4-1 show that the study sample, made up of 60 participants, had an even split of 30 (50%) who had their electricity supplied from Eskom and 30 (50%) who did not get electricity for Eskom. Most of the respondents (49 or 81.7%) were employed by Eskom, while 11 (18.3%) were not. Most of the research participants (56 or 93.3%) were employed or had family members who had work, while only 4 (6.7%) had the whole household unemployed.

Table 4- 1 Frequency distribution of the background

Background variables	Response	Frequency	Percentage
Q1. Is your electricity supplied by Eskom?	Yes	30	50.0%
	No	30	50.0%
Q2. Are you employed by Eskom?	Yes	49	81.7%
	No	11	18.3%
Q3. Are you currently employed, or is someone in your household employed?	Yes	56	93.3%
	No	4	6.7%
Q4. If you are not employed, how long have you been unemployed?	2 Years	11	18.3%
	N/A	49	81.7%

Results in Table 4- 2 show a significant association between employment at Eskom and whether one gets their electricity from the company or not (Chi-square=9.017, p-value=0.003, exact p-value=0.006).

The results show that only 40.8% (20 out of 49) of those employed by Eskom get their electricity from the company. In comparison, 90.9% (10 out of 11) of those not employed by Eskom get their electricity from the company. These results mean that more of those employed by Eskom are supplied by the alternative energy service providers and not directly by Eskom.

Table 4- 2 Test association between employment at Eskom and source of electricity supply.

		Q1. Is your electricity supplied by Eskom?	
		Yes	No
Q2. Are you employed by Eskom?	Yes	20 (40.8%)	29 (59.2%)
	No	10 (90.9%)	1 (9.1%)
Chi-square test of association			
Chi-square value	9.017		
Degrees of freedom	1		
p-value	0.003	Exact p-value = 0.006	

4.3 Section B: Triggers of Non-technical Losses

The research question addressed in this section is" What are the causes of electrical energy theft in Eskom?"

Various questions that address possible reasons for NTL losses are analyzed in the following sections.

4.3.1 Affordability of electricity tariffs

Suppose there is a perception that the affordability of electricity tariffs is not affordable. In that case, some customers might resort to illegal connections or use other energy sources to avoid paying for Eskom-supplied electricity.

Table 4-3. Affordability of electricity tariffs.

Q5. Electricity tariffs are affordable?			
	Frequency	Percentage	
Strongly disagree	16	26.7%	61.7%
Disagree	21	35.0%	
Neither agree nor disagree	6	10.0%	10.0%
Agree	15	25.0%	28.3%
Strongly Agree	2	3.3%	

Results in Table 4-3 and Figure 4-1 show that most respondents find electricity tariffs are not affordable, as indicated by 61.7% who disagree or strongly disagree with the notion that "electricity tariffs are affordable." Only 28.3% of the respondents found electricity tariffs affordable.

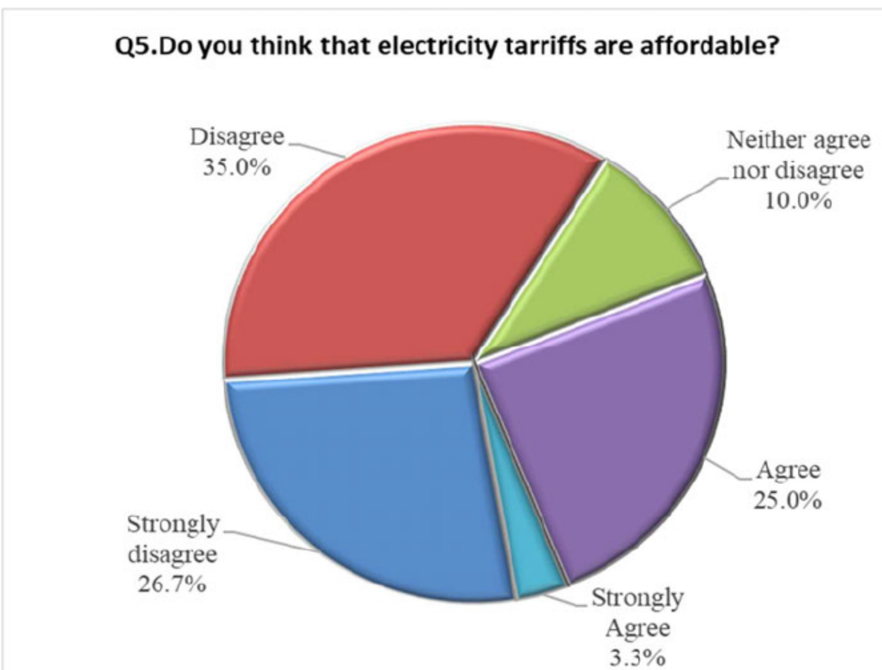

Figure 4-1. Affordability of electricity tariffs

Results in Table 4-4 show no significant difference in affordability between the electricity supplied by Eskom or other suppliers (Chi-square=3.462, p-value=0.0.177, exact p-value=0.183).

The results in Table 4-4 indicate that suppliers of electricity other than Eskom have similar pricing models to Eskom. This rules out alternative (or competing) electricity suppliers as a reason for the increase in Eskom's NTL losses. This finding is an indication that Eskom is not losing customers to their competitors, Eskom to look elsewhere for the reasons for NTL losses, as other suppliers would be experiencing the same. Although the results do not indicate any significant differences in affordability, a higher percentage of those finding electricity less affordable among non-Eskom customers (73.3% disagreeing and 20.0% agreeing) than among Eskom customers (50.0% disagreeing and 36.7% agreeing).

However, there is not enough statistical evidence to say that this difference in affordability is significant.

Table 4-4. Cross-tabulation of affordability of electricity tariffs against whether one gets electricity from Eskom or not.

		Q5 Electricity tariffs are affordable?		
		Disagree/Strongly disagree	Neither agree nor disagree	Agree/ strongly agree
Q1. Is your electricity supplied by Eskom?	Yes	15 (50.0%)	4 (13.3%)	11 (36.7%)
	No	22 (73.3%)	2 (6.7%)	6 (20.0%)
Chi-square test of association				
Chi-square value	3.462			
Degrees of freedom	2			
p-value	0.177	Exact = 0.183		

4.3.1.1 Appliances in households

Another possible cause of an increase in Eskom's NTL losses could be the type of appliances the customers are using. The results in Table 4-5 show that most respondents indicated that they had more than just basic appliances (81.7%), with only 18.3% indicating that they had basic appliances.

Table 4-5. Cross-tabulation of appliances usage against in use by customers.

Q6. I have the following electrical appliances in my household?		
	Frequency	Percentage
Basic Appliances	11	18.3%
More Appliances	49	81.7%

To assess if appliance ownership had a bearing on the perceived affordability of electricity tariffs, a cross-tabulation of questions 6 and 5 was carried out. The results are shown in Table 4- 6 below.

Table 4-6. Cross-tabulation of appliances in use against affordability of electricity tariffs.

		Q5. Electricity tariffs are affordable?		
		Disagree/Strongly disagree	Neither agree nor disagree	Agree/strongly agree
Q6. I have the following electrical appliances in my households	Basic Appliances	7 (63.6%)	3 (27.3%)	1 (9.1%)
	More Appliances	30 (61.2%)	3 (6.1%)	16 (32.7%)
Chi-square test of association				
Chi-square value	5.787			
Degrees of freedom	2			
p-value	0.055	Exact = 0.039		

The exact p-value in Table 6 shows a significant association between appliance use and the perceived affordability of electricity tariffs (Chi-square=5.787, p-value=0.055, exact p-value=0.039). Those who use more appliances seem to have a higher percentage agreeing/strongly agreeing that electricity tariffs are affordable (32.7%) than those with basic appliances (9.1%). The socio-economic status of the two groups may have a direct impact on these results. Those with more appliances earn more than those with essential appliances.

4.3.2 Payment levels in communities

Non-payment for the usage of electricity by customers in communities is a potential source of Eskom's NTL losses. Study participants were asked about their opinion regarding paying for electricity by customers in their communities. Their responses are summarized in Table 4-7 and Figure 2 below.

Table 4-7. Non-payment of customers in communities

Q9. All customers my community members pay for electricity?			
	Frequency	Percentage	
Strongly disagree	22	36.6%	68.3%
Disagree	19	31.7%	
Neither agree nor disagree	2	3.3%	3.3%
Agree	13	21.7%	28.4%
Strongly Agree	4	6.7%	

The results in Table 4-7 and Figure 4-2 show that most respondents were of the view that most community members do not pay for their electricity usage (68.3% disagree or strongly disagree) with only 28.4% agreeing or strongly agreeing that customers in their communities pay for their electricity.

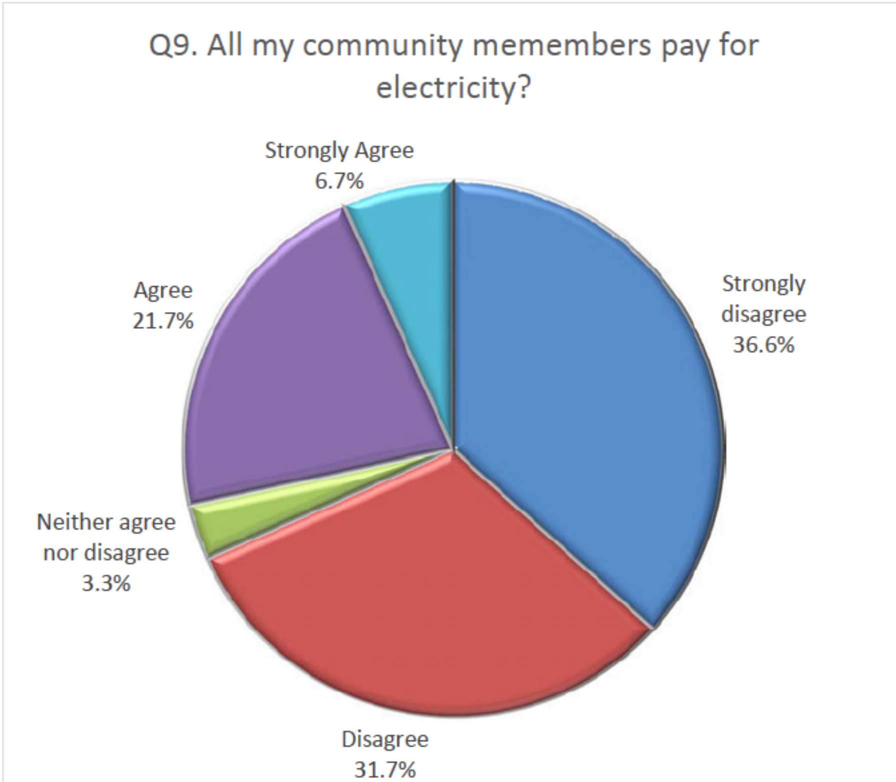

Figure 4-2. Payment of electricity in communities

4.3.3 Electricity theft

The theft of electricity through illegal connections is another potential cause of Eskom's NTL losses. Study participants were asked about their opinion regarding the theft of electricity and their responses are summarized in Table 4-8 and Figure 4-3 below.

Table 4-8. Electricity theft

Q12. I think it is easy to steal electricity??			
	Frequency	Percent	
Strongly disagree	4	6.6%	18.3%
Disagree	7	11.7%	
Neither agree nor disagree	10	16.7%	16.7%
Agree	25	41.7%	65.0%
Strongly Agree	14	23.3%	

The results show that the majority believe or know that it is easy to steal electricity (65.0% agree or strongly agree) with only 18.3% disagreeing or strongly disagreeing. This means that electricity theft is a significant driver of Eskom's losses.

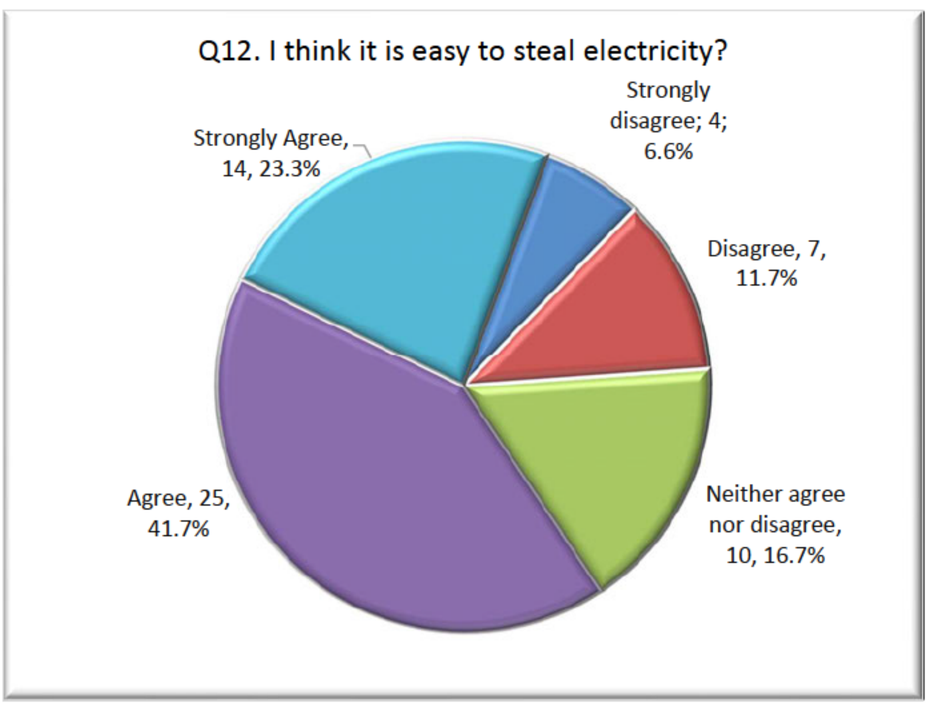

Figure 4-3. Theft of electricity.

4.3.4 Settlement of debt

The willingness to settle debts by those who owe Eskom is another potential cause of Eskom's NTL losses. The results about the willingness to enter a payment arrangement by debtors to settle amounts owing are summarized in Table 4-9 below.

Table 4-9 Willingness to enter payment arrangements for amounts owing.

Q21.I would enter into a payment arrangement to settle the historical debt?			
	Frequency	Percent	
Strongly disagree	27	45.0%	53.3%
Disagree	5	8.3%	
Neither agree nor disagree	28	46.7%	46.7%

Results in Table 4-9 show that none of the respondents showed any willingness to make payment arrangements to settle amounts owing. The result indicates a general resistance to paying any historical debts by customers.

4.3.5 Network performance and NTL losses

This section looks at network performance as a potential source of NTL losses. The results are addressed by questions 10 and 11 of the questionnaire. The summary statistics addressing this research question are presented in Table 4-10 below. The results show that only 20% of the respondents indicated that they rarely experienced power failures in their areas, while 36.7% experienced power failure usually (21.7%) or always (15%).

This indicates a system that is generally or always malfunctioning 36.7% of the time. This is a significant loss to Eskom.

Table 4-10. Frequency of power failures.

	Category	Frequency	Percent
Q10. I often experience power failures frequently in my area?	Rarely	12	20.0%
	Sometimes	26	43.3%
	Usually,	13	21.7%
	Always	9	15.0%
Q11. I experience power failures during peak periods from 5 pm to 8 pm and 6 am to 9 am?	Yes	31	51.7%
	No	20	33.3%
	Not Applicable	9	15.0%

The power failures are also mostly experienced during peak periods from 5 pm to 8 pm and from 6 am to 9 am as indicated by 51.7% of participants who said they experienced power failures. The frequency of power failures during peak periods is an indication of overloaded networks resulting in poor network performance. Only 33.3% indicated that these power failures were not during peak periods.

4.3.6 The relationship between network performance and customer satisfaction

This section looks at the relationship between network performance and customer satisfaction. Issues around customer satisfaction are addressed in questions 18, 19, and 20, and network performance is measured by questions 10 and 11 of the questionnaire.

4.3.6.1 Customer behavior

Lack of customer education on energy-saving techniques could give rise to NTL losses, results from the table below 66.7% of respondents said that Eskom has educated them sufficiently on energy-saving techniques and 18.3% of respondents disagreed. Eskom needs to continue Educating customers on energy-saving techniques.

Table 4-11. Customer Education

Q22. I have been educated by Eskom sufficiently on energy-saving techniques?			
	Frequency	Percent	
Strongly disagree	3	5.0%	18.3%
Disagree	8	13.3%	
Neither agree nor disagree	9	15.0%	15.0%
Agree	33	55.0%	66.7%
Strongly Agree	7	11.7%	

The summary statistics for network performance are presented in Table 4-11 above and results of customer satisfaction are presented in Table 4-12 below.

Table 4-12. Customer satisfaction is measured by time to respond to fault reports, updates on logged faults, and general satisfaction with Eskom service delivery.

<table>
<tr><th></th><th>Category</th><th>Frequency</th><th>Percent</th><th></th></tr>
<tr><td rowspan="3">Q17.When I have logged a fault with Eskom is it attended within a reasonable time?</td><td>Same day</td><td>16</td><td>26.7%</td><td rowspan="2">81.7%</td></tr>
<tr><td>Within a week</td><td>33</td><td>55.0%</td></tr>
<tr><td>Longer than a week</td><td>11</td><td>18.3%</td><td>18.3%</td></tr>
<tr><td rowspan="5">Q18.I am given continuous updates and feedback on faults logged?</td><td>Strongly disagree</td><td>7</td><td>11.7%</td><td rowspan="2">51.7%</td></tr>
<tr><td>Disagree</td><td>24</td><td>40.0%</td></tr>
<tr><td>Neither agree nor disagree</td><td>16</td><td>26.7%</td><td>26.7%</td></tr>
<tr><td>Agree</td><td>12</td><td>20.0%</td><td rowspan="2">21.7%</td></tr>
<tr><td>Strongly Agree</td><td>1</td><td>1.7%</td></tr>
<tr><td rowspan="7">Q19. I am satisfied with Eskom's service delivery.</td><td>Very Dissatisfied</td><td>8</td><td>13.3%</td><td rowspan="3">38.3%</td></tr>
<tr><td>Dissatisfied</td><td>7</td><td>11.7%</td></tr>
<tr><td>Somewhat Dissatisfied</td><td>8</td><td>13.3%</td></tr>
<tr><td>Neither Dissatisfied nor Satisfied</td><td>6</td><td>10.0%</td><td>10.0%</td></tr>
<tr><td>Somewhat Satisfied</td><td>14</td><td>23.3%</td><td rowspan="3">51.7%</td></tr>
<tr><td>Satisfied</td><td>16</td><td>26.7%</td></tr>
<tr><td>Very Satisfied</td><td>1</td><td>1.7%</td></tr>
</table>

As far as the response time to faults is concerned 81.7% of the respondents indicated that faults are attended to on the same day or within a week. Only 18.3% indicated that it took longer than a week to have faults attended to.

This shows that Eskom has a reasonable response time to faults. However, there is a need to improve on communicating updates on logged faults as 51.7% indicated that no updates and feedback on logged faults are not given. Only 21.7% indicated that they got continuous updates and feedback on faults logged. The balance of satisfaction on service delivery is tilted towards the positive as 51.7% indicated that they were somewhat satisfied (23.3%), satisfied (26.7%), and very satisfied (1.7%). It is still a major cause of concern that 38.3% are between somewhat dissatisfied to very dissatisfied.

4.3.6.2 Impact of network performance and customer satisfaction

While questions 17 (When I have logged a fault with Eskom is it attended within a reasonable time?) and 18 (I am given continuous updates and feedback on faults logged?) somewhat address customer satisfaction, it is question 19 (I am satisfied with Eskom's service delivery.) which directly addresses customer satisfaction. Chi-square tests were carried out to assess the association between network performance and the direct measurement of customer satisfaction (question 19).

Table 4-13. Tests of the relationship between network performance and customer satisfaction.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Q19. I am satisfied with Eskom's service delivery.</td><td colspan="3">Chi-square tests</td></tr>
<tr><td>Strongly Disagree to Disagree</td><td>Neither Agree nor Disagree</td><td>Agree too Strongly Agree</td><td>χ^2</td><td>df</td><td>p-value</td></tr>
<tr><td rowspan="4">Q10.I often experience power failures frequently in my area?</td><td>Strongly Disagree</td><td>3</td><td>2</td><td>7</td><td rowspan="4">14.997</td><td rowspan="4">6</td><td rowspan="4">0.020</td></tr>
<tr><td>Disagree</td><td>5</td><td>4</td><td>17</td></tr>
<tr><td>Agree,</td><td>8</td><td>0</td><td>5</td></tr>
<tr><td>Strongly agree</td><td>7</td><td>0</td><td>2</td></tr>
<tr><td rowspan="3">Q11. I experience power failures during peak periods from 5 pm to 8 pm and 6 am to 9 am?</td><td>Strongly Agree</td><td>14</td><td>2</td><td>15</td><td rowspan="3">2.913</td><td rowspan="3">4</td><td rowspan="3">0.607</td></tr>
<tr><td>Strongly Disagree</td><td>7</td><td>2</td><td>11</td></tr>
<tr><td>Neither Agree nor Disagree</td><td>2</td><td>2</td><td>5</td></tr>
</table>

The results in Table 4-13 show that there is a significant association between the frequency at which customers experience power failures and satisfaction with Eskom's service delivery (Chi-square=14.997, p-value=0.020).

Those who rarely or sometimes experienced power failures in their areas had higher numbers of satisfied customers than those who usually or always experienced power failures.

However, there is no significant association between the period when power failures were experienced and satisfaction with Eskom's service delivery (Chi-square=2.913, p-value=0.607).

4.3.7 Electrification rollout.

This section assesses if the rollout of electrification projects is reaching customers timeously before they are tempted to steal electricity. The research question addressed in this section is

- Are the electrification projects reaching customers timeously?

4.3.7.1 Assessment of rollout of electrification projects

Results in Table 4-14 show that the respondents were not impressed with the rollout of electrification projects.

Table 4-14. Assessment of the rollout of electrification projects.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Agree/ strongly agree
Q13. I feel that the Department of Minerals and Energy has provisioned an adequate budget allocation to meet the electrification targets?	Count	9	25	13	11	2	21.7%
	Percent	15.0%	41.7%	21.7%	18.3%	3.3%	
Q14. Households in rural areas timeously electrified?	Count	12	22	8	16	2	30.0%
	Percent	20.0%	36.7%	13.3%	26.7%	3.3%	
Q15.Pricing structures for new service applications is affordable?	Count	15	23	13	9	0	15.0%
	Percent	25.0%	38.3%	21.7%	15.0%	0.0%	
Q16. Pricing structures for customer upgrades is affordable?	Count	13	28	11	8	0	13.3%
	Percent	21.7%	46.7%	18.3%	13.3%	0.0%	

Only 21.7% of the respondents agreed or strongly agreed that the Department of Minerals and Energy had provisioned an adequate budget allocation to meet the electrification targets. Only 30.0% agreed or strongly agreed that households in rural areas were timeously electrified. This is an indication that there is a need to put more effort into the rollout of electrification projects.

As far as pricing is concerned, most of the respondents believe that the pricing structures for new service applications were not affordable. Only 15% believed that the pricing structures were affordable. Only 13.3% of the respondents agreed or strongly agreed that the pricing structures for customer upgrades were affordable with the majority disagreeing (46.7%) or strongly disagreeing (21.7%).

4.3.7.2 Assessment of electronification by Eskom and other suppliers

The electrification performance assessment between Eskom and other suppliers is executed utilizing the chi-square, and the results are presented in Table 4-15.

Results in Table 4-15 show no association between electricity suppliers and views on whether the Department of Minerals and Energy had provisioned an adequate budget allocation to meet the electrification targets (Chi-square=3.059, p-value=0.217). This means that similar response patterns were realized for those who get their electricity from Eskom and those from other suppliers. Only 23.3% of Eskom customers agreed or strongly agreed that the Department of Minerals and Energy had provisioned an adequate budget allocation to meet the electrification targets, while 20.0% from other suppliers also agreed or strongly agreed. The levels of agreement are not significantly different.

Concerning whether rural households are timeously electrified, there was a higher level of agreement with Eskom customers (43.3%) than customers of other suppliers (16.7%). Responses from these two groups of customers were significantly different (Chi-square=6.997, p-value=0.030).

Table 4-15. Assessment of the association between rollout of electrification projects and electricity supplier.

		Q1. Is your electricity supplied by Eskom?		Chi-square tests		
		Yes	No	χ^2	df	p-value
Q13. I feel that the Department of Minerals and Energy has provisioned an adequate budget allocation to meet the electrification targets?	Disagree/Strongly disagree	14	20	3.059	2	0.217
	Neither agree nor disagree	9	4			
	Agree/Strongly agree	7	6			
	%	23.3%	20.0%			
Q14. Households in rural areas timeously electrified?	Disagree/Strongly disagree	12	22	6.997	2	0.030
	Neither agree nor disagree	5	3			
	Agree/Strongly agree	13	5			
	%	43.3%	16.7%			
Q15.Pricing structures for new service applications is affordable?	Disagree/Strongly disagree	19	19	1.692	2	0.429
	Neither agree nor disagree	8	5			
	Agree/Strongly agree	3	6			
	%	10.0%	20.0%			
Q16. Pricing structures for customer upgrades is affordable?	Disagree/Strongly disagree	20	21	1.343	2	0.532
	Neither agree nor disagree	7	4			
	Agree/Strongly agree	3	5			
	0%	10.0%	16.7%			

There was no significant association between supplier (Eskom or others) and whether pricing structures for new service applications were affordable (Chi-square=1.692, p-value=0.429) and whether pricing structures for customer upgrades were affordable (Chi-square=1.343, p-value=0.532). In both cases, customers for Eskom and other suppliers found the pricing structures rather unaffordable as indicated by low percentages of those either agreeing or strongly agreeing that they were affordable.

4.3.8 Socio-economic inclusive tariffs

This section analyses the alignment of Eskom's tariff structures to cater to all socio-economic groups. The research question addressed in this section is

To recommend strategies that will improve revenue collection.?

The questions that best address revenue collection is as follows:

5. Electricity tariffs are affordable?

15. Pricing structures for new service applications affordable?

16. Pricing structures for customer upgrades affordable?

21. I am billed per my energy consumption.

Employment status and ownership of certain electronic appliances can be regarded as socio-economic status thus the questions that address socio-economic groups are as follows:

3. Are you currently employed or is someone in your household employed?

6. I have the following appliances.

The associations among these groups of variables can be regarded as a measure of the alignment of Eskom's tariff structures to cater to all socio-economic groups.

4.3.9 Assessment of Eskom's tariff structures by employment status

The results in Table 4-16 show that the affordability of electricity tariffs is significantly different between those whose households have someone who is employed and those who do not (Chi-square=20.256, p-value<0.001). Although respondents generally found electricity tariffs not affordable, those who are not employed were even more negative about it (0% agreed or strongly agreed) while those with someone in the household employed were a little more positive about the affordability of tariffs (30.4% agreed or strongly agreed).

The affordability of the pricing structures for new service applications was found to be significantly different between those who are currently employed and those who are not (Chi-square=7.264, p-value=0.026). Those who are not employed were more negative about the pricing structures for new service applications (0% agreed or strongly agreed) while those with someone in the household employed were a little more (16.1% agreed or strongly agreed).

Table 4-16. Assessment of the association between employment status and Eskom's tariffs structures.

		Q3. Are you currently employed or is someone in your household employed?		Chi-square tests		
		Yes	No	χ^2	df	p-value
Q5. Electricity tariffs are affordable?	Disagree/Strongly disagree	36	1	20.256	2	<0.001
	Neither agree nor disagree	3	3			
	Agree/Strongly agree	17	0			
	%	30.4%	0.0%			
Q15.Pricing structures for new service applications is affordable?	Disagree/Strongly disagree	37	1	7.264	2	0.026
	Neither agree nor disagree	10	3			
	Agree/Strongly agree	9	0			
	%	16.1%	0.0%			
Q16. Pricing structures for customer upgrades is affordable?	Disagree/Strongly disagree	39	2	3.126	2	0.209
	Neither agree nor disagree	9	2			
	Agree/Strongly agree	8	0			
	%	14.3%	0.0%			
Q21. I am billed per my energy consumption.	Disagree/Strongly disagree	12	0	1.116	2	0.572
	Neither agree nor disagree	13	1			
	Agree/Strongly agree	31	3			
	%	55.4%	75.0%			

There were no significant differences between those who are employed and those who are not in the way they viewed the pricing structures for customer upgrades (Chi-square=3.126, p-value=0.209), and how they perceived billing per energy consumption (Chi-square=1.116, p-value=0.527).

4.3.10 Assessment of Eskom's tariff structures by the appliances in the household

Table 4-17. Assessment of the association between type appliances used and Eskom's tariff structures.

		Q6, I have the following electrical appliances in my household		Chi-square tests		
		Basic Appliances	More Appliances	χ^2	df	p-value
Q5. Electricity tariffs are affordable?	Disagree/Strongly disagree	7	30	5.787	2	0.055
	Neither agree nor disagree	3	3			
	Agree/Strongly agree	1	16			
	%	9.1%	32.7%			
Q15 Pricing structures for new service applications is affordable?	Disagree/Strongly disagree	6	32	5.702	2	0.058
	Neither agree nor disagree	5	8			
	Agree/Strongly agree	0	9			
	%	0.0%	18.4%			
Q16. Pricing structures for customer upgrades is affordable?	Disagree/Strongly disagree	7	34	0.812	2	0.666
	Neither agree nor disagree	3	8			
	Agree/Strongly agree	1	7			
	%	9.1%	14.3%			
Q21. I am billed per my energy consumption.	Disagree/Strongly disagree	4	8	2.255	2	0.324
	Neither agree nor disagree	2	12			
	Agree/Strongly agree	5	29			
	%	45.5%	59.2%			

The results in Table 4-17 show that the affordability of electricity tariffs is not significantly different between those who use basic and those who use more appliances (Chi-square=5.787, p-value=0.055).

The affordability of the pricing structures for new service applications was found to be not significantly different between the basic appliance users and those who have more (Chi-square=5.702, p-value=0.058). The affordability of the pricing structures for new service applications was found to be not significantly different between the basic appliance users and those who have more (Chi-square=5.702, p-value=0.058).

The same applies to the affordability of pricing structures for customer upgrades (Chi-square=0.812, p-value=0.666) and the perception of whether customers are billed per their energy consumption or not (Chi-square=2.255, p-value=0.324)

4.4 Section C: Open ended questions

Section C comprised of two open-ended questions that were more qualitative and aimed to answer the research questions and give recommendations that can be employed to address the NTL in Eskom. What do you feel that the government can do differently to address the energy theft crisis in South Africa? The first question aims to get the respondents' opinions on whether the government support was adequate to address the energy theft crisis in South Africa. This question established the areas that attribute to NTL to recommend to Eskom.

4.4.1 Summary for question 23

Table 4-18. Possible Government actions to address the energy theft crisis in South Africa.

Q23.What do you feel that government can do differently to address the energy theft crisis in South Africa?		
Comment	Frequency	Percent
Strengthen Law enforcement and put in place heavy penalties	17	31.5%
Educate people that they must pay for services and create jobs so that people can pay for their electricity	7	13.0%
Strengthen relationships between local municipalities and Eskom and safeguard accountability	1	1.9%
Electrify both urban and rural areas timeously	6	11.1%
Reduce rates or provide free or low tariffs to the low-income earners	8	14.8%
Government must support Eskom to make electricity affordable	2	3.7%
Train and monitor contractors on new technologies	1	1.9%
Research and implement new technologies and strategies including tamper-proof cables	6	11.1%
Proper maintenance infrastructure and manpower development	2	3.7%
Educate people, lower tariffs, and tighten law enforcement	1	1.9%
Offer informal settlements alternative sources of affordable electricity	2	3.7%
Engage and have a dialogue with community leaders and get community-based solutions.	1	1.9%

Out of the 60 respondents to this question, 17 respondents said law enforcement needs to be strengthened and heavy penalties are to be imposed on defaulters; 8 of them thought that electricity rates should be reduced or lower tariffs to be offered for lower-income earners.

In contrast, 7 respondents said that people must be educated to pay for services and jobs must be created so that the people can afford to pay for electricity, 6 respondents said that research and implementation of new technologies, 6 participants said both urban and rural should be electrified timeously, 2 participants said the informal settlement should be offered alternative sources of affordable electricity, whilst 2 participants said the government should support Eskom to make electricity cheap, 2 respondents said proper maintenance and manpower development, 1 respondent said train and monitor contractors on new technologies and the1 respondent said engage community leaders and get community-based solutions.

Figure 4-4 is the graphical representation of table 4-18. 31.5% of respondents said the government needs to strengthen law enforcement and impose heavy penalties, 14.8% of respondents said to reduce the rates for lower-income earners, 13 % of respondents said job creation and customer education were needed so customers could pay for the services rendered to them, 11.1% respondents said that research into better technological solutions, 11.1% respondents said that electrification in urban and rural areas should be given equal priority, 3.7% said informal settlements should be offered an alternative source of energy that is affordable, 3.7% respondents said proper maintenance of networks and manpower developments is needed and lastly 1.9% said engagements with community leaders and to get community-based solutions.

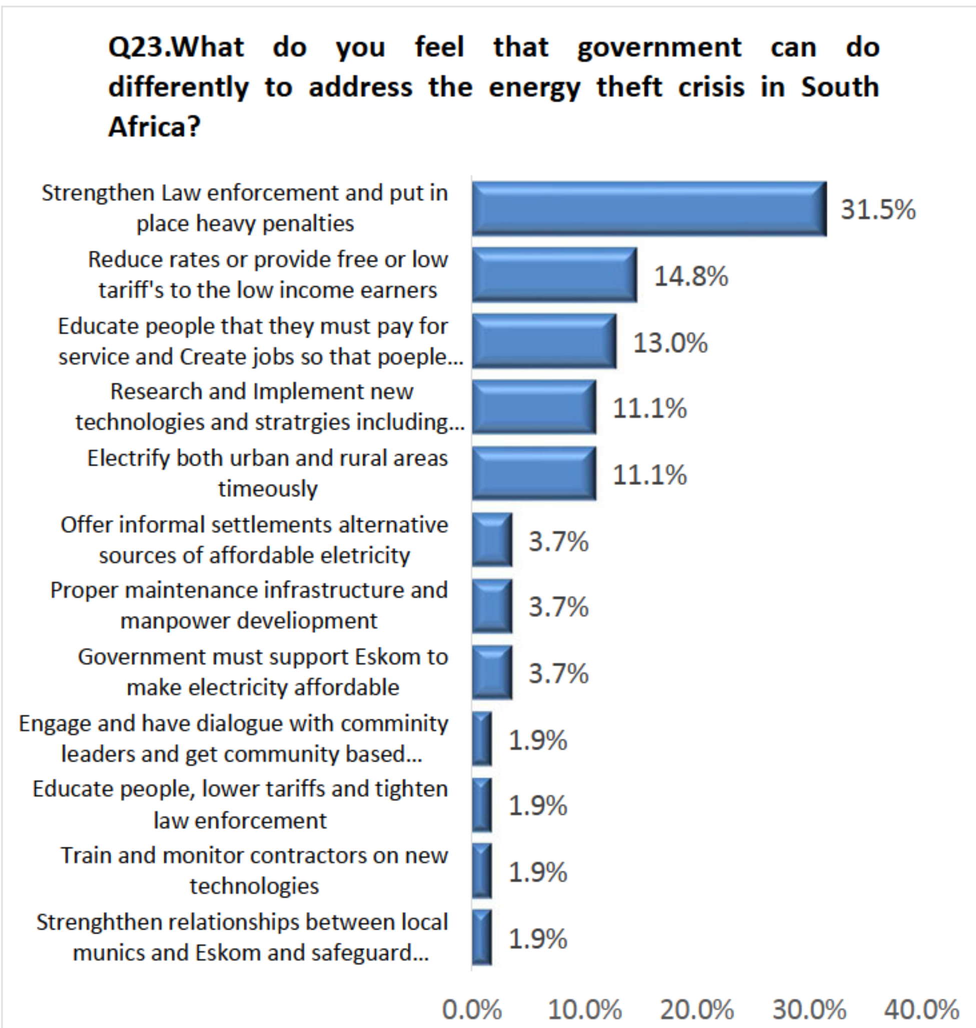

Figure 4-4. Possible government actions to address the energy theft crisis in South Africa are arranged in order of the most mentioned actions

The second open-end question aimed to get the respondent's views on methods to improve revenue collection for the power debt-stricken power utility Eskom.

4.4.2 Summary for question 24

Table 4-19 Possible actions to address the revenue collection crisis in Eskom South Africa.

Q24.What do you think Eskom should do differently to improve revenue collection?		
	Frequency	Percent
Provide adequate electricity supply/ Expedite the electrification/normalization projects	3	5.8%
Get community leaders/councilors involved in educating the masses about paying tariffs.	2	3.8%
Limit contracting out projects.	1	1.9%
Rollout tamper-proof prepaid meters, get the government involved for bulk customers, / prosecute offenders.	7	13.5%
Timely supply of electricity and attending to faults.	4	7.7%
Employ more people for meter reading, auditing, checking illegal connections, and disconnections.	5	9.6%
Expand infrastructure.	2	3.8%
Normalize all illegal customers into prepaid, tamper-proof meters.	4	7.7%
Supervise all electricity vendors closely.	1	1.9%
Conduct regular customer audits and follow up on payments. Arrange payment plans. Promote customer awareness.	4	7.7%
Use monitoring devices that will help Investigate and identify any electricity theft.	3	5.8%
Do proper customer risk assessment before connecting them.	1	1.9%
Deal with corruption decisively/ investigate and prosecute offenders	3	5.8%
New technology that detects meters or systems tampering/ smart metering.	10	19.2%
Provide cheaper flat rates to underprivileged communities.	1	1.9%
Cut off, non-paying customers.	1	1.9%

Table 4-19 and figure 4-5, are the tabular and graphical representations of question 24 which seek to obtain the respondent's views on methods to improve revenue collection. Out of the 60 respondents 19.2% said that the introduction of new technology that detects meter or system tampering/ smart metering, 13.5% respondents said rollout tamper proof prepaid meters and get the government involved bulk customers and prosecute offenders, 9.6 % respondents said employ more meter reading, auditing and checking illegal connections, 7.7% conduct regular audits and follow-up on payments and promote customer awareness, 7.7% normalize illegal customers into prepaid tamper proof meters, 7.7% timely supply of electricity and attending to faults, 5.8 % respondents said deal with corruption decisively/ investigate and prosecute offenders, 5.8% use monitoring devices that will help research and identify and electricity theft, 5.8% provide adequate electricity supply to expedite on electrification/normalization projects, 3.8% expand on infrastructure , 3.8% get community leaders involved to educate customers about paying for services , 1.9% cut off non-paying consumers, 1.9% provide a cheaper flat rate to under privileged communities, 1.9% do a proper risk assessment before connecting the customers, 1.9 % supervise all electricity vendors closely, and lastly 1.9% limit the contracting our projects.

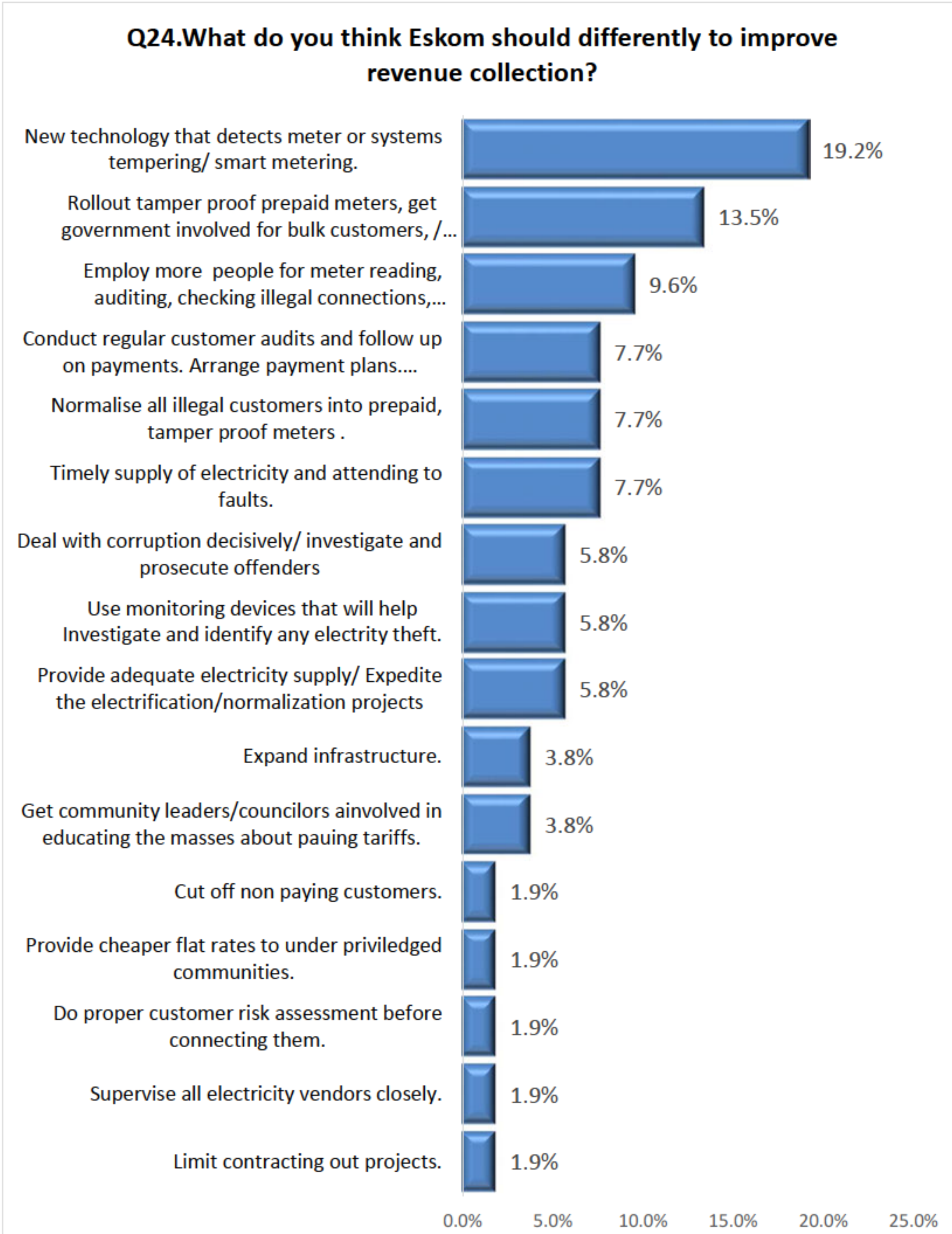

Figure 4-5. Possible Eskom actions to address the energy theft crisis in South Africa arranged in order of the most mentioned actions

4.5 Reliability check using Cronbach's Alpha

Validity and Reliability are two important aspects of precision in research that enable the study to yield designed results. An acceptable reliability coefficient reflects 0.7 or higher for a newly developed construct (Sürücü and Maslakci, 2020).

Table 4-20 Reliability analysis

Construct	**Number of items**	**Cronbach's Alpha**	**Comment**
Increase in NTL losses increase	8	0.712	Moderate internal consistency
Electrification projects	5	0.632	Moderate internal consistency
Socio-economic inclusive tariffs	5	0.701	Moderate internal consistency
Overall questionnaire All QUESTIONNAIRE Questions except the background information	18	0.723	Moderate internal consistency

Table 4-20 above, is the reliability analysis of the constructs using Cronbach's Alpha. The overall questionnaire is within the expectable limits, the overall constructs had a moderate internal consistency.

Below is the formula that was utilized to calculate the Cronbach Alpha for the three constructs and the overall questionnaire.

Formula:

$$\alpha = \frac{K}{K-1}\left[1 - \frac{\Sigma S^2 y}{S^2 x}\right]$$

Where α is the Cronbach alpha, K is the number of test items, $\Sigma S^2 y$ is the sum of the item variance and $S^2 x$ is the variance of the total score.

Table 4-21 Overall Cronbach Alpha for the Questionnaire

Cronbach Alpha	No of the items (excluding questions 1 to question 5)
0.723	18

Table 4-22 Interpretation of the Cronbach

Cronbach Alpha	Interpretation of the Cronbach Alpha
$\geq 0,9$	The scale of the internal consistency is high
$0,7 \leq \alpha < 0,9$	Scale has internal consistency
$0,6 \leq \alpha < 0,7$	Internal consistency of scale is acceptable
$0,5 \leq \alpha < 0,6$	Internal consistency of scale is weak
$\alpha \leq 0,5$	The scale has no internal consistency

Source: (Sürücü and Maslakçı, 2020:2714)

In table 4-20 the Cronbach for the following constructs Increase in NTL losses increase was at 0,712 which is within the acceptable limits of 0,7. Electrification projects with a Cronbach Alpha of 0,632 which is within the acceptable limits. The socio-economic inclusive tariffs construct had a Cronbach Alpha of 0.701 which has internal consistency.

In table 4-21 the overall Cronbach Alpha was 0,723 for the 18 items which excluded questions 1 to 5.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Introduction

The data collected from the study relating to the research questions were presented in the preceding chapter. In this chapter, the investigation concluded and based on the analysis, the recommendations to address the NTL in Eskom Kwa- Zulu Natal Operating Unit.

The objective was to investigate the motives behind energy theft from energy consumers in the electricity consumers of Eskom Kwa-Zulu Natal Operating Unit.

The investigation addressed the following questions.

- What are the causes of electrical energy theft in Eskom?
- What are the electrification gaps in Eskom and how can they be improved?
- What can be done to improve revenue collection at Eskom?

In chapter 2, the researcher aimed to use literature to answer the above investigation questions. A survey questionnaire additionally was employed to collect empirical data from participants. In chapter 3, the collected data is analyzed and presented in chapter 4. In the preceding section, furthermore, presented is the summary of the findings

5.2 Summarized findings

In chapter 2, the researcher identified two main reasons for the utility's increasing NTL: the perceived perception that electricity is a right and the socio-economic factors.

5.2.1 The perceived perception that electricity is right

The perceived perception that electricity is a right refers to people who do not have access to electricity or cannot afford the payment charges to access the electricity grid. Universal access to electricity is a concern for most Sub-Saharan countries, including South Africa.

Politics have also contributed to the perceived perception that electricity should be free to everyone, thus giving rise to the perceived perception that electricity is a right.

5.2.1.1 Electrification

The distance between households in rural areas can be significantly great, increasing electrification project costs. Electrification in rural areas has high connection charges, and Eskom needs to carefully consider the choices between consumption levels and density population (Dagnachew et al., 2017:180).

In the study, 36.7% of participants felt that rural households are not electrified timeously.

Political influences and external pressures further exert constraints on Eskom to deliver on electrification projects. Eskom relys on government subsidies to able to fund electrification projects. When the government imposes budget cuts and Eskom cannot meet the forever-increasing electrification demand, and thus people resort to connecting themselves to the electricity grid illegally.

The illegal connections induce further constraints on the aging infrastructure. The net effect resultant is poor quality supply to paying legal customers connected to the electricity grid. Poor supply quality has a ripple effect on SA’s economic stability and thus contributes to the high unemployment rates.

5.2.1.2 Non-payment culture

The non-payment culture refers to the behavioral tendency that dates to the apartheid era, where people were dissatisfied due to poor service delivery that resulted from segregation due to ethnic affiliation.

Post the apartheid era, the culture of non-payment for services still poses a significant risk to utility sustainability. In this study, 53.3% of the respondents indicated that they would not settle the historical debt if Eskom allowed consumers to make payment arrangements. 68% of the respondents stated that they believed that, generally, most communities do not pay for electricity. Non-payment culture has been condoned for many decades with no proper repercussions for the defaulters.

In this study, 31.5% of respondents indicated that the government could support utilities by strengthening law enforcement measures to help utilities reduce NTL.

5.2.1.3 Affordability

93.3% of the respondents were employed in the study, and 6.7% were unemployed. The researcher can deduce that even though most respondents were employed, they struggled to pay for their electricity services.

In the study, 67% of respondents stated that they found the electricity tariffs were unaffordable. The study revealed that other electricity suppliers other than Eskom had similar pricing models to Eskom.

In the study, the respondents from both households with someone employed and where no one is employed found electricity unaffordable.

5.2.1.4 Customer satisfaction

Customer satisfaction is dependent on good customer service; good customer service can provide many benefits for utilities. Customer satisfaction can have detrimental impacts on businesses. The rolling blackouts have negatively impacted Eskom's potential for revenue collection. Consumers have lost confidence in Eskom's ability to deliver uninterruptable electricity services, and therefore, the Eskom brand image is further tarnished.

5.2.2 Socio-economic factors

SA is rated among the world's highest countries with equality with inequality. In 2015, 55% of SA's population were living at the upper poverty line and were struggling to purchase basic items such as food (World Bank Group, 2020).

5.2.2.1 Social inclusive tariffs

81.7% of participants in the study indicated that they had more than just basic appliances in their households. The participants in the study confirmed that there is a significant association between appliances in use and the perceived affordability of electricity tariffs. The socio-economic status of those with more appliances enabled them to have the perception that the electricity tariffs are affordable and those with fewer appliances find electricity tariffs unaffordable.

In the study a test was conducted to test the association between employment status and Eskom tariff structures, generally, the respondents found the electricity tariffs unaffordable. Both the unemployed and employed participants found that pricing structures for customer upgrades and new service applications were unaffordable.

68% of the participants indicated that they believe that not all their communities pay for electricity.

5.2.2.2 Electricity theft

Electricity theft has been a going concern for most power utilities worldwide. SA is no exception to energy theft. In SA average loss of revenue due to electricity theft is R20 billion per year. Electricity theft can be characterized into a few categories such as ghost vending (selling illegal electricity vouchers), physically connecting to the electricity grid without payment, theft of cables, and vandalism of infrastructure (Nhede, 2017:170).

In the study, 65% of the participants believed that is relatively easy to steal electricity in SA. Participants felt that it was generally easy for communities to access Eskom meters and that the utility needs to invest in innovative technological solutions to limit the public from Eskom's infrastructure. 31.5% of the participants indicated that additional law enforcement measures and penalties should be enforced on those who steal electricity. 7.7% of the participants indicated that normalizing illegal consumers to be legal consumers would assist Eskom's efforts toward decreasing energy theft.

5.3 Recommendations

Below are recommended strategies to enable Eskom the financially constrained utility to reduce NTL and thus increase the potential to collect revenue.

5.3.1 The perceived perception that electricity is right

Eskom needs to collaborate with the government to change this mindset that people are entitled to free services. Local government personnel such as community leaders should form partnerships in addressing non-technical losses in communities.

5.3.2 Customer satisfaction

Eskom needs to ensure that the customers are satisfied to purchase more services; if customers are not satisfied with services rendered, they will be reluctant to buy services. Eskom needs to improve customer satisfaction to improve the company's corporate image. Consumer satisfaction can be improved by providing continuous feedback for fault restoration times. The electricity consumers perceived satisfaction could be attained by keeping the continuous feedback loop.

5.3.3 Electrification

Eskom needs to ensure that both rural and urban customers are given equal preference to electrification projects. Eskom should avoid being influenced by politics as these have proven to affect the way projects are prioritized. Alternative energy source measures, such as micro-grids and solar panels should be considered to provide alternative sources of electricity to the rural areas, this could enable Eskom to reduce the cost per connection for rural households.

5.3.4 Non-payment culture

The non-payment culture for Eskom services can be corrected by joint partnerships between Eskom and the government. The government needs to support Eskom in introducing new legislative laws and acts, to support the paradigm shift of paying for services. Strict penalties across the whole energy sector should be imposed as reinforcement measures against defaulters.

Eskom needs to introduce pre-paid debt recovery, to assist defaulting customers to able to make payment arrangements for outstanding debts.

5.3.5 Social inclusive tariffs

Eskom needs to design tariffs that cater to all socio-economic groups. Pricing models for new connections and customer upgrades need to be reviewed.

5.3.6 Upgrading of infrastructure

The power utility needs to intensify efforts to improve customer satisfaction. The utility needs to continue to intensify efforts in performing network cleanups by conducting audits and disconnecting consumers that tampered with the Eskom infrastructure.

Eskom should consider a phased approach in upgrading the current distribution infrastructure to smart grids that have built-in analytics and intelligence to monitor, detect, and non-technical energy losses on the distribution network. The utility needs to invest in upskilling and training their manpower to cater to future technological advancements.

Recommendations for future research are needed to observe the impact of technology in reducing NTL.

5.4 Conclusion

Utilities from first-world countries and third countries are negatively impacted by NTLs. NTL is a going concern for all utilities and innovative measures are required to enable the utility to optimize the opportunity cost of the revenue foregone.

The increase in NTL experienced by Eskom not only affects Eskom but affects the larger masses of South Africa as energy access has a direct correlation with GDP and the livelihoods of households. A collaborative approach is needed between Eskom and the government to address the rising pressures induced by NTL, the use of theoretical knowledge in new technologies, reviewing tariff structures, the introduction of new policies in the country to help reduce energy theft, joint partnerships between Eskom and the community leaders and strengthening law enforcement.

For adequate generalization to be made using this study, some parameters need to be re-investigated to cater to electricity consumers that are also supplied by other electricity service providers. Although the study was concluded, the study was only limited to Eskom customers in KZNOU. Considering the socio-economic impact of the study, it would be beneficial to replicate the study in other provinces to observe consumer behavior.

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7. APPENDIXES

A: Gate keeper letter with Amended title

Eskom

Nontobeko Matli
Unique number: 3884542
ID number: 8406050432088

Date: 02 February 2023

Enquiries: Khanyisa Sihlobo
Position: Middle Manager Zone Management Maintenance and Operations

Contact: 033 395 7021/ 083 535 9952

TO WHOM IT MAY CONCERN
RE: APPLICATION TO CONDUCT RESEARCH WITHIN ESKOM KWA-ZULU NATAL

This is to certify that **Nontobeko Samukelisiwe Matli,** ID No. **8406 05043 2088** is currently employed in Eskom CentralEast Cluster as a **Manager Control Plant Maintenance**.

She is granted permission to conduct a research on: **The impact of electrical energy theft on revenue collection at Eskom in KwaZulu-Natal province**

Yours sincerely

Khanyisa Sihlobo
Middle Manager – Zone Management Maintenance and Operations
Eskom Distribution – KZN Operating Unit
1 Portland Road
Mkhondeni, Pietermaritzburg
Tel: 033 395 7021| Cell: 083 535 9952
Email: SihlobKP@eskom.co.za

Signature: ...[redacted].................
Date: 02 Feb 2023 ....

Eskom Distribution CentralEast Cluster
1 Portland Road
Mkhondeni, Pietermaritzburg 3610 SA
Tel +27 33 395 7021 www.eskom.co.za

Eskom Holdings SOC Limited Reg No 2002/015527/06

B: Informed consent

Master of Business Administration (MBA) Research Project

Researcher: Nontobeko Matli (+27 730 22 5158)

Supervisor: Dr Bibi Zaheenah Chummun (+27 31 260 8943)

Research Office: Ms. D Dlamini (+27 31 260 4557) or
Mrs M Snyaman (+27 31 260 8350)

Dear respondent,

I Nontobeko Matli, student no. 219037416 an MBA (Master of Business Administration) student, at the Graduate School of Business and Leadership of the University of Kwa-Zulu Natal invite you to participate in the research study titled. The investigation into the impact of electrical energy theft on revenue collection at Eskom in KwaZulu-Natal province.

This research aims to understand the motives behind energy theft from electricity consumers. In understanding the motives behind energy theft, the utility can explore obtaining innovative solutions to reduce energy theft and increase revenue in Kwa-Zulu Natal Operating Unit.

The participation of this research is limited to only consumers of electricity that are directly fed by Eskom customers and Eskom employees

Electricity consumers that are directly fed by municipality infrastructure are excluded from participating in this research.
The results of the study are intended to be used for the compilation of my dissertation as a requirement to achieve an MBA

The researcher cannot guarantee that there will be no discomfort in answering the following questions. You are encouraged to answer all questions and your responses will be purely used for research purposes only.

There is no promise that you will receive any benefit from taking part in this study.
Your participation in this study may help the researcher understand electricity consumer behavioral patterns.

Your records will be kept confidential and will not be released without your consent except as required by law. Your identity will be kept private. The results of this study will be written in an academic paper and your name will not be used nor disclosed.

Your decision to take part in this research study is entirely voluntary. Should you wish to withdraw from your participation in the research, please inform the researcher.

Should you wish to ask any questions about the research before partaking please direct them to me the researcher or the supervisor. If you agree to take part in this research study, you will be given a survey questionnaire to complete that will take 10 to 15mins to complete.

I would like to appreciate and thank you in advance for your interest, time, and support in participating in this survey.

Regards

Nontobeko Matli Date: …………………………
(Researcher)

NB: *Participant’s Copy*

UNIVERSITY OF KWAZULU-NATAL

INYUVESI YAKWAZULU-NATALI

Graduate School of Business and Leadership

Master of Business Administration (MBA) Research Project

Researcher: Nontobeko Matli (+27 730 22 5158)

Supervisor: Dr Bibi Zaheenah Chummun (+27 31 260 8943)

Research Office: Ms. D Dlamini (+27 31 260 4557) or

Mrs M Snyaman (+27 31 260 8350)

I ……………………………………………………………. (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participate in the research project.

I understand that I have the right to withdraw my participation in the research at any time, should I wish to do so.

Signature of participant: …………………………… Date: …………………………….

***NB:** Researcher's Copy*

C: Survey questionnaire

NAME *:

SURNAME*:

DEPARTMENT *:

AREA:**

*Optional

** Mandatory for respondents

QUESTIONNAIRE

Section A: Please mark with an X the most appropriate response		
Questions	YES	NO
1. Is your electricity supplied by Eskom?		
2. Are you employed by Eskom?		
3. Are you currently employed or is someone in your household employed		

	NOT APPLICABLE	LESS THAN 2YEARS	GREATER THAN 2YEARS
4. If you are not employed, how long have you been unemployed?			

SECTION B					
Number	1	2	3	4	5
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Question					
5. Electricity tariffs are affordable?	1	2	3	4	5

6. I have the following electrical appliances in my household? Geyser Four-plate stove Air-conditioner Pool pump Microwave Fridge	1 1 1 1 1 1	2 2 2 2 2 2	3 3 3 3 3 3	4 4 4 4 4 4	5 5 5 5 5 5
7. I spend between 50 to 60% of your income on electricity?	1	2	3	4	5
8. It is a basic right to have free electricity?	1	2	3	4	5
9. All my community members pay for electricity?	1	2	3	4	5
10. I often experience power failures frequently in my area?	1	2	3	4	5
11. I experience power failures during peak periods from 5pm to 8pm and 6am to 9am?	1	2	3	4	5
12. I think it is easy to steal electricity?	1	2	3	4	5
13. I feel that the Department of Minerals and Energy has provisioned an adequate budget allocation to meet the electrification targets?	1	2	3	4	5
14. Households in rural areas are timeously electrified?	1	2	3	4	5
15. Pricing structures for new	1	2	3	4	5

service applications is affordable?					
16. Pricing structures for customer upgrades is affordable?	1	2	3	4	5
17. When I have logged a fault with Eskom is it attended within a reasonable time?	1	2	3	4	5
18. I am given continuous updates and feedback on faults logged?	1	2	3	4	5
19. I am satisfied with Eskom's service delivery.	1	2	3	4	5
20. I am billed per my energy consumption?	1	2	3	4	5
21. I would enter into a payment arrangement to settle the historical debt?	1	2	3	4	5
22. I have been educated by Eskom sufficiently on energy-saving techniques?	1	2	3	4	5

Please answer the following questions

23. What do you feel the government can do differently to address the energy theft crisis in South Africa?

....
....

24. What do you think Eskom should do differently to improve revenue collection?

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

D: Clearance letter

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

22 October 2021

Nontobeko Samukelisiwe Matli (219037416)
Grad School Of Bus & Leadership
Westville Campus

Dear NS Matli,

Protocol reference number: HSSREC/00003491/2021
Project title: The investigation into the impact of electrical energy theft on revenue collection at Eskom in KwaZulu-Natal province
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 13 October 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 22 October 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics

E: Change of Title Approval

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

02 February 2023

Nontobeko Samukelisiwe Matli (219037416)
Grad School of Business &Leadership
Westville Campus

Dear NS Matli,

Protocol reference number: HSSREC/00003491/2021
Project title: The investigation into the impact of electrical energy theft on revenue collection at Eskom in KwaZulu-Natal province
Amended title: The impact of electrical energy theft on revenue collection at Eskom in KwaZulu-Natal Province
Degree: Masters

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 22 January 2023 has now been approved as follows:

- Change in title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Best wishes for the successful completion of your research protocol.

Yours faithfully

[redacted]

………………………………………………………
Professor Dipane Hlalele (Chair)

/ms

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email:** hssrec@ukzn.ac.za **Website:** http://research.ukzn.ac.za/Research-Ethics