NELSON MANDELA UNIVERSITY

Business School

# THE ECONOMIC IMPACT OF ELECTRICAL METER TAMPERING WITHIN WESTERN CAPE MUNICIPALITIES

by

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Submitted in partial fulfilment of the requirements for the degree

**MASTERS IN BUSINESS ADMINISTRATION**

In the FACULTY of BUSINESS and ECONOMIC SCIENCES at the

NESLON MANDELA UNIVERSITY

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Date: April 2020

**DECLARATION**

I, **Petrus J Brink** hereby declare that:

- This dissertation is my own work except as cited in the in-text references.
- This dissertation has not previously been submitted in full or partially to any other recognised education institution for assessment or for any other qualification.
- This declaration is in line with Rule G5.6.3.

20 November 2019

**Petrus J Brink** **Date**

**ACKNOWLEDGEMENTS**

I started the MBA programme with the vision of academic achievement, but along the way the programme guided me on a life journey. This journey was supported by people to whom I want to give special recognition and to whom I am truly grateful. The people I would like to thank are:

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# The Degree of MASTERS IN BUSINESS ADMINISTRATION (MBA)

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*The Economic Impact of Electrical Meter Tampering within Western Cape Municipalities*

**Abstract:**

Electricity access is fundamental for satisfying elementary human needs, raising living standards, preserving satisfactory human health, assisting in the relief of poverty and helping expedite sustainable development. Furthermore, access to electricity helps to uplift communities and empower businesses, contributing to an all-round positive environment ultimately leading to the development of a country.

Worldwide, electricity is generated at identified areas and by specific entities such as Eskom in South Africa, Nampower in Namibia and LEC in Lesotho. Electricity generation, transmission and distribution are a business just like any other business and its main goals are to service the needs of its customers as well as to make a profit and look after the interests of the shareholders. Although electricity must be made available for use by all the citizens and businesses in a country, it is not a free service and must be paid for.

An electricity meter is used to measure the amount of electricity used and bill the consumer accordingly. Tampering with any electrical meters in order to avoid paying for electricity is illegal and a criminal offence.

Electrical meter tampering and the economic impact it has on a utility is a massive overall problem. An initial review of the problem revealed that there are studies and

published statistics for electrical meter tampering in South Africa on a national level, but that there is a lack of focus and results on a regional level.

The purpose of this study is to assist regional municipalities and determine how to challenge electricity meter tampering and therefore influence the economic effect it might have on such a municipality. This study looks at investigating regional municipalities with a specific focus on municipalities situated within the Western Cape.

To initiate this study, secondary data was collected from academic sources and presented in the form of a literature review. The literature review addresses research questions and objectives around the background, nature and extent of managing electricity, electrical meters, the importance of solving the problem and the potential causes of electrical meter tampering.

An interpretive research philosophy was followed and primary data was gathered through a qualitative study by interviewing eleven (11) participants from ten (10) local Western Cape Municipalities. Furthermore, it was identified that the two qualitative approaches best suited to this research was a case study and grounded theory. In order to analyse the primary data gathered, a sophisticated software programme called ATLAS.ti was used to identify themes and codes emanating from the data. The analysis of the primary data was presented in the form of column, bar and pie charts and the key findings interpreted with reference to the secondary data gathered earlier in the study.

The treatise was concluded with recommendations to municipal managers of how to challenge electrical meter tampering and what economic impact meter tampering has on their municipalities. It was left to the municipal manager's discretion to decide if they want to share the results of the study with their senior and middle managers who acted as participants in the study.

**Key words:** Western Cape Municipalities, electricity meter, electricity meter tampering, economic impact, primary data, secondary data, Atlas.ti, findings and recommendations

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## LIST OF ABBREVIATIONS

| Abbreviations | Meaning |
|---|---|
| AC | Alternating Current |
| EDI | Electricity Distribution Industry |
| IEP | Integrated Energy Plan |
| IED | Intelligent Electric Devices |
| DMC | Dough Moulded Plastic |
| GHS | General Household Survey |
| SARPA | Southern Africa Revenue Protection Association |
| SALGA | South African Local Government Association |
| CIU | Customer Interface Unit |
| EU | Energy Unit |
| EMU | Energy Management Unit |
| kWh | Kilowatt Hour |
| SANEDI | SA National Energy Development Institute |
| NERSA | National Energy Regulator (South Africa) |
| NTL's | Non-technical Losses |
| TL's | Technical Losses |
| RQ | Research Question |
| RO | Research Objective |
| NDP | National Development Plan |

# 1. CHAPTER 1: SCOPE OF THE STUDY

## 1.1. INTRODUCTION

The National Development Plan (NDP) for South Africa, envisages that by 2030, South Africa will have an energy sector that promotes economic growth and development through adequate investment in infrastructure. The NDP also envisages that by 2030, South Africa will have an adequate supply of electricity and liquid fuels to ensure economic activity and that welfare are not disrupted, and that at least ninety five percent (95%) of the population will have access to grid or off-grid electricity (South African Government, 2019).

In order to grasp the full intent of the electricity supply industry in South Africa, it is important to identify several sectors, such as: available sources for electricity generation, transmission and distribution, sources of electricity consumption as well as applicable role players in the electricity market. The spread of electricity usage in South Africa, covers the following consumers:

- Transportation 2.7%
- Commercial 11.4%
- Industrial Segment 40.9%
- Residential Segment 36.8%
- Other 8.1% (South African Government, 2019).

There are also distinct role players in the electricity market who are responsible for the generation, transport and delivery of electricity in order to supply electricity to the various consumers as stated above. This study will identify the largest generator and transmission entity of electricity in South Africa but largely concentrates on the distributing parties who deliver the electricity to consumers. Furthermore, this study concerns itself with the economic aspects and security issues faced by the distributing parties, surrounding the delivery of electricity to consumers.

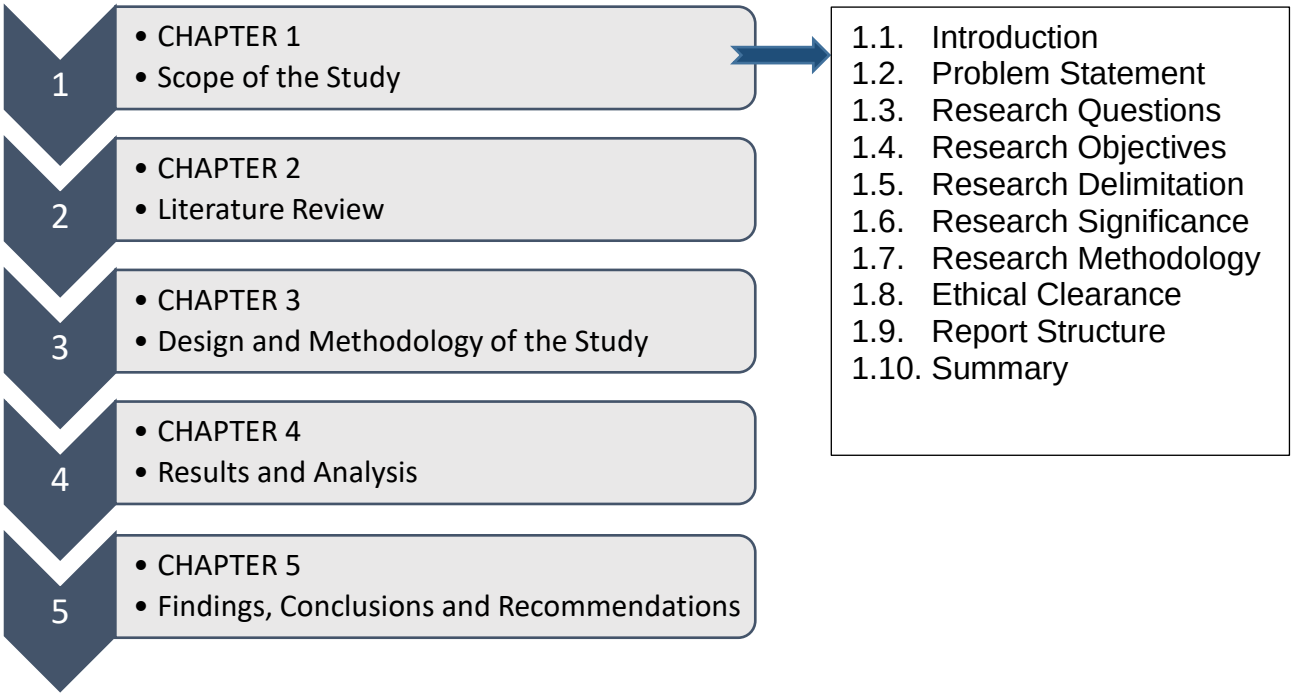
The vision of the NDP for 95% of the population to have access to grid or off-grid electricity is largely dependent on economic growth and development through adequate investment in South Africa’s electricity infrastructure. The growth in the infrastructure can only be established if enough monetary funds are generated and

invested. Funds are mostly generated from paying consumers, but for as long as electricity has been supplied to consumers (1922), there have been security issues leading to extreme losses within the electricity networks (Nel, 2019).

Electricity theft is displayed in various formats, such as illegal electricity connections, non-payment of tariffs, meter tampering, vandalism, transformer oil theft and the buying and selling of prepaid electricity vouchers (Lowvelder, 2016). In 2017, the electricity generator and distributors in South Africa lost an estimated combined total of over R 20 billion due to electricity theft (Vector, 2017). Killian (2017), provides a breakdown and confirms that out of the R 20 billion, R 15.2 billion as a combined total, was lost amongst distributors. Entities that are involved in the electricity network, refer to these loses as non-technical losses (NTL's). Therefore, this study focuses on the NTL of meter tampering, specifically targeting distributors of electricity within the Western Cape.

Thus, the purpose of this study is to investigate the NTL of meter tampering, clearly define the determinants of why it is happening and highlight the economic impact it has on electricity distributors within the Western Cape. Once this has been concluded, the study will proceed to make recommendations on strategies of how to manage and improve the provision of electricity for electricity distributors within the Western Cape. A summary of Chapter 1 is illustrated in Figure 1.1.

*Figure 1.1: Chapter 1 Summary*




Source: Author's Own Construction (2019)

## 1.2. PROBLEM STATEMENT

Electricity access is essential for satisfying elementary human needs, raising of living standards, the preservation of satisfactory human health, relief of poverty and expediting sustainable development (Tully, 2006).

Electricity that is distributed to customers is monitored by an electricity meter in order to measure the amount of electricity supplied for billing purposes. However, there is evidence of meter tampering, which has an economic impact on the generating, transmission and distributing bodies. Therefore, there is a need for a focused study on Municipalities within the Western Cape, in order to establish the extent of the problem and possible solutions.

Given the above-mentioned, the research statement was formulated as follows:

**Problem Statement:** A primary research objective was set with the aim to develop a viable strategy to improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

## 1.3. RESEARCH QUESTIONS

The nature and extent of the research problem as discussed in Section 1.2, lead to the Main Research Question ($RQ_M$) being formulated as follows:

$RQ_M$: Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities?

With the $RQ_M$ defined above, the following supporting research questions ($RQ_S$) were populated:

$RQ_1$: What is the economic importance of having an electricity meter?

$RQ_2$: What type of meters are installed in household and business premises within Municipalities of the Western Cape?

$RQ_3$: What type of electrical enclosures are the meters installed in?

$RQ_4$: Why does electricity meter tampering take place?

$RQ_5$: What is the economic impact of meter tampering for a municipality within the Western Cape?

$RQ_6$: What possible solutions have been formulated to decrease meter tampering in a municipality in the Western Cape?

$RQ_7$: What are the potential obstacles within Western Cape Municipalities for implementing the possible formulated solutions?

$RQ_8$: What are the perceived benefits and disadvantages of adopting the selected possible solutions within the Western Cape Municipalities?

## 1.4. RESEARCH OBJECTIVES

Based on the above-mentioned research questions, the Main Research Objective ($RO_M$) was defined as follows:

$RO_M$: To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

In order to accomplish the above-mentioned $RO_M$, the following secondary research objectives are pursued:

$RO_1$: Conduct a literature study around the management of electricity and the challenge of electricity meter tampering.

$RO_2$: Construct a research design to investigate why and how electricity meter tampering takes place.

$RO_3$: Conduct interviews with a selected sample of municipal employees on reasons why and how electricity meter tampering is taking place.

$RO_4$: Transcribe the interviews, through the use of Atlas.ti, in order to process the raw data on which appropriate data analysis methods can be applied.

$RO_5$: Interpret the findings, draw conclusions and make recommendations.

The research alignment plan between the research questions and research objectives is illustrated in Figure 1.2 at the end of the chapter.

## 1.5. RESEARCH DELIMITATION

The primary objective of this treatise is to develop viable strategies in order to manage the long term provision of electricity within Western Cape Municipalities. The research aims to do that by investigating how the challenge of electricity meter tampering can be addressed.

The generation, transmission and distribution of electricity in the Western Cape is done by thirty (30) Municipalities which are grouped by region into one (1) Metropolitan Municipality, five (5) Rural District Municipalities and twenty four (24) Local Municipalities. Due to time and fund restraints, the data collected was limited to only ten (10) Local Municipalities who were approached for interviews in order to perform the said research.

Therefore, it is suggested that further research should be carried out to better determine how the challenge of electrical meter tampering can be addressed in order to provide electricity within Western Cape Municipalities. Furthermore, this study can be applied and duplicated in other regions or at a national level.

## 1.6. RESEARCH SIGNIFICANCE

The amount of electricity that is needed in a municipal network should be determined by the amount of paying customers, whose electricity consumption is measured by an electrical meter. However, the load of the network is determined by the demand; therefore when consumers bypass and tamper with the electrical meters, various problems are created. Potential problems include the following:

- When the amount of electricity consumed in the network stays the same but the billable amount of electricity units is much lower, it causes serious financial problems for a municipality (Ruiters, 2018).
- If more consumers join the network without paying for electricity, the municipality needs more electricity, but without the revenue to support such a need, the result leads to massive overall electricity hikes (Niselow & Omarjee, 2019).
- Another threat resulting from electrical meter tampering is that of complete municipal network equipment failure.

The main motive for electricity meter tampering is the desire to save money, and thus the issue should be considered under the categories of economy, society, infrastructure and legalities (Czechowski & Kosek, 2015). Although there are information and figures available on a national level, limited studies have been done on the importance of the economic impact of electrical meter tampering on Local Municipalities, thus this study aims to highlight the economic impact of electrical meter tampering specifically within Western Cape Municipalities and make recommendations in this regard.

## 1.7. RESEARCH METHODOLOGY

### 1.7.1. Research Approach

The full research approach is discussed in Section 3.4. However, for this study, typical research designs for an interpretive research philosophy are qualitative approaches such as ethnography, phenomenology, symbolic interaction, case study, grounded theory and other naturalistic designs (Chilisa & Kawulich, 2015). However, the two qualitative approaches best suited to this study are: case study and grounded theory.

### 1.7.2. Literature Study

A literature study was used as a secondary data collection resource and is discussed in detail in Chapter 2. The literature review was compiled by reviewing academic journals, published books and articles. Formal database websites such as Sage, Academia, Access Engineering, Science Direct and Google Scholar were used to access the necessary information.

Although the resources had a lot of information, not all of the information was relevant to the topic, as this is the first known study to concentrate on electrical meter tampering with specific reference to “Western Cape Municipalities”.

All the resources used and referred to in this treatise are cited in-text, as well as documented in a reference list.

### 1.7.3. Data Collection and Analysis

Data collection was gathered from primary and secondary resources. Ten (10) Western Cape Municipalities were targeted in order to collect primary data. This was done through interviews with nominated senior and middle municipal managers and is discussed in Section 3.6. Secondary data were collected through the review of academic journals, published books and articles and are discussed in Chapter 2 as a “literature review”.

Data analysis were done using tools such as computer software programmes (Atlas.ti) together with other statistical and technical tools and are discussed in Section 3.6.3.

## 1.8. ETHICAL CLEARANCE

As part of this study, there are certain criteria which were put in place by NMU to clarify if full ethical clearance for this research is required. Upon review of this research objective, it was established that full ethical clearance is needed and Ethical Clearance Application Form REC-H must be completed. The approval letter for REC-H Ethics Application is attached as Annexure A: Application for Approval Nelson Mandela University Research Ethics Committee (HUMAN).

## 1.9. OUTLINE OF THE STUDY

This study consists of five (5) chapters that cover the following content:

### 1.9.1. Chapter 1: Scope of the Study

Chapter 1 introduces the scope of the study and provides the reader with an introduction to the study. Furthermore the chapter reflects the problem statement, the research questions and objectives as well as the delimitation, research methodology and ethical clearance. The chapter finishes by giving the outline and a summary of the study.

### 1.9.2. Chapter 2: Literature Review

In Chapter 2, various published academic sources are selected, studied and reviewed in order to address three (3) of the research questions (RQs) and associated research objectives (ROs) directly, and with limited relevancy to the remaining five (5) research questions. The applicable research questions are:

- $RQ_1$: What is the economic importance of having an electricity meter? This RQ addresses $RO_1$: Conduct a literature study around the management of electricity and the challenge of electricity meter tampering.
- $RQ_3$: What type of electrical enclosures are the meters installed in? This RQ addresses $RO_1$: Conduct a literature study around the management of electricity and the challenge of electricity meter tampering.
- $RQ_4$: Why does electricity meter tampering take place? This RQ addresses $RO_1$: Conduct a literature study around the management of electricity and the challenge of electricity meter tampering.

### 1.9.3. Chapter 3: Design and Methodology of the Study

In Chapter 3, the following research questions are addressed:

- $RQ_2$: What type of meters are installed in household and business premises within Municipalities of the Western Cape?
- $RQ_5$: What is the economic impact of meter tampering for a Municipality in the Western Cape?
- $RQ_7$: What are the potential obstacles within Western Cape Municipalities for implementing the possible formulated solutions?
- $RQ_8$: What are the perceived benefits and disadvantages of adopting the selected possible solutions within the Western Cape Municipalities?

These RQs form the basis for ROs such as:

- $RO_2$: Construct a research design to investigate why and how electricity meter tampering takes place.
- $RO_3$: Conduct interviews with a selected sample of municipal employees on reasons why and how electricity meter tampering is taking place.
- $RO_4$: Transcribe the interviews, through the use of Atlas.ti, in order to process the raw data on which appropriate data analysis methods can be applied.

Taking into consideration the above-mentioned research questions and objectives, this chapter discusses the research design, including the theoretical approaches as well as the methodology. It also addresses the unit of analysis, data collection methods and participants in the study.

### 1.9.4. Chapter 4: Results and Analysis

In Chapter 4 the main research question is addressed and lays the foundation for Chapter 5. It answers $RQ_M$: Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities? This also relates to the main research objective, $RO_M$: To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

### 1.9.5. Chapter 5: Key Findings, Recommendations and Conclusion

Chapter 5 addresses $RQ_6$: What possible solutions have been formulated to decrease meter tampering in a Municipality in the Western Cape? This relates to $RO_5$: Interpret the findings, draw conclusions and make recommendations.

As mentioned in Section 1.9.4, the analysis described in Chapter 4 is the source for Chapter 5 which articulates key findings, managerial recommendations and a conclusion. In Chapter 5, the approach and discussions are dealt with from an integrative perspective and discussion, which emanates from Chapter 2, right through to Chapter 4. Furthermore, Chapter 5 identifies prospects for future research, and highlights the delimitations of the study. The chapter finishes with a conclusion based on the identified research problem. Figure 1.2 outlines the structure and layout of the treatise which is referred to as the alignment plan.

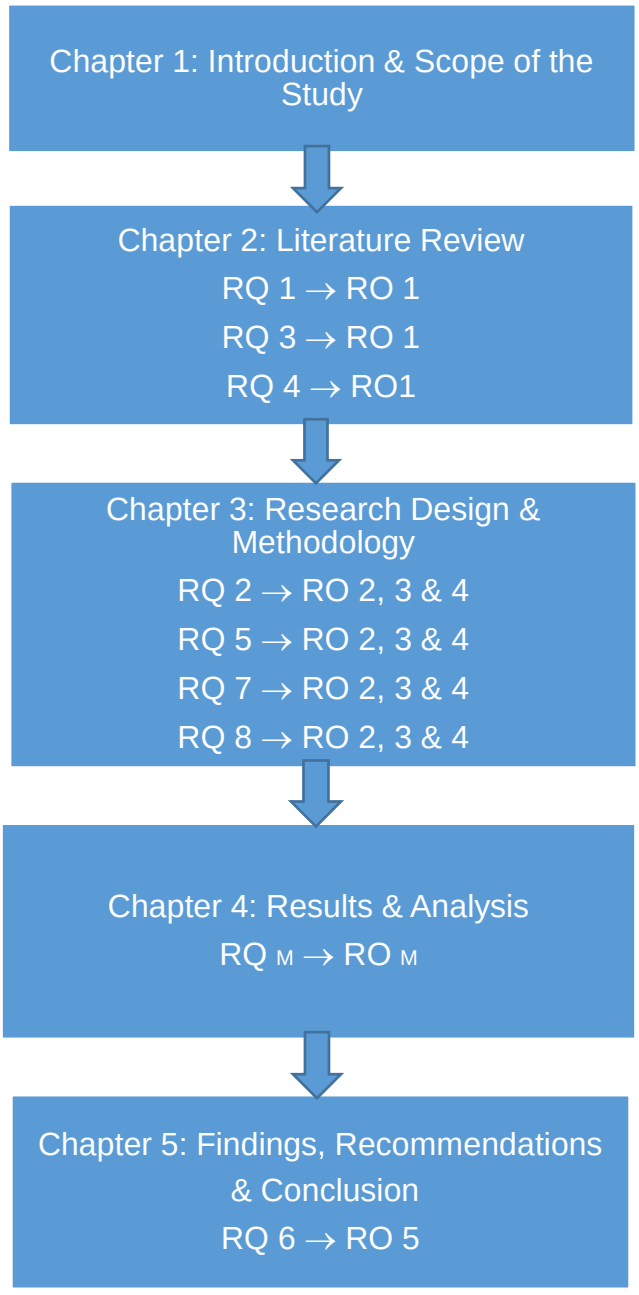
## 1.10. SUMMARY

The main aim off Chapter 1 is to introduce the topic of this study through the problem statement. Furthermore it presents the main research question ($RQ_M$) and objective ($RO_M$), as well as explicating all the rest of the research questions and objectives.

In Sections 1.5 and 1.6, the chapter discusses the research delimitation and the significance of the research. The chapter goes on to highlight the research methodology which includes the research approach, examines the full ethical

clearance concept and finishes by discussing the report structure which is made up out of various separate sections.

*Figure 1.2: Research Alignment Plan*




Source: Author's Own Construction (2019)

# 2. CHAPTER 2: LITERATURE REVIEW

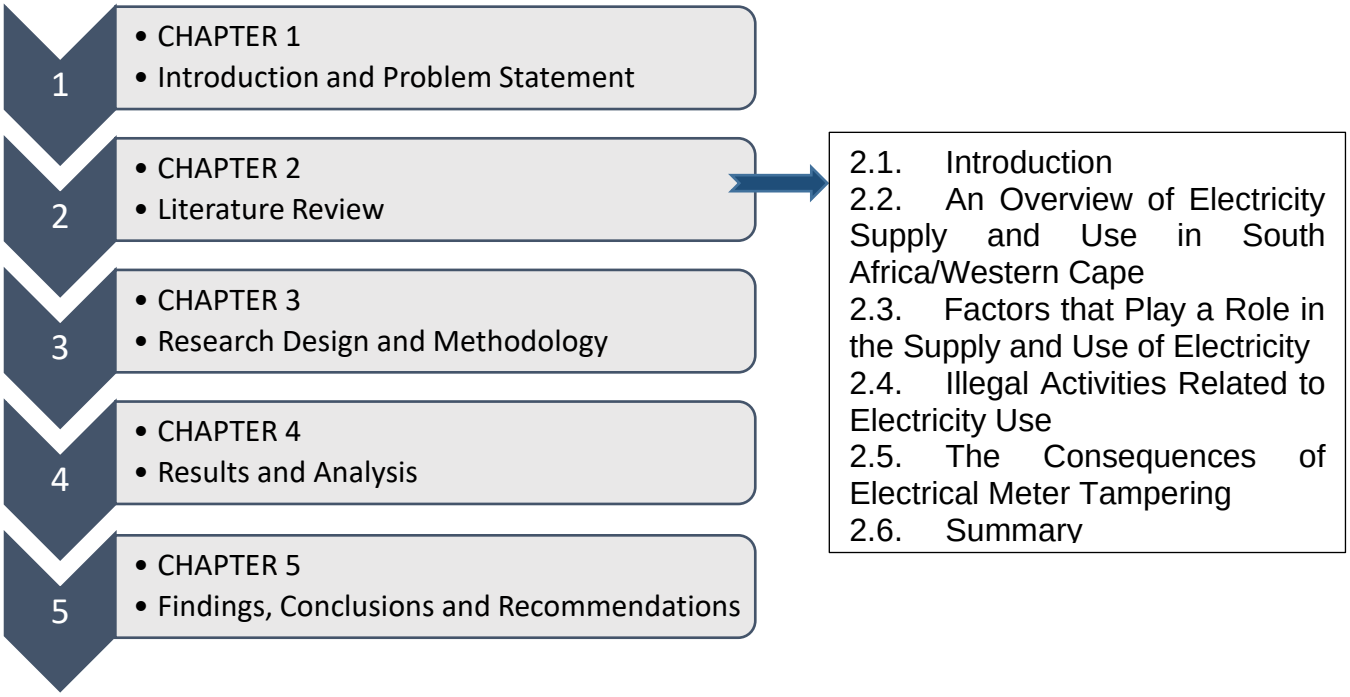
## 2.1. INTRODUCTION

Chapter 1 started by introducing the background of the study and confirmed the significance of the study. It also contains all the research questions and their alignment with the associated research objectives as reflected in Figure 1.2. Taking Chapter 1 into consideration, the objective of Chapter 2 is to conduct secondary research or collect secondary data in the form of a literature review.

Since the dawn of electricity supply and usage, illegal activities such as meter tampering and its economic impact across most municipal regions, have not yet been defined or established. Findings through the review of academic journals, published books, articles and databases from formal websites will be used for information on a national and regional level. Using a literature review, Chapter 2 aims to define what the economic impact of an electrical meter is, what type of meters are installed in general, what type of enclosures electrical meters are installed in and why electrical meter tampering takes place. Taking the above-mentioned into account, Chapter 2 addresses three (3) of the research questions outlined in Chapter 1.

The research questions addressed in Chapter 2 are RQ1, RQ3 and RQ4 together with their corresponding research objective RO1. RQ1 questions: What is the economic importance of having an electricity meter? $RQ_3$ questions: What type of electrical enclosures are the meters installed in? $RQ_4$ questions: Why does electricity meter tampering take place? These three (3) questions all correspond to RO1 which is to: Conduct a literature study around the management of electricity and the challenge of electricity meter tampering. A summary of Chapter 2 is illustrated in Figure 2.1

*Figure 2.1: Chapter 2 Summary*




Source: Author's Own Construction (2019)

## 2.2. AN OVERVIEW OF ELECTRICITY SUPPLY AND USE IN SOUTH AFRICA / THE WESTERN CAPE

Electricity is one of the finest inventions in people's lives, and yet the question is often posed if anyone has ever stopped to think about how their mobile device and other electronic devices are charged? (Sunshine, 2018). Everything and anything that is visible runs on one or the other form of electricity (Atomberg Team, 2016), whether to keep people digitally connected, saving lives in hospitals, powering industries or keeping the South African economy going (Sunshine, 2018). Electricity is a concept that many are unfamiliar with. Electricity for such people is to switch on a button, the appliance starts to work, switch off the button and that is it. The importance of electricity is most probably only understood when the electricity goes off (Atomberg Team, 2016).

Sunshine (2018) mentions that "whether it's a 19th Century energy source like coal or a 21st Century source like solar, it's worth knowing how electric energy works, how it's generated and where the juice that powers everyone's lives comes from."

### 2.2.1. Electricity Defined

Electricity is "a type of energy fueled by the transfer of electrons from positive and

negative points within a conductor" (Business Dictionary, 2019). The following example can be used to easily explain what is meant by the definition of electricity above.

Imagine there are a couple of people standing next to each other in the shape of a circle. Each one of them represents a single atom, which is the building blocks of all things known to mankind. Every atom has a nucleus at its centre and is surrounded by a cloud of electrons. Now, imagine each one in the circle is holding a single ping-pong ball which represents an electron. If everyone were to pass the ping-pong balls/electrons around the circle, the flow of electricity would be replicated (Study.com, 2019). Therefore, electricity is when electrons move from one atom to another, in much the same way the ping-pong balls were passed from one person in the circle to another. The flow of electricity is called a current, which is measured in amperes (A), also known as amps (Study.com, 2019).

However, besides measuring current, electricity's voltage, watts, and resistance are also measured. Volt (V) is the power available to push electricity around a circuit. It can be compared to water pressure in a pipe: the more voltage there is, the more quickly electricity flows through a circuit. To take the correlation further, resistance can be compared to the pipe size and is measured in ohms (r). Finally, electrical power is measured in watts (W), which is obtained by multiplying amps by volts (Study.com, 2019). The most important point to remember is that electricity is measured in watts (W), as the study will later refer to it in Section 2.2.4: Electricity Metering and Measurement.

### 2.2.2. Electricity Generation

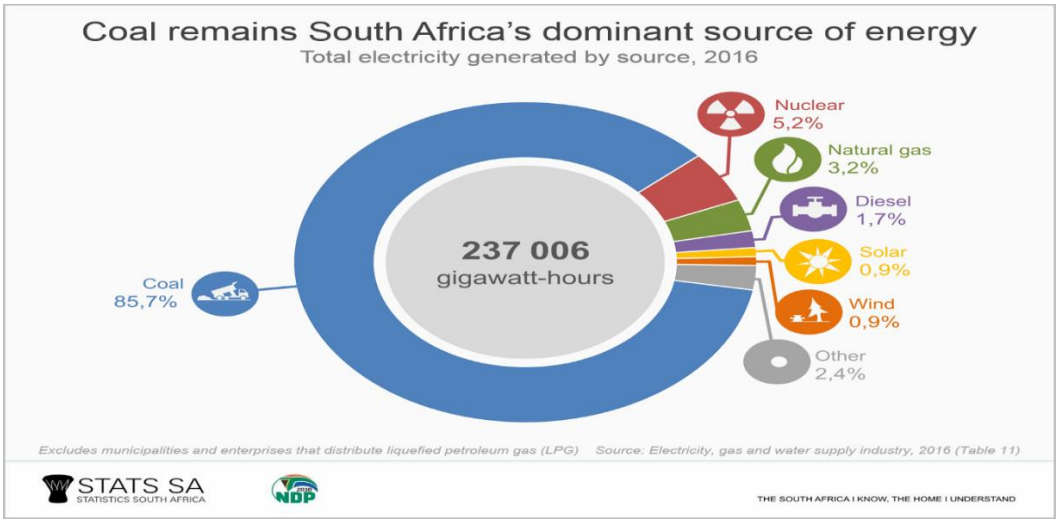
With reference to the definition and explanation of what electricity is, the generation of electricity can be defined as "the conversion of other forms of energy into an electrical current" (Eskom, 2016). There are various forms of electricity generation, such as:

- **Electricity from coal:** This is the most popular method of generation for power stations in South Africa. Coal is burned and then used to heat water in order to convert it to steam. The steam is then directed onto the blades of an enclosed turbine to make it rotate. This in turn rotates a magnetic rotor inside a coil to generate electricity (Eskom, 2016).

- **Electricity from the atom:** In the case of nuclear power stations, water is heated not by burning coal, but by the heat released in a nuclear reaction. The amount of heat can be increased or decreased by controlling the rate at which the uranium atoms are split (Eskom, 2016).
- **Electricity from water:** This in generally known as a conventional hydroelectric scheme. Situated close to a river or a dam next to a river, water flows through a waterway to the hydro turbine which rotates a shaft. The shaft is connected to and rotates a magnetic rotor, thus generating electricity (Eskom, 2016).
- **Electricity from gas:** In South Africa's largest generator of electricity, Eskom's gas turbine power stations use a fuel/air mixture which is ignited to form a hot, high velocity gas. The gas turns a turbine which is connected to a shaft. The shaft is connected to and rotates a magnetic rotor thus generating electricity. Natural gas can be used as an alternative to liquid fuels such as diesel or kerosene (Eskom, 2016).
- **Renewable energy:** This type of energy is infinite and is naturally replenished energy that is generated from natural resources such as wind, sunrays, water flow, ocean tides and geothermal heat (Eskom, 2016).

Considering the above, it can be said that there are three major categories of energy for electricity generation. These are fossil fuels (coal, natural gas, and petroleum), nuclear energy, and renewable energy sources. Figure 2.2 demonstrates the total electricity generated in South Africa, and what the contribution of each generation source is.

*Figure 2.2: Total Electricity Generated by Source in South Africa*




Source: STATS SA (2019)

### 2.2.3. Electricity Transmission and Distribution

After electricity is generated using one of the resources as stipulated in Figure 2.2, it goes through two processes:

- **The Transmission of Electricity:** This involves the process of delivering generated electricity, over long distances, via high-voltage transmission lines to what is called a "distribution grid" (Afework, Hanania & Donev, 2018). The electricity is received from the high-voltage transmission lines and passed through a step down transformer to lower the voltage at a substation. These substations are mostly located within regional populated areas (Business Dictionary, 2019).

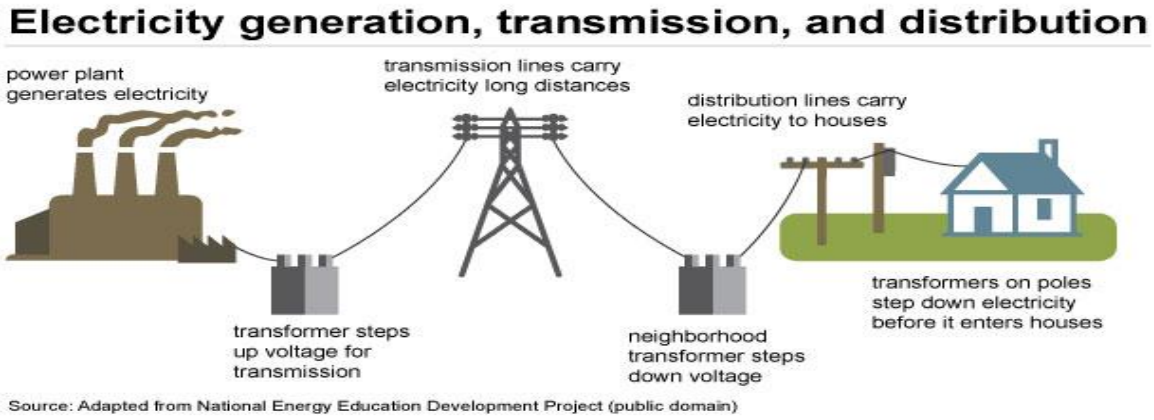
After the electricity has been received by the substation, it is transmitted to a network of local electric distribution lines (Business Dictionary, 2019).

- The Distribution of Electricity: This involves the porcess of reducing the high voltage power to a safe customer-usable level and delivering the electric power to the grid (Business Dictionary, 2019). The distribution grid refers to the final stage of the electrical grid in which electricity is distributed to homes, industries and all other end-users (Hanania, Stenhouse & Donev , 2018).

In summary, transmission lines help with the movement of electricity from a power plant or power station to the various substations whereas

the distribution lines carry electricity from the substation to the consumer's premises (Business Dictionary, 2019). Figure 2.3 depicts a flow diagram indicating the typical flow from generation to transmission to the distribution of electricity.

*Figure 2.3: Flow Diagram of Electricity Generation, Transmission and Distribution*




Source: Adapted from national Energy Education Development Project (public domain) (2019)

The electrical grid is made up out of the power plants, transmission, sub-stations and distribution systems. That said, the electricity distribution industry (EDI) is a vital link between the generator, in South Africa it usually is Eskom, and the customers that buy and use electricity (Eskom, 2019). Although Eskom generates and transmits electricity, distribution includes the help of national metropoles, district municipalities as well as local regional municipalities. At one time, there were nearly 500 distributors of electricity in South Africa, but this number has been reduced through consolidation to less than 300 (Eskom, 2019).

### 2.2.4. Electricity Regulators and Legislation Control

- The National Energy Regulator of South Africa (NERSA) is the regulatory authority for electricity, piped gas and petroleum pipelines in South Africa.
- The National Nuclear Regulator is responsible for the safety standards and regulatory practices for the protection of people, property and the environment against nuclear damage.
- The Nuclear Energy Corporation of South Africa is responsible for the undertaking and promoting of research and development in the field of nuclear energy and radiation sciences. It is also responsible for processing source

material, including uranium enrichment, and co-operating with other institutions, locally and abroad, on nuclear and related matters.

- The South African National Energy Development Institute (SANEDI) is mandated to stimulate innovation in energy research and development, transform the gender and race profile of researchers in the sector and improve South Africa's competitiveness in energy research internationally.
- The Central Energy Fund is responsible for the research, finance, development and exploiting of appropriate energy solutions across the spectrum of energy sources in order to meet South Africa's future energy needs.
- The National Radioactive Waste Disposal Institute is mandated to manage the disposal of radioactive waste nationally (South African Government, 2019).

### 2.2.5. Electricity Meters and Measurement

Earlier in this study, it was established that in South Africa, Eskom mostly generates and transmits electricity to distributors also referred to as distribution operations. This study will focus on electricity distributors for Eskom, such as local regional municipalities, and specifically on those situated in the Western Cape.

Therefore, a local regional Municipality in the Western Cape will act as a distribution operation for Eskom, will take the responsibility to construct and maintain equipment, will transform the power supply accepted from the Eskom transmission network and convert it to the type of electricity that meets their customer needs (Eskom, 2019). Furthermore, the municipality must meter the amount of electricity that their customers use, provide the appropriate billing for electricity usage and collect applicable payments in its municipal area (Eskom, 2019).

In order for a Western Cape Municipality to establish the amount of electricity used by a customer, it is crucial to have specific equipment in place. The specific equipment for the measuring of electricity usage in an electrical network, is referred to as an "electricity meter".

The definition for an electricity meter is: "an electricity meter, electric meter, electrical meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device" (Eskom, 2019).

Thanks to engineers such as Oliver Shallenberger at Westinghouse in 1888, the invention of the electricity meter was an incredible accomplishment, considering the difficult task of trying to measure something which no one can see, taste, touch, or hear (Blalock, 2014).

As technology progressed throughout the years, various types of electrical meters (EM) have been installed throughout South Africa as well as in the Western Cape. When it comes to explaining the countless types of EMs, things can become somewhat technical, therefore this study will focus on and explain the workings of the five (5) most popular EMs.

- **Kilowatt Hour Meter:** This is one of the most important meters ever invented. It measures the amount of alternating current (AC) used by a customer. The traditional kilowatt hour (kWh) meter uses a disk that spins due to electromagnetic fields. A counter measures the number of rotations. The more energy the customer uses, the faster the disk spins (Blalock, 2014).

  These kWh meters are calibrated in billing units, the most common being kilowatt hour (kWh). The more modern kilowatt hour meters are also available in a digital format. Typically the meter must be read monthly or in the worst case scenario, every three (3) months. This is done by a utility service official who physically visits every customer's premises and takes the meter readings. The readings are registered, data processed and the customer receives a bill for the amount of electricity used (Thiele, 2019).

*Figure 2.4: A Typical Analogue and Digital Kilowatt Hour Meter*

Analogue kWh Meter


Source: Esi-Africa.com (2019)

Digital kWh Meter


Source: Esi-Africa.com (2019)

- **Prepayment Meter:** A prepayment meter is an advanced type of digital electricity meter that records when, and how much electricity is consumed. It then deducts the consumed amount of electricity from a prepaid balance, loaded by the customer, prior to usage. In other words, the clients decide how much electricity they want to use or want to purchase, prepay for the electricity, and load the purchased amount into the meter for usage. The most common types of prepaid meters are:

  **a) Common Base Prepayment Meter:** This unit is a keypad-based prepaid electricity meter in a housing that can be fitted into a standard plug-in common base electricity dispenser socket (JKNV Energy, 2019). Most importantly, the meter or Energy Unit (EU) and Customer Interface Unit (CIU) are as per figure 2.5, housed within one unit and installed inside the customers' residential premises. The EU and CIU communicate with each other, enabling the CIU to display exactly what a customer's electricity credit balance is. The meter allows a customer to view near real-time electricity usage over time and helps them to manage their consumption (Eskom, 2019). Figure 2.5 illustrates what a Common Base Prepayment Meter looks like.

*Figure 2.5: Example of Common Base Prepayment Meter*

Source: Metermate.co.za (2019)

  **b) Split Prepayment Meter:** This unit consists of a meter or Energy Unit (EU), which in this case is generally installed outside the customer's premises in a low voltage electrical enclosure. The Customer Interface Unit (CIU), is installed

inside the customers' premises, therefore the name "split prepaid meter" as per Figure 2.6. The EU and CIU communicate with each other remotely enabling the CIU to display exactly what a customer's electricity credit balance is. The meter allows a customer to view near real-time electricity usage over time and helps them to manage their consumption (Eskom, 2019). Figure 2.6 illustrates what a Split Prepayment Meter looks like.

*Figure 2.6: Example of Split Prepayment Meter*

Source: Metermate.co.za (2019)

- **Bulk Meter:** These meters are generally used to meter electricity usage for large electricity users such as residential complexes, such as a block of flats, or townhouses, business complexes or free standing businesses. The meters used can be kilowatt hour or prepayment meters. When it comes to residential and business complexes or a block of flats, the electricity is normally measured by the body corporate in several different ways (JKNV Energy, 2019). The most common being:

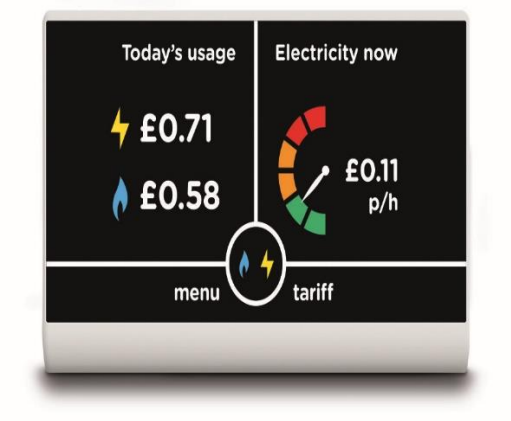
  a) Electricity for each townhouse or flat in some areas can be registered directly with the city council. This means that each unit in the complex has a separate meter and account with the relevant city council and is billed directly (JKNV Energy, 2019).

  b) More commonly, electricity is managed by the body corporate or property manager and incorporated with the levy account. In this case there is one bulk electricity meter for the entire complex registered with the city council. Each unit would then have its own sub meter installed by the body corporate from which readings are taken (JKNV Energy, 2019).

**Smart Meter:** A fair number of utilities across South Africa have started to install smart meters. Smart meters provide two-way communication between the customer and the utility. This function helps the utility to gather vital information, such as to know about blackouts in a certain area. The utility can also read information of the meter and send information to the meter, such as programming updates (Energy.gov, 2019).

Furthermore, the two-way or bi-directional communication helps utilities to maintain a more reliable electrical service. Smart meters can be used with home energy management systems such as web-based tools that a utility provides, or devices that can be installed in a customer's home. Smart meters can display customers' home energy use, help them find ways to save energy and money, and even allow them to remotely adjust their geyser thermostat or turn appliances off (Energy.gov, 2019). Another function is that automated instructions can be sent to interrupt the power supply when the customers' prepaid balance reaches zero as well as to reconnect their power supply once they loaded more credit (Eskom, 2019).

*Figure 2.7: Example of Monitoring & Smart Meter*




Source: Waviot.com (2019)


Source: Iothub.com.au (2019)

### 2.2.6. Low Voltage Electrical Enclosures

The type and size of a low voltage electrical enclosure that houses an electrical meter, ultimately depends on the type of meter that is installed. Figure 2.7 shows examples of ground mounted kiosks and pole mounted boxes. The decision of which one to use depends on various factors. Low voltage electrical enclosures are manufactured from various raw materials such as steel, polyethylene, dough moulded plastic (DMC) or fibre glass. Some raw materials are more attracted to corrosion or brittleness than

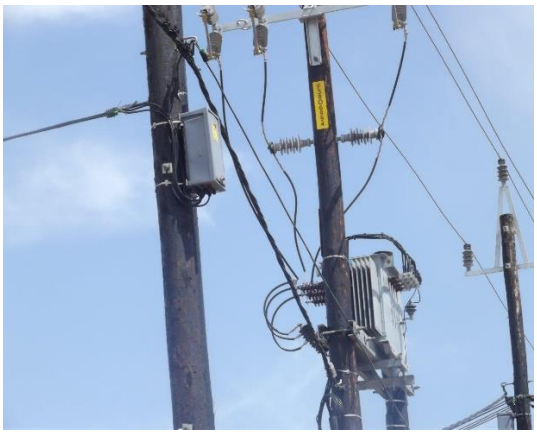
others, and a utility must choose wisely before they decide which material to use (Polybox, 2019).

Secondly, utilities must recognise their electricity network and whether their distribution lines will be overhead, underground or a combination of both. Overhead lines will make use of pole mounted boxes and underground lines will make use of ground mounted kiosks. Expansion of electrical networks are generally a costly exercise and the decision of overhead or underground as well as what material to use, is most often driven through the available utility budget. The choice of enclosure size is also determined by various factors such as the layout of the electrical network, the number of customers that must receive electricity as well as the type of meter to be installed being kWh, split, bulk or smart meters (Polybox, 2019).

Low voltage electrical enclosure development has mostly been driven by individual manufacturing companies. Companies are frequently exposing the market to higher impact strength, anti-vandalism and smart enclosures. Anti-vandal enclosures are concerned with higher grade and thicker materials and the development of anti-tamper locking systems. On the other hand, smart enclosures are concerned with installing bi-directional communication systems within the enclosure with anti-tamper alarms, smoke detection capabilities and remote locking (Polybox, 2019). Figure 2.8 below depicts examples of Low Voltage Electrical Enclosures.

*Figure 2.8: Examples of Low Voltage Electrical Enclosures (Ground & Pole Mount)*

Source: Polybox.co.za (2019)



Source: Polybox.co.za (2019)

The previous sections in this study indicated that an electrical power network consists of three (3) major components, such as generation, a high voltage transmission grid,

and a distribution system. The high voltage transmission system links the generators to the substations, which supply electricity to the user through the distribution system. The electricity used by a customer is then measured with an applicable electricity meter which is installed in a purposeful low voltage electrical enclosure.

South Africa is a developing country, with a population of about 53 million people living in around 13.2 million households. The South African Government-owned company, Eskom generates 95% of the electricity used in South Africa and 45% of the electricity used in Africa with 17 million customers (Thibane, 2017/18). South Africa's household electrification programme has seen a significant increase in the number of households with access to electricity (Thibane, 2017/18). In the early 1990s, the electrified households' percentage was around 35% which grew to around 76.7% in 2002 and to 84.4% in 2017. This includes both formal and informal sectors while 87% of the growth percentage is applicable to the formal sector only. From this, it is clear that the South African government electrified the residential sector on a priority basis and although the electrification programme has seen a significant increase in the number of households with access to electricity, there is still a reasonable backlog of around 3.4 million households waiting to be electrified (Thibane, 2017/18; DOE, 2013).

Eskom plans to electrify the formal household residential sector to its maximum limit of up to 97% by 2025. From the statement above made by the Department of Energy, it is clear that they are not only considering the above-mentioned 3.4 million household backlog, but also anticipating future growth in the residential sector (Jamal, 2015). As an example of increased electricity use, Statistics South Africa's (Stats SA) General Household Survey (GHS) (2017), indicated that the percentage of households that used electricity for cooking increased from 57.5% in 2002 to 75.9% in 2017. The use of electricity as a source of energy for cooking was highest in the Free State (85,6%), Northern Cape (84,9%), and Western Cape (79,8%) and lowest in more rural provinces such as Limpopo (60,2%), Mpumalanga (72,4%) and Eastern Cape (74,8%) where electricity is not yet readily available, or alternative fuels such as wood are perhaps more accessible and affordable (Thibane, 2017/18). Nevertheless, it is very clear that electricity forms an integral part of every South African household and makes a huge contribution to the wellness and health of families, but at the same time, the electricity generator and distributor must operate as a fully-fledged business to keep delivering the needed electricity to said households, businesses, etcetera.

The sale of electricity is the main form of revenue for an electricity generation, transmission and distribution utility (Arango, Deccache, Bonatto, Arango & Pamplona , 2017). Therefore electricity utilities are seen as a typical business with significant credit sales (Aminu & Rahman, 2010). In spite of the low-income levels in developing countries such as South Africa, cost recovery is a prerequisite for the sustainability of electricity utilities. The success of a company is mainly dependent on how much revenue it is able to generate to cover its operational costs (Aminu & Rahman, 2010). It is imperative that electricity utilities take steps to maintain constant cash flows through sustained and improved bill presentation and payment. Timely bill presentation and collection of payments thereof show how efficient the utility is in utilising its massive investment in assets (Aminu & Rahman, 2010). However, timely payment of bills on the part of customers, which is supposedly the most reliable source of cash flows for these utilities, has been generally very poor especially in the context of much of the developing world (Aminu & Rahman, 2010).

Utilities do not only lose revenue due to lack of payments on the part of customers but also due to various other factors. Not all purchased energy from generators such as Eskom is sold to energy distributors or consumers (Arango et al., 2017). Part of the purchased energy is lost due to electrical losses from the conditions and characteristics of the electrical network or technical losses (TL), and another part is lost in the form of non-technical (NTL) or commercial losses (Arango et al., 2017). The sum of technical losses with non-technical losses represents the global system losses. As mentioned earlier in Section 1.1, the sums of electricity losses are represented by:

**Technical Losses**

- Electrical network hardware such as cables, overhead lines, transformers and other equipment used to transfer and distribute electricity.
- Electrical networks that are highly loaded where losses vary as the power flow changes.
- Sweating of networks.
- Malfunctioning of electricity meters (Navani, 2009)

**Non-Technical Losses**

- Electricity theft in the form of illegal electricity connections, electricity meter tampering, bypassing of electrical meters, and non-payment of accounts.
- Vandalism of electrical equipment (Navani, 2009)

Although technical losses can account for about 3% of the total electricity losses in a metropole or municipality, this study aims to focus on the non-technical losses. The non-technical losses during electricity distribution have a major economic impact on the utility's revenue because of the lost electricity that is not billed (Arango et al., 2017). When the amounts of these losses get too high, the electricity utility should worry because its expenses might remain fixed but its billed revenue becomes lower (Arango et al., 2017). Depending on which action was taken by customers, non-technical losses are referred to as either fraud or theft. The theft of electricity can be defined as "energy delivered to customers that is not measured by the energy meter for the customer" (Navani, 2009).

## 2.3. FACTORS THAT PLAY A ROLE IN THE SUPPLY AND USE OF ELECTRICITY

Czechowski & Kosek (2016), mention that the main motive for NTLs including electricity meter tampering, is the desire to save money. The issue of meter tampering should be considered under four categories:

- **Economy**

The harsh economic climate throughout the whole of South Africa contributes significantly to customers being short of money for utility bills. Eskom has the monopoly because it generates 95% of all distributed electricity and this leads to improper tariff hikes to distributors. South Africa's utility regulator, the National Energy Regulator (NERSA), considered Eskom's request for tariff hikes, and after deliberation, cut back the utility's request and granted it a sizable 22% annual rate increase for seven years. Nevertheless, in the beginning of 2015, NERSA granted Eskom another 9.4% rate hike, but this was denied by a court in Johannesburg, stating that Eskom did not follow the correct procedures to apply for an increase. Furthermore, Eskom's management had failed to submit its quarterly reports during 2014/2015.

These reports were intended to be assessed by NERSA and communicated to Eskom's customers, including their distributors, as a regular pricing signal plan for possible future tariff increases (Rambe & Modise, 2016). More recently, in 2019, NERSA approved electricity tariff hikes for the next three financial years of 9.41%, 8.1% and 5.2% respectively, with a direct impact on customers (Niselow & Omarjee, 2019).

Municipalities need to supply a constant flow of electricity to their customers, maintain infrastructures and replace aged equipment. Therefore, an increase in their tariffs and costs, is directly projected onto their customers. Furthermore, it should be remembered that municipal losses caused by illegal electricity consumption in the form of meter tampering, is also conveyed to the customers in the form of payments for electricity supplied (Czechowski & Kosek, 2016).

Other economic factors that cause potential meter tampering is the high rate of unemployment, increases in the cost of living (Vermeulen, 2015), the growing use of electrical and electronic appliances resulting in more power consumption, and overall poverty (TETRA TECH, 2012).

- **Society**

Meter tampering leading to illegal electricity consumption, causes paying customers to experience pessimistic emotions in terms of commonly understood social justice. They do not understand why they, as paying customers, should pay their electricity bills when other illegal meter tampering consumers are not burdened with these costs, nor are apprehended, fined or jailed. This creates a motivation for legal customers to join the group of illegal customers (Czechowski & Kosek, 2016). Adding to the social justice tension, is that a large majority of poor customers are registered as municipal indigents, who qualify for certain free municipal services. According to the State Bill passed in 2005, these customers will receive 50 kWh of free electricity per month, especially in the rural areas. The question asked by paying customers, is whether these premises are metered and regularly inspected for any meter tampering (Ruiters, 2018).

- **Infrastructure**

Older regional municipality networks incorporate and operate with electromechanical meters such as kWh meters, which have several moving parts and are easier to tamper with. These meters are generally mounted inside the premises of a customer, giving anyone with malicious intentions more than enough time to tamper with, or bypass, a meter. Furthermore, besides the access to meters, deteriorating electrical enclosures for housing meters, give easy access to any customer wanting to resort to meter tampering (Pabla, 2011).

- **Legal**

Due to the lack of legal control and policies, the activity of meter tampering is enhanced. Municipal by-laws and the Southern African Revenue Protection Association (SARPA) work very hard to establish rightful punishment in the form of disconnections, fines and even jail time, for those who exercise illegal meter tampering. SARPA promotes the exchange of information between distribution utilities and finding solutions in protecting the income and assets of utilities against theft, abuse of electricity and misconduct (SARPA, 2019). Although SARPA is involved in the setting of National Standards and influences legislation, far too often weak policies and ineffective municipal management, overlook those who trespass and break the law regarding meter tampering. This creates a mind set and standard and ultimately an invitation for meter tampering since there are no real consequences for these actions.

## 2.4. ILLEGAL ACTIVITIES RELATED TO ELECTRICITY USE

Globally, NTLs, also known as fraud and theft of electricity or illegal activities, account for $96 billion per annum. (Yip, Tan, Tan, Gan & Wong, 2018). In South Africa that figure is R20 billion yearly of which three (3) quarters, R15 billion, is reported to be losses suffered by local regional municipalities (Lowvelder, 2016). An electricity network can never be a hundred percent (100%) secure from NTLs such as electricity meter tampering.

In many networks the amount of illegal activities may be small (1-2%) in terms of the electricity generated, but the financial losses are high due to the large amount of electricity distributed (Smith, 2004). Eskom (2019) noted that, in South Africa, the consensus seems to be that electricity theft cost between 0.2% and 3.1% of annual

gross revenues for electricity generated. This seems like a small percentage until it is considered that Eskom's electricity revenues were in the R 177 billion range during 2018 (EE Publishers, 2018). Therefore between R1 and R5.5 billion's worth of electricity is stolen annually through illegal activities. In South Africa, electricity is rarely discussed without reference to electricity theft since it is such a common and widespread practice.

The financial losses are critical to any electricity utility. Lost revenues can have a detrimental effect and lead to lack of profits, shortages of funds for investment in the electrical network capacity and improvement, and a necessity to expand generating capacity to cope with all the electricity losses (Smith, 2004). In some cases throughout South Africa, these lost revenues lead to local regional municipalities being bankrupt. In general, where there is theft, corruption is never too far away. Corruption increases and becomes rooted within an organisation in such a way that "favours" can be bought from the electricity utility employees in the form of inaccurate billing and allowing illegal connections. What is even worse, is if political leaders intervene to ensure that comrades and supporters are not prosecuted (Smith, 2004). It is crucial to acknowledge the problems associated with NTLs before these become institutionalised as part of the political, economic and managerial culture of governance in any utilities.

### 2.4.1. Types of Illegal Activities

There are at least four (4) kinds of illegal activities associated with electricity theft that are common in all power systems and most utilities. The extent of the electricity theft will depend upon various factors such as cultural influences and even to how the power utility is managed (Smith, 2004). The following illegal activities can be considered:

- **Fraud:** This is when the customer purposefully tries to deceive the utility, with the intended result of financial or personal gain. A common practice of fraud is to tamper with the electricity meter so that a lower reading of electricity use is registered as opposed to what was really used. There is a high risk involved since not everyone knows how the electrical system operates and, in many cases "amateurs" get electrocuted. On the other hand, there are a lot of professional electrical operators for sale who approach residents and businesses offering to "fix" the meter for a moderate fee (Smith, 2004).

- **Stealing Electricity:** Electricity theft is organised by rigging a line from the power source to where it is needed, bypassing the meter completely. This is quite a common site in poor residential areas where people either do not have allocated lines to their residential premises or they simply cannot afford to pay for electricity. As an example in the township of Soweto, South Africa, over 6 tons of “spider web” cable used for illegal connections was recovered in a raid by the electrical authorities during 2004. The illegal lines are easy to detect since they are generally above ground tapping off an overhead cable, transformer or electrical enclosure and are highly visible (Smith, 2004).

  It is a huge logistical task to try and remove these “spider webs” and often corrupt officials from the electrical utility may take bribes from residents or businesses in order to allow for the practice to continue. On a larger scale, businesses sometimes interact with senior electrical officials and organise for direct electricity feeding lines to their buildings or offices, bypassing the meter completely. It has been found that inspectors have also been bribed in order not to report the theft. In most of the cases the bribes cost much less than the value of the electricity stolen (Smith, 2004).

- **Billing Irregularities:** This can occur from several sources. Some electrical utilities may not be very effective in measuring the amount of electricity used, either through outdated meters or by inefficient meter reading officials, and unintentionally can give customer a higher or lower consumption figure, rather than an accurate one. This creates the opportunity for customers who want to commit fraud to either involve officials to organise much lower bills instead of actual usage or to record the meter at a lower usage number than what is shown. The consumer pays a lower bill and the meter reading official earns an unofficial salary (Smith, 2004).

  Another irregularity can occur should customers find out that utility office staff are on the take, and that is for the staff member to move the decimal point on the customer’s account so that the customer pays R 56.00 instead of R 560.00

and the staff member gets a bribe on the side. These corrupt practices can easily become the norm in a utility to the extent that staff members might regard eliciting payments as part of their job (Smith, 2004).

- **Unpaid Bills:** There are no difference between the previously mentioned illegal activities and not paying what is owed to the utility after making use of a service supplied by them. Some residential and business consumers just do not pay their electricity bills. In South Africa, a “culture of non-payment” is very evident and amounts to millions of rand owed to the generation, transmission and distributors of electricity (Smith, 2004).

  There seems to be at least two different groups classified as non-payers. It is either the very rich and politically powerful customers who know that their electricity will not be cut off regardless of whether they pay or not. The second group is the group that regards electricity as a free service from government, something that they are completely entitled to without any financial connotation. This mentality is often associated with the poor who cannot afford to pay for electricity supplied. The reality is that as electricity increase in cost, some people might find it difficult to pay their electricity bills and might find ways to reduce their bills, such as tampering with the electricity meter. However, it really does not matter in which category unpaid bills fall, this action should always be treated and classified as theft (Smith, 2004).

In most of the electricity distribution utilities, the extent of illegal activities and their impact has serious consequences. Data on fraud, billing irregularities and unpaid bills within Western Cape Municipalities are not easily available for this study, therefore the data and analysis in this study deals primarily with the stealing of electricity and more specifically with meter tampering.

### 2.4.2. Meter Tampering Defined

Meter tampering is when a consumer makes the meter stop functioning, under-register, stop registering how much electricity is consumed, or even bypass the meter all together (Eskom, 2019).

It can also be defined as “to interfere with, damage or bypass a utility meter, conduit or attachment with intent to impede the correct registration of a meter or the proper function of a conduit or attachment” (Citiq, 2019).

### 2.4.3. How Does Meter Tampering Occur?

Although a common denomination is used to refer to meter tampering, it happens in various ways, such as:

- **Tampering with meters and seals:** One of the oldest ways to tamper with a kWh meter is to fit two strong magnets to the sides of the meter which slows down the rotating disc and registers less electricity usage. Prepaid meter tampering is generally visible since either the seal is broken, the meter cover at the bottom is loose or additional wiring connections to and from the meter can be seen (Citiq, 2019).

  Meter bases are generally sealed at the bottom with a tamper evident meter seal. This means that in order to open and tamper with the meter, the meter base seal must be cut and can no longer seal properly. Obviously tampering can be visually detected just by looking at the seal.

- **By-passing meters:** This is a very common trade and is done in various ways such as to “tap” or “hook” directly onto the distribution lines. A “tap” can be visually identified since the lines are in general above-ground leading from the overhead distribution line down to the consumer’s premises. These are the “spider webs” referred to earlier in this chapter.

- **Damaging or removing meters:** Some users damage the meters to such an extent where they cannot properly function, or in other cases the meter is permanently and completely removed. The flow of electricity through the system is restored by linking the opening with basically anything available that can conduct electricity such as kitchen knives, screwdrivers and most ordinary metals. Figure 2.9 shows typical examples of how electrical meter tampering takes place.

*Figure 2.9: Examples of What Meter Tampering Looks Like*

Source: Eskom.co.za (2019)

Source: Govanmbeki.gov.za (2019)

### 2.4.4. Initiatives to Address the Problem of Meter Tampering

It is very clear that electricity meter tampering is an ongoing and tedious problem for every electrical generation, transmission and distribution authority. Generally, initiatives to address and reduce electricity theft can include technical solutions such as tamper-proof meters, managerial methods such as inspection and monitoring, and in some cases restructuring power systems ownership and regulation (Smith, 2004).

However, more detailed suggestions for possible solutions to minimise non-technical losses and retain economic levels include the following:

- Most of the electricity networks in the Western Cape are aged and need new technology upgrades. Traditional electromechanical and common base prepaid meters make up a large portion of the networks, and have generated a variety of traditional tampering methods, such as the use of magnets, interfering with the wiring, complete bypassing and even using electroshock devices to disrupt metering (Eisenbeiss, 2015). One of the fundamental drawbacks of conventional metering systems, is that they do not have bi-directional communication abilities in order to send meter readings to municipalities. The utilities need this information for real time billing purposes as well as to try and control the non-technical losses occurring at the customers' premises (Hussaine, Memon, Das, Hammad & Awan , 2017).

  Meter manufacturers have responded with the development of newer, smarter meters, and driven significant improvements. Physically, meter design has advanced to present more robust meters that are difficult to break into and interfere with (Jhansi & Pushpa Rani, 2017). Furthermore, smart meters have

been designed to prevent, rather than cure tampering. Their biggest feature is that they can detect tampering, and feedback information to the utility via a two-way communication function. This allows utilities to quickly detect and investigate any anomalous usage patterns (Eisenbeiss, 2015).

- Preceding smart meters, prepaid split metering was one of the previous suggested solutions introduced by meter manufacturers. As previously mentioned in this chapter under type of meters, a split prepaid meter consists of two parts, one being the customer interface unit (CIU), put into each customer's house, and the other the meter which is installed in a low voltage electrical enclosure on the pavement or on a pole outside the house (Hartleb, 2015).

  Although this seemed like a fool proof solution, those determined to tamper with electricity meters merely shifted their focus to breaking into or vandalising the low voltage electrical enclosure in order to access the energy management unit (EMU) of the meter. This has led to a drive for electrical enclosure manufacturers brainstorming to come up with more innovative and better solutions for preventing trespassers being able to access enclosures, and these are referred to as anti-vandal and smart kiosks, and as per the smart meters, include two-way communication (TETRA TECH, 2012).

- In the Integrated Energy Plan (IEP), the Department of Energy noted a further increase in the generation and operational costs of the electrical network system in the future, which will result in further financial burdens for a municipality if opting only for the grid network option (Jamal, 2015). Thus, introducing new alternative economic off-grid electricity generation methods to the developing areas within the municipal region is essential (Baker & Phillips, 2018). As one renewable option, the government and Eskom have supplied 50 Watt Solar Home Systems (SHS) to 75 272 households, from 2002 to 2013, throughout different areas of South Africa (Jamal, 2015).

- As mentioned earlier in this section, the main motive for electricity meter tampering is the desire to save money. The Continuous Research and Development (R&D) of intelligent electronic devices (IEDs), like home appliances, has led to them being embedded with both intelligence and sensors that provide them with decision-making capabilities to save electricity, resulting in a lower electricity bill for a customer (Santoso & Beaty, 2018). There might be a lack of knowledge in the municipality regarding IEDs, resulting in the fact that the options are not suggested or transferred to the customers.

- Municipalities can mainly try to counteract the problem of meter tampering with increased tariffs, penalties and legislative controls. However, they can also appeal to their customers to look out for those who tamper with meters and offer them rewards. Electricity distributors can launch special hotlines where any noticed tampering can be reported anonymously or identified (Czechowski & Kosek, 2016). Alternatively, municipalities can reward customers who effectively and efficiently manage their electricity with practical and usable rewards for their household or business; for example, the issuing of grocery tokens.

- As electrical meter tampering escalated during the past few years, research and industry started to focus on smart grids. Smart grids provide a completely controllable and monitored network, where two-way communications between the different elements of the grid and the control centre is possible. Smart meters are considered to be an important element of smart grids which is used to monitor the electricity usage of different customers, both residential, business and industrial, and to feed back the billing information to the customer. It is the responsibility of the utility to regularly check the grid and meters since wrong readings can result in users tampering with the meter in order to justify their bills (Mesbah, 2017).

- Metropolitan, district and local regional municipalities should add a separate revenue protection department whose sole purpose is to take note of, monitor and regulate meter tampering activities. Such a department will abide by

government or municipal by-law regulations, recover penalties and consumption losses and provide master replacement and sealing of meters. If it is not possible for a utility to secure such a department themselves, they can outsource it to an external contractor. These revenue protection companies perform functions such as analytical review of consumption, utility billing analysis, site inspections, identification of technical losses, meter audits, tamper investigations, tariff expertise, legislation enforcement, by-law governance and regulation, recovery of consumption losses, meter replacements, LPU audits and meter sealing. (Power Measurement, 2019).

- Eskom launched an initiative called Operation Khanyisa during October 2010 which continues to be active in 2019. The main aim of this operation is to raise awareness of and educate the South African nation about the impact and consequences of electricity theft. Social mobilisation across all sectors and compliance interventions aim to instil a culture of legal, safe and efficient electricity use. Also to address the problem of electricity theft in municipalities, Operation Khanyisa has partnered with the South African Local Government Association (SALGA) and various different municipalities (Eskom, 2014). Some of the key successes include: (1) More than 8 000 tip-offs have been received via Crime Line (SMS: 32211) and Eskom's toll-free reporting line (0800 11 27 22). (2) In the 2013/14 financial year, 18 suspects appeared before various courts in South Africa on charges related to electricity theft. Since the launch of Operation Khanyisa more than 60 court cases have been heard and over 112 arrests made for crimes relating to electricity theft. (3) Eskom teams have conducted more than two million audits of electricity meters and installations and removed over 80 000 illegal connections (Eskom, 2014).

- The South Africa Revenue Protection Association (SARPA) is a non-governmental organisation that promotes the exchange of information and finding solutions in protecting the income and assets of utilities against pilfering, misapplication and misappropriation (SARPA, 2019). SARPA work together with Eskom, as well as metro, district and local regional municipalities to combat all illegal activities involved with electricity use. They have branches throughout

South Africa and are often involved in the setting of national standards and influencing legislation regrading all illegal activities around electricity use. (SARPA, 2019).

## 2.5. THE CONSEQUENCES OF ELECTRICAL METER TAMPERING

Illegal activities such as electrical meter tampering can never totally be eliminated in any electrical network. It is therefore important to keep in mind what consequences such behaviour and actions can have not only on the electrical generators, transmission and distribution authorities, but also on the consumers of electricity.

The amount of electricity that is needed in a municipal network should be determined by the number of paying customers, whose electricity consumption is measured by an electrical meter. However, the load on the network is determined by the demand, therefore when customers bypass and tamper with the electrical meters, various problems are created.

Firstly, the amount of electricity consumed in the network stays the same, but the billable amount of electricity units is much lower. The result is that the municipality collects less revenue from its customers, but still pays Eskom for the same amount of electricity consumed. Out of South Africa's 284 municipalities, 171 are electricity distributors and have experienced severe difficulties managing their meter tampering, billing and collecting of electrical revenue. Twenty three of the largest regional municipalities only managed to meter and collect 60 per cent (60%) of the electricity they distributed, and by the end of 2006, they faced serious cash flow problems (Ruiters, 2018).

Secondly, more consumers can join the network without paying for electricity if they bypass or tamper with their meters. Eventually, the municipality will experience a need for more electricity in their network, but without an equally growing revenue stream. The municipal management somehow must recover the revenue shortfall in order to pay Eskom, which will ultimately raise the electricity tariffs. In fact, in January 2019, the National Energy Regulator (NERSA) approved electricity tariff hikes for the next three financial years of 9.41%, 8.1% and 5.2% respectively (Niselow & Omarjee, 2019).

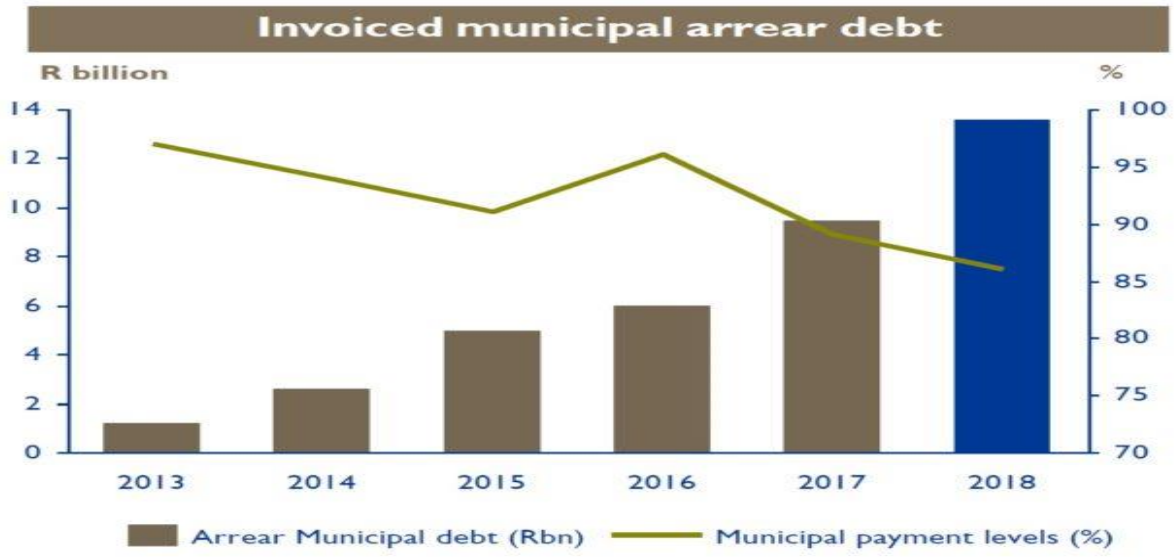
Thirdly, another threat if the problem of electrical meter tampering persists, is that of network equipment failure. Normally the municipal network is designed to only handle a certain amount of power and overloading the network can put huge stresses on the hardware, such as cables, mini-substations, transformers, low voltage kiosks and switchgear. Continuous overloading can cause serious damage to equipment and ultimately cause the electrical network to collapse. Regular upkeep and maintenance of equipment in the network is very important, and a lack of revenue collection through metering, prevents municipalities from doing this, also resulting in a possible network collapse. Failure to maintain electrical equipment can also cause serious injury to customers and in the worst cases, cause death. Transformers that explode, mini-substation switchgear that overloads, electrical enclosure doors that do not lock properly, deteriorating overhead cables, and so on can all contribute to this problem.

No electricity means the infrastructure of a municipality, business or household cannot function. No electricity means no economy, and no economy leads to job losses which make customers poorer, resulting in health problems and eventually complete poverty for the municipal region.

Lastly, just to be clear and reiterate what the economic impact of electrical meter tampering on utilities is, it is crucial to remember that first and foremost the utility must be appreciated and seen as a business. Therefore, when looking at the issue from a business perspective, electricity meter tampering results in economic losses to the utility (Smith, 2004). Some consumers may argue that large utilities providing essential services give poor service, over-charge, make too much money anyway, and therefore, some illegal activities including theft and meter tampering will not break the utility or drastically affect its operations and profitability. Others looking at the same situation would argue that any illegal activity such as theft and meter tampering is a crime and should not be allowed at all; in fact, it should be treated with the same measures and consequences as any other ordinary crime (Smith, 2004). As mentioned earlier in this chapter, The South Africa Revenue Protection Association established themselves and offered to assist the utilities in the detection and prevention of illegal electricity activities and therefore mainly help to secure their financial positions.

The economic impact of electrical meter tampering is important for the survival of the utility and the viability of the services they provide. The combined losses (including non-payment of bills) in some Western Cape Municipalities have severe impacts resulting in utilities operating at a loss and therefore must continually increase electricity charges to make up for deficits (WCG, 2019). Locked into a culture of inefficiency and corruption, the electricity utilities have difficulty delivering a reliable service. Even in reasonably efficient distribution electrical networks throughout South Africa, illegal activities account for economic losses of R 15 billion annually (Eskom, 2019). This situation worsens if municipalities cannot settle their Eskom accounts leading to a knock on effect as stated by Eskom in July 2018, when they announced a loss of R20.7 billion due to the cost of servicing high levels of debt, the increased cost of primary energy and unpaid municipal debts (EE Publishers, 2018). They further stated that one of their biggest challenges is the clearing of municipal debt. An amount of R13-billion is owed to Eskom by about 20 defaulting municipalities. The situation has worsened over the last five years and it will be difficult to prevent this trend from continuing (EE Publishers, 2018). Figure 2.10 illustrates how municipal debt payments to Eskom have declined through the past six (6) years.

*Figure 2.10: Invoiced Municipal Arrear Debt (Eskom)*




Source: EE Publishers (2018)

However, the other side of the spectrum is bright and full of opportunities should customers not perform illegal activities such as meter tampering. If customers pay for

their electricity usage, the municipalities will be able to bill and collect the right amount of revenue. They will be able to pay their Eskom bill, maintain their network and if managed properly, expand their network and build infrastructure to host more businesses. Industrialisation incorporates more businesses, which in return creates jobs and leads to a positive growing economy.

## 2.6. SUMMARY

The objective of Chapter 2 was to conduct secondary research or collect secondary data in the form of a literature review. This chapter started with an introduction followed by an overview of electricity supply and usage in South Africa and the Western Cape. This section defined electricity and highlighted several other aspects such as electricity generation, transmission and distribution through local regional municipalities. Types of electrical meters, electricity measurement and electrical enclosures were discussed followed by the factors that play a role in the supply and use of electricity.

Thereafter the chapter explained the illegal activities related to electricity usage as well as identified the consequences of electrical meter tampering. The research questions addressed in Chapter 2 were RQ1, RQ3 and RQ4 together with their corresponding research objective RO1. The next chapter, Chapter 3, will explain the research methodology adopted in this study to determine the economic impact of electrical meter tampering in Municipalities within the Western Cape.

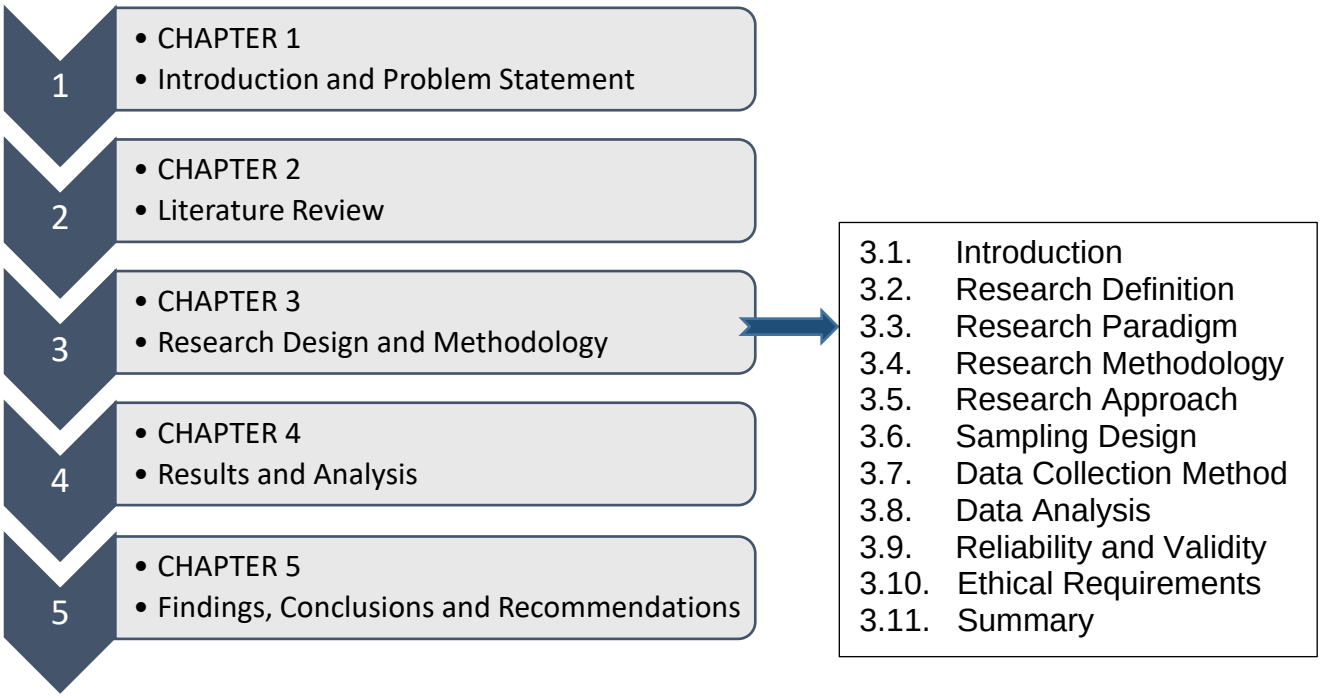
# 3. CHAPTER 3: DESIGN AND METHODOLOGY OF THE STUDY

## 3.1. INTRODUCTION

Chapter 2 gave a literature review in the form of a theoretical overview of the economic importance of having an electricity meter, the type of electrical enclosures the meters are installed in and possible reasons why electricity meter tampering takes place. These are all in line with the objective around the management of electricity and the challenge of electricity meter tampering in general, meaning nationally and regionally.

Chapter 3 commences with defining what research is, followed by the research design. The chapter continues to provide insight about the chosen research paradigm and approaches and Section 3.4 explains the research methodology. The chapter also include sections that address the data sampling design, the data collection methods and data analysis process, specifically aimed at gathering and analysing data for research questions $RQ_2$, $RQ_5$, $RQ_7$ and $RQ_8$ and research objectives $RO_2$, $RO_3$ and $RO_4$. Section 3.7 discuss the ethical issues and how they were addressed to comply with the NMU Ethical Clearance guidelines. Section 3.8 closes off the chapter with a summary. The Chapter 3 summary is illustrated in Figure 3.1

*Figure 3.1: Chapter 3 Summary*




Source: Author's Own Construction (2019)

## 3.2. RESEARCH DEFINITION

According to the Concise Oxford Dictionery (2007), research can be defined as: “The systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions.” Furthermore, research can be decribed as a process that includes aquiring scientific knowledge through modes of various objective methods and procedures (Welman, Kruger & Mitchell , 2007). The term objective indicates that these methods and procedures do no rely on personal feelings or opinions but rather on specific methods to be used at each stage of the research process (Welman et al., 2007). These methods include procedures for the drawing of samples, the measuring of variables, collecting and analysing of the information or so-called “data” in research terms.

## 3.3. RESEARCH PARADIGM

A paradigm is a manner of describing a worldview or a set of assumptions of how things work (Chilisa & Kawulich, 2015). A paradigm leads us to a shared understanding of reality, thus forcing us to ask valid questions and use appropriate paths to an efficient study, known as methodology (Chilisa & Kawulich, 2015).

Johnston (2014), emphasises that researchers are pointed towards a research methodology approach depending on their standpoint when it comes to positivism, realism, interpretivism or pragmatism. However, the two main paradigms that underpin social science research are interpretivism and positivism (Collis & Hussey, 2014). Distinctions between these two philosophies are often overemphasised or oversimplified and many researchers do not strictly fall into one camp or another (Sage, 2018).

Positivist social scenes use methods resembling those of the natural sciences as tools for understanding society (Sage, 2018). As a philosophy, positivism clings to the view that only factual knowledge gathered through scrutiny is trustworthy. The researcher’s role is limited to data collection and interpretation in an unbiased or impartial way and the research findings are usually obvious and measurable.

(Dudovskiy, 2019). The four main principles of a positivism research philosophy can be summarised as follows:

- There are no differentiations in the logic of research across sciences.

- The research should aim to explain and anticipate or conclude.
- Research should be analytically observable via human senses. Inductive reasoning should be used to develop statements (hypotheses) to be tested during the research process.
- Science is not the same as individual common sense. Individual common sense should not be allowed to prejudice the research findings (Dudovskiy, 2019).

Typically, a positivism paradigm utilises a quantitative approach (Dudovskiy, 2019). Quantitative approaches are discussed in more detail in Section 3.4 under Research Methodology.

An interpretive research philosophy was followed in the course of this study, since it is more intuitive or instinctive and personal (Collis & Hussey, 2014). Collis & Hussey (2014) describe interpretive studies as those which focus on developing theories, delivering qualitative and subjective data, making use of small samples, producing findings with a high validity, but low reliability. It allows for results of one context to be inferred to another related context. The five main principles of the interpretivist research philosophy can be summarised as follows:

- Researchers are often entrenched in what they are studying and therefore can be classified as a research instrument. While they need to give personal insights, they must be aware of their personal biases and not let these influence the accuracy of the research.
- Interpretive analysis: Interpretation must occur on two levels. Firstly, from the subjective perspective of the participant and secondly, to understand the meaning of the participants' experiences.
- Naturalistic enquiry: Social sciences should be studied within their natural setting and the contextual variables should be observed and considered in seeking explanations of the phenomenon of interest.
- Use of expressive language: Documenting the verbal and non-verbal language of participants and the analysis of such language are integral components of interpretive analysis.
- Emphasis must be placed on the understanding of a research topic and the observations must continue until theoretical saturation is reached, where after

additional observations do not yield any more insight into the research topic (Lumen, 2019).

Furthermore, unlike positivist research, which starts with a hypothesis, interpretive research asks open ended questions (Lewis, 2015). Typically, an interpretive paradigm utilises a qualitative approach (Chilisa & Kawulich, 2015). There is a tight connection between the interpretivist paradigm and qualitative methodology as one is a methodological approach and one is a means of collecting data. Researchers who are using the interpretivist paradigm and qualitative methods often seek experiences, understandings and perceptions of individuals for their data to uncover reality rather than rely on numbers of statistics (The American Institute of Science, 2015). Qualitative approaches are discussed in more detail in Section 3.4 under Research Methodology.

The interpretive research questions are typically open-ended, descriptive and non-directional (Creswell & Plano Clark, 2011). A common model includes a main research question followed by a small number of sub-questions (Chilisa & Kawulich, 2015). The main research question is a presentation of the problem that is investigated in the study in its most extensive form, posed as a regular issue, so as not to limit the study (Creswell & Plano Clark, 2011). The sub-questions are used as guides for the methodology and methods used to enable the researcher to answer the broad-based main research question. The researcher also has to establish trust, rapport and authentic communication patterns with the participants and address ethical behaviour throughout the process (Chilisa & Kawulich, 2015).

## 3.4. RESEARCH METHODOLOGY

Firstly, in order to truly understand what research methodology is, it is important to understand what data is and the types of data that exist. Data can be described as individual pieces of factual information recorded and used for the purpose of analysis (Macalester, 2019). Data may be grouped into four main types based on methods for collection:

- Observational data is captured through observation of a behaviour or activity. It is collected using methods such as human observation, open-ended surveys or the use of an instrument to record information.

- Experimental data are collected through active intervention by the researcher to produce and measure change or to create a difference when a variable is altered and is typically projectable to a larger population.
- Simulation data are generated by imitating the operation of a real-world process or system over time using computer test models. This method is used to try to determine what would, or could, happen under certain conditions.
- Derived data involves using existing data points, often from different data sources, to create new data through some sort of transformation, such as an arithmetic formula or aggregation (Macalester, 2019).

Choosing the right type of research data to use in a study is followed by identifying the right collection method. Generally, data is collected using a wide variety of methodologies (Macalester, 2019). A research methodology involves specific techniques that are adopted in the research process to identify, collect, process and analyse data about a topic. It defines those tools that are used to gather relevant information in a specific research study. There are three methods or tools available to the researcher when doing research, such as mixed methods, quantitative methods, and qualitative methods (Collis & Hussey, 2014).

- The mixed research method is also sometimes referred to as the “third methodological movement” or “third research paradigm” since it contains a combination of quantitative and qualitative approaches in the methodological orientation of the study (Creswell & Plano Clark, 2011). Included in this orientation is a mix of philosophical positions, inferences, and the interpretations of results (Creswell & Plano Clark, 2011).

  In using mix methods, the researcher collects and analysis both quantitative and qualitative data and integrates the two forms of data by merging them through a process where the one is embedded within the other or one is built on top of the other (Creswell & Plano Clark, 2011). Included in this orientation is a mix of philosophical positions and inferences. Depending on what the researcher’s focus is, emphasis will either be put on one or both forms of data and the procedures used will either be a single study or in multiple phases of a programme or study (Creswell & Plano Clark, 2011). Furthermore, the researcher frames the procedures within philosophical worldviews and

theoretical lenses and combines the procedures into specific research designs that direct the plan for conducting the study.

- Quantitative research methods are used when a researcher is trying to quantify a problem or study topic and wants to address aspects of a research question such as the “what” and the “how many”. This method seeks to classify features, count them and create statistical models to test hypotheses and explain observations. Generally, it is data that can either be counted or compared on a numeric scale. Quantitative data is collected using techniques or tools such as surveys, questionnaires and evaluations that include multiple choice items and rating scales such as the Likert Scale as well as statistical software programmes such as SPSS in order to provide quantitative data for analysis.

- Qualitative research methods aim for complete, detailed descriptions of observations including the content of event and circumstances. This method seeks to balance documentation of action in natural settings with insight into its meaning to those involved in describing qualities or characteristics (Hobbs & Wright, 2006).

  Qualitative data is collected using techniques or tools such as questionnaires, in-depth interviews, focus group discussion and observations. The data often appears in a descriptive form that must be examined for patterns of meaning (Macalester, 2019). This is mostly done making use of a process such as coding that allows the researcher to categorise the qualitative data in order to identify themes and patterns that coincide with the research questions and then perform quantitative analyses (Macalester, 2019).

Quantitative research produces a quantity of data that can be generalised, whereas qualitative researchers are after depth and analysis in the data rather than quantity (Nagy, Biber & Leavy, 2006). A direct comparison between qualitative and quantitative methodology approaches are explained in Table 3.1 below:

*Table 3.1: Comparison between Quantitative and Qualitative Research*

| **Quantitative Methodology Approach** | **Qualitative Methodology Approach** |
|---|---|
| Purpose: Evaluate objective data | Purpose: Evaluate subjective data |
| Analysis: Based on complex structured methods to confirm or disprove hypotheses | Analysis: Based on flexible and explorative methods to better understand the research topic |
| Deals with an abstraction of reality | Investigates the constraints of day to day events |
| Understands the research from an outsider perspective – stays detached, objective and free from bias | Understands the research from an insider's view – talks to and observes subjects in an objective way |
| Keeps research as stable as possible | Works with the dynamic and changeable data |
| Particularistic approach: specific measurement instruments are used | Holistic approach: Collects a wide array of data through documents, case studies, interviews, observations, photos and records. |
| Aims for reliable and valid results although the focus is more towards reliability | Aims for reliable and valid results although the focus is more towards validity |
| Research aims for larger numbers of cases | Research involves smaller samples of people |
| Uses empirical and inferential methods | Uses interviewing and observation processes |

Source: Welman et al. (2007)

While there are many theoretical and practical differences between the various approaches such as general points of view, the way questions are asked and particular ways of thinking (Nagy et al., 2006), the method or tool best suited to do research for this study is a qualitative method.

## 3.5. RESEARCH APPROACH

Typical research designs for an interpretive research philosophy are qualitative approaches such as ethnography, phenomenology, symbolic interaction, case study, grounded theory and other naturalistic designs (Chilisa & Kawulich, 2015). The two qualitative approaches best suited to this study are:

### 3.5.1. Case Study

A case study examines the comprehensive elected samples to better understand a phenomenon. This method illustrates the qualitative researcher's preference for depth, detail, and context, regularly working with smaller and more pinpointed samples, compared with the large samples of elementary interest to statistical researchers seeking general laws (Chilisa & Kawulich, 2015). In other words, the term case study concerns itself with the fact that a limited number of units of analysis, often only one, is studied intensively (Welman et al., 2007). The units of analysis for a case study include individuals, groups and institutions. The researcher is guided to understand the singularity and consider the way of thought of a particular case in all its complexity (Welman et al., 2007).

Furthermore, the units of analysis do not necessarily have to be humans but can include personal documents such as diaries or letters or records such as indexes or ratios. Three aspects must be considered when performing case studies (Welman et al., 2007). They are:

- Boundaries must be determined but may be adjusted promptly by the researcher, if necessary, during the course of the research.
- Irrespective of the techniques used to collect data, the researcher must observe and take note of recurring patterns and consistent regularities in an analytical way.
- In case study methodology, the number of case studies is limited, and the very purpose is to intensely examine those cases that are chosen. An attempt must be made to confirm the findings in at least three different approaches, remembering that the researcher is often seen as a research instrument (Welman et al., 2007).

Case studies do have some limitations such as problems with validity of data, creative links which are difficult to test and inductions cannot be made based on a single case study. Therefore, it is critical to check the original data from which the case study was drawn. Video or audio recordings are often used to capture new data so that it can be re-analysed by other researchers if need be (Terre Blanche, Durrheim & Painter, 2008).

### 3.5.2. Grounded Theory

Grounded Theory (GT) is a broad scale methodology for promoting theory that is grounded in data, which is meticulously collected and analysed (Glaser & Strauss, 1967). Furthermore, grounded theory can be described as a qualitative method with a goal to develop theoretical accounts on the basis of a close, inductive engagement with the context of study (Terre Blanche et al., 2008). Instead of formulating a hypothesis, grounded theory commences with the collection and analysis of data (Creswell, 2009).

One example is that the idea of theoretical saturation is taken from grounded theory since the process of data collection and analysis is not always seen as two different phases but may occur at the same time (Terra Blanche et al., 2008). At the point of theoretical saturation, additional samples no longer provide any new information that challenges or adds to the research. In other words, any further information becomes redundant, to the extent that is becomes repetitive (Terra Blanche et al., 2008).

Maree (2016) states that, “the major difference between grounded theory and other research methods is its specific approach to theory development. Grounded theory seeks to develop theory that is grounded in data systematically gathered and analysed.”

## 3.6. SAMPLING DESIGN

It is important to understand what sampling is before the study discusses the sampling design that will be used. Sampling can be defined as “The process of selecting a number of individuals for a study, in such a way that the individuals represent the larger group from which they are selected” (Hajimia, 2014). Therefore the purpose of sampling is: “To gather data about the population in order to make an inference that can be generalized to the population” (Hajimia, 2014).

Although quantitative and qualitative research can use probability and non-probability sampling techniques, quantitative researchers tend to rely on probability sampling techniques while qualitative researchers rely on non-probability sampling techniques (Bhat, 2019). The differences between the two (2) techniques are discussed in Section 3.6.2. There is an array of probability sampling types that researchers can use. These include the following:

- Random Sampling: Selecting samples so that the members of a population have an equal and independent chance of being selected.
- Systematic Sampling: Here the researcher selects every Kth subject from a list of the members of a population.
- Stratified Sampling: The population is divided into two (2) or more groups called strata. This is done on the basis of certain criteria, such as geographic location, age, income, grade level and sub-samples are randomly selected from each stratum.
- Cluster Sampling: The process of randomly selecting intact groups, not individuals, within the defined population sharing similar characteristics (Hajimia, 2014).

Like probability sampling, researchers also have an array of non-probability sampling types to choose from. These include the following:

- Convenience Sampling: The process of including whoever happens to be available at the time. Also referred to as accidental or haphazard sampling.
- Purposive Sampling: The process whereby the researcher selects a sample based on experience or knowledge of the group to be sampled.
- Quota Sampling: The process whereby the researcher gathers data from individuals possessing identified characteristics and quotas.
- Consecutive Sampling: The researcher picks a single person or a group from the sample, conducts research over a period of time, analyses the results and then moves to another subject or group of subjects if needed.
- Snowball Sampling: This is when the researcher does not know the best people to study because of the unfamiliarity of the topic. Therefore, the researcher asks participants during the interviews to suggest other individuals to be sampled (Hajimia, 2014).

The stages in the selection process of a sample are as follows: • define the target population • select a sampling frame • determine if a probability or non-probability sampling method will be used • plan the procedure for selecting the sampling units • determine the sample size •select the actual sampling units • conduct the fieldwork (Hajimia, 2014).

### 3.6.1. Population of the Study

This study is concerned with the challenge of electricity meter tampering in the Western Cape; therefore the unit of analysis would include all Western Cape Municipalities responsible for the supply and distribution of electricity.

Unfortunately, due to various factors such as population size, costs and the time frame available to complete the research, it is not possible to reach all thirty (30) of these local regional municipalities. Instead, a representative population sample was chosen which is represented by a maximum of twelve (12) senior managers and six (6) middle managers employed within the electricity department of ten (10) local regional municipalities (Collis & Hussey, 2014). The selection of a representative population sample ensured that participants could be reached easily, and that the researcher could complete the study within the anticipated budget and time frame.

### 3.6.2. Participants of the Study

The study title refers to the economic impact of electrical meter tampering within Western Cape Municipalities. Therefore, in order to access and collect relevant data, the unit of analysis used was nominated individuals that are employed within Western Cape Municipalities and operational within the electricity departments.

There are various sampling methods available; however for the purpose of this study, the technique of non-probability sampling with purposive sampling as a type, was used (Wegner, 2016). Firstly, non-probability sampling relies on the subjective judgement of the researcher to select the relevant samples/participants. In this technique, not all members of the population have a chance of participating in the specific study, unlike probability sampling where each member of the population has a known chance of being selected (Bhat, 2019). One of the disadvantages of non-probability sampling is the inability to accurately measure sampling errors, creating the risk that the entire

research population is not potentially represented. However, the major advantages of cost and time effectiveness surpass the disadvantages (Wegner, 2016).

Secondly, purposeful sampling is widely used in qualitative research when the researcher has knowledge about the study and the population, and therefore can select participants according to the needs of the study. Hence, the study refers to senior and middle managers employed within the electricity departments of Western Cape Municipalities. Participants who do not meet the criteria for the study, are rejected (NBCI, 2016).

## 3.7. DATA COLLECTION METHOD

Data collection can be defined as a process whereby the researcher collects information from identified and applicable resources in order to find answers to the stated research problem, test the interpretation and evaluate the outcome (Business Jargons, 2019). Accurate data collection is a crucial part of any research study because inaccurate data collection will lead to an invalid result and thus make the research null and void.

Data gathering techniques are selected, depending on the choice of design, the nature of the respondents and the research problem. They include interviews, observations, visual aids, personal and official documents, photographs, drawings, informal conversations, and artefacts (Chilisa & Kawulich, 2015).

Secondary and primary data are the two categories in which data can be divided. Secondary data is collected from current sources such as internal records, publications and internet records (Wegner, 2016). Primary data is collected from authentic sources such as surveys, interviews and focus groups (Wegner, 2016).

As mentioned earlier, an interpretive research philosophy will be followed using qualitative data collection, and one of the primary methods for this type of collection is interviews (Lewis, 2015).

Interviews can be categorised as either structured interviews (questions are identical for all interviews), semi-structured interviews (questions can vary from one interview to another) and unstructured interviews (questions and interviews are more informal) (Saunders, Lewis & Thornhill, 2009).

Thus, primary data collection for this study was collected through pre-arranged, structured interviews, asking open-ended, descriptive, non-directional questions (Creswell & Plano Clark 2011). All interview answers were captured in writing as well as audio-recorded by voice recording device and were transcribed during analysis.

### 3.7.1. Interview Schedule Development

An interview can simply be defined as a meeting between two people, generally referred to as the interviewer and the interviewee, where questions are asked by the interviewer to obtain information, qualities, attitudes, wishes etcetera from the interviewee (Business Communication, 2019).

There are many types of interviews such as informal or conversational, standardised or open ended, closed or fixed response, persuasive, counselling, disciplinary, stress interviews, and so on (Business Communication, 2019).

However, the following types of interviews are specifically important for research since the interviewer, in this case the researcher, is guided by what the research questions and objectives of the study are. They can be grouped into three (3) types (Easwaramoorthy & Zarinpoush, 2006).

a) Structured Interviews: Here the interviewer prepares and asks a set of specific standard predetermined questions about a particular topic and in a specific order.

b) Semi-structured Interviews: Here the interviewer works within a framework but does not necessarily strictly follow a formalised list of questions. A discussion format instead of a straightforward questions and answer format, is followed.

c) Unstructured Interviews: Here the interviewer has no specific set of predetermined questions although the interviewer has a particular topic in mind that s/he wishes to discuss. These interviews are generally more informal and open ended (Easwaramoorthy & Zarinpoush, 2006).

After deciding which interview type to use, it is equally important to decide what type of interview questions to apply. The right interview type combined with the right question structure, will ensure that all interviews are relevant to the study as set out by the main research question and objective. There are many types of research

interview questions such as open ended questions, probing questions, specific and closed questions.

The research interview type chosen for this study was structured interviews, combined with open ended, descriptive and non-directional research questions. Here are some definitions in order to fully understand what this means:

> **Open ended questions** are referred to as questions in which the possible answers are not suggested and the respondent's answers cannot be a simple yes or no. The respondents must answer in their own words and in doing so, provide qualitative information or data. Open ended questions are generally asked during exploratory research (TECKS, 2019).
>
> **Descriptive questions** are used to describe characteristics of a population or topic being studied. In order to answer them, the researcher must observe what is happening or talk to people about what is happening so that this can be described. Furthermore, these questions need answers that contain definitive information about the research topic or describe some special event (TECKS, 2019).
>
> **Non-directional questions** are very open ended and therefore do not guide the respondents' answers but rather rely on their own responses to answer the question reflecting their own view and personal perspective (TECKS, 2019).

The process for data collection by way of interviews consisted of two important steps. The first was to get consent from the municipal manager for the municipality to engage in the research, and secondly to get consent from the nominated senior or middle manager who would be interviewed. Following procedure, during different time frames, both these parties were approached with a one or two part email. The first part of the email was a letter of invitation that supplied them with specific information, such as the study topic, the primary objective of the study, the research problem, the research approach, the data collection and analysis methods as well as the reporting and synthesis process.

The second part of the email asked for their consent and voluntary participation. More importantly, this part confirmed the ethical approval from the Nelson Mandela University Ethics Committee and reiterated the need to protect the participant's rights to privacy and anonymity and to preserve confidentiality with respect to data gathered. (Refer to Annexure 2: Senior/Middle Management Consent Letter, Annexure 3: Written information given to Senior/Middle Manager prior to participation and Annexure 5: Letter of Invitation to Western Cape Municipal Managers and Municipal Manager Consent Form).

## 3.8. DATA ANALYSIS

The first step to decide how to analyse the study data is to define the unit of analysis. The unit of analysis is the "how, where, when, who, what and why" that was analysed for this study (The Pell Institute, 2019) and could be an individual, a group or an entire programme. It is critical to understand that the unit of analysis in not the same as the unit of observation (The Pell Institute, 2019). The unit of analysis for this study was the selected Western Cape Municipalities, and the unit of observation was the nominated individuals that were interviewed within these municipalities.

Data analysis tools such as computer software programmes, statistical and other technical tools, were used to present primary data to all applicable municipal management. It was completed in a well communicated and ease of use format in order for them to easily interpret and make strategic decisions (Wegner, 2016).

In order to analyse the qualitative data collected from this study, a sophisticated software programme called Atlas.ti was used. Detailed transcriptions of all recorded interviews were made and prepared to load on the Atlas.ti cloud. Atlas.ti assisted in coding and grouping all applicable data which helped to develop theories and interpret the collected data. As per conversation analysis, Atlas.ti assisted the researcher to perform an inductive data-driven analysis aiming to find recurring patterns of interaction. Based on the analysis, the study explained the occurrence of patterns, which were sorted into emerging themes and theories (Creswell & Plano Clark, 2011).

## 3.9. RELIABILITY AND VALIDITY

All research must involve an explicit, disciplined, systematic (planned, ordered, and public) approach in order to establish the most appropriate results. A key indicator of

the quality is the proper measurement of reliability and validity of the research. Actually, the foundation of good research is the trustworthiness, reliability and validity, of the data, otherwise no good decisions can be made. Therefore, research methodologies are judged for rigour and strength based on validity, and reliability of the research (Mohajan, 2017).

Considering that this study is concerned with qualitative research, it must be stressed that this research is inductive in nature, and the researcher generally explores meanings and insights in a given situation (Mohajan, 2017). As mentioned earlier, it refers to a range of data collection and analysis techniques that use purposive sampling and semi-structured, open ended interviews (Mohajan, 2017).

Since reliability and validity are two key aspects of all research, researchers assert that rigour, which refers to the precision, thoroughness and accuracy of the qualitative research, equates with the concepts of reliability and validity and are all necessary components to establish quality. However, the precise definition of quality has created various debates among naturalistic researchers (Collis & Hussey, 2014). The two concepts of reliability and validity have been operationalised quite extensively in quantitative texts but at the same time were deemed not to pertinent to qualitative research, especially during the 1990s (Collis & Hussey, 2014). Meticulous attention must be given to the reliability and validity in qualitative research studies, where the researcher's subjectivity can so readily cloud the interpretation of the data and where research findings are often questioned or viewed with scepticism by the scientific community. The researcher must be able to answer questions such as whether the findings and conclusions would be valid when investigated, or if there would be consistency in the findings when the study is repeated (Collis & Hussey, 2014). Reliability and validity are defined below:

### 3.9.1 Reliability

In quantitative research, reliability refers to exact replicability of the processes and the results. In qualitative research with diverse paradigms, such a definition of reliability is challenging and methodology counter-instinctive. Hence, the essence of reliability for qualitative research lies with consistency. In qualitative research, a margin of variability for results is tolerated, provided the methodology and methodological logistics

consistently yield data that are theoretically and within reason similar but may differ in richness and ambience within similar dimensions (Lueng, 2015).

Zohrabi (2013) indicates that there are various ways to enhance the dependability and/or reliability of the research results. They are:

a) The researcher's position: The researcher must ensure that the different steps and processes of the research are clearly explained.
b) Audit trail: The researcher must be sure and very clear on how data is collected, analysed, themes derived and results presented.
c) Triangulation: In certain scenarios the researcher might be regarded as one of the measuring instruments to form triangulation. Some of the other methods used to collect various data are interviews, questionnaires and observations.

However, Lueng (2015), also states that in order to enhance the reliability of the research and the results, approaches such as contradiction analysis, constant data comparison, comprehensive data use, the use of tables and the inclusion of the deviant case can be used. As data were extracted from the original sources, researchers must verify their accuracy in terms of form and context with constant comparison, either alone or with peers in order to establish a form of triangulation. The scope and analysis of data included should be as comprehensive and inclusive as possible, with reference to quantitative aspects if available. Furthermore, reliability can be assessed by adopting Karl Poppers' falsification theory where the researcher can respond by revising the theory, or rejecting the theory in favour of a rival or by maintaining the theory as is and adding a supplementary hypothesis (Lueng, 2015).

### 3.9.2. Validity

Validity in qualitative research means "appropriateness" of the tools, processes, and data. This considers whether the research question is valid for the desired outcome, the choice of methodology is appropriate for answering the research question, the design is valid for the methodology, the sampling and data analysis are appropriate, and finally the results and conclusions are valid for the sample and context. In assessing validity of qualitative research, the challenge can start from the philosophy or theory and methodology of the issue being studied; for example, the concept of

“individual” is seen differently between humanistic and positive psychologists due to differing philosophical perspectives (Lueng, 2015).

Set off on different pathways, qualitative research regarding the individual's wellbeing will be concluded with varying validity. The choice of methodology must enable detection of circumstances and events in the appropriate context for it to be valid, with due regard to cultural and contextual variables (Lueng, 2015). It will be very beneficial for the study if the researcher bears the following in mind:

a) For sampling, procedures and methods must be appropriate for the research paradigm and be distinctive between systematic, purposeful or theoretical (adaptive) sampling.
b) For data extraction and analysis, several methods were adopted to enhance validity, including first tier triangulation (of researchers) and second tier triangulation (of resources and theories), a well-documented audit trail of materials and processes, multidimensional analysis as concept- or case-orientated and respondent verification (Lueng, 2015).

Zohrabi (2013) further indicates that there are various ways in which validity of a study can be measured:

- Content validity refers to the extent to which the items on a test are fairly representative of the entire domain the test seeks to measure. In other words, it refers to how well a test measures the behaviour for which it is intended and if the test does indeed measure what it is supposed to measure. If it does, it is said to have content validity. Content validation methods seek to assess this quality of the items on a test (Salkind, 2010).
- Internal validity relates to the degree of confidence that the casual relationship being tested is trustworthy and not influenced by other factors or variables. The less factors or variables, the higher the internal validity of the study. Thus it answers the question: Was the research done “right?”
- Utility criterion refers to the task where administrators, managers and other stakeholders validate the degree of effectiveness that the evaluation has for them.

- External validity relates to how applicable the findings are to the real world. It refers to how well data and theories from one setting apply to another. Does the same thing happen in other settings?

It must be mentioned that due to the fact that the sample size for this study was small, exploratory analysis could not be conducted but other validity criteria could be met. In order to ensure the interviews in this research were validated correctly, questions with reference to previous reviews and studies were developed. In addition, the supervisor for this study and the NMU Business School department head were consulted and the appropriate changes made. Therefore, the guidelines for content validity, internal validity, utility criterion and external validity were adhered to.

## 3.10. ETHICAL REQUIREMENTS

Ethics can be defined as a focus on the practices that study standards of conduct, such as philosophy, theology, law, psychology, and sociology. It can also be described as a method, procedure or perspective for how to behave and for how to analyse problems and topics (Resnik, 2015). There are several reasons why it is important to adhere to ethical norms in research, such as:

- Norms promote the aims of research, such as knowledge, truth and avoidance of error.
- Ethical standards promote the values that are critical to synergistic work, such as trust, accountability, mutual respect, and fairness.
- Ethical norms ensure that researchers can be held accountable to the public for their actions.
- Ethical norms and transparency help build public support for research.
- Research norms and ethics help promote various other important moral and social values, such as social responsibility, human rights, animal welfare, compliance with the law as well as public health and safety (Resnik, 2015).

It is important to consider that various disciplines, institutions, organisations and professions have specific standards or guidelines of behaviour that suit their distinct aims and goals (Resnik, 2015).

The guidelines for ethical clearance posed by the NMU Ethics Committee and followed in this study, are as follows:

> This study does not include a research population which is vulnerable in terms of age, physical characteristics and/or disease status. It also does not include any NMU staff, students, children under the age of 18 or elderly persons over the age of 60. No samples are used from institutions such as hospitals or schools, or from any mentally or physically handicapped people/participants (NMU, 2019).

Data for this study were collected from samples that require institutional authority which was obtained through the applicable gatekeeper before research commenced. A once-off email to all the participants explained the privacy, anonymity and confidentiality with which this research was conducted. All participants were asked to participate at a voluntary level with no remuneration or incentives. All interviews were conducted on a face to face basis, with strict sample control measures. Besides municipal manager consent forms, no questionnaires, data collection or responses of any kind, were conducted via any email correspondence.

Upon review of the research objective, it was established that full ethical clearance is needed and Ethical Clearance Application Form REC-H must be completed. The signed REC-H Ethics Letter of Approval is attached as Annexure A: Application for Approval Nelson Mandela University Research Ethics Committee (HUMAN).

### 3.11. SUMMARY

Chapter 3 defined research in general and also established the appropriate research paradigm and methodology suited for this study. It investigated research philosophies such as positivism and interpretivism as well as research methodologies such as mixed, quantitative and qualitative methodologies.

The chapter then explained the data sampling design, the data collection methods and data analysis process, specifically aimed at gathering and analysing data for research questions RQ2, 5, 7 and 8 and research objectives RO2, 3 and 4. The research questions were constructed to incorporate the themes that arose from the literature review. The importance and enhancement of data reliability and validity as well as ethical consideration were discussed.

The next chapter records the data and outlines the empirical results obtained from the research instrument from both a descriptive and inferential statistical perspective.

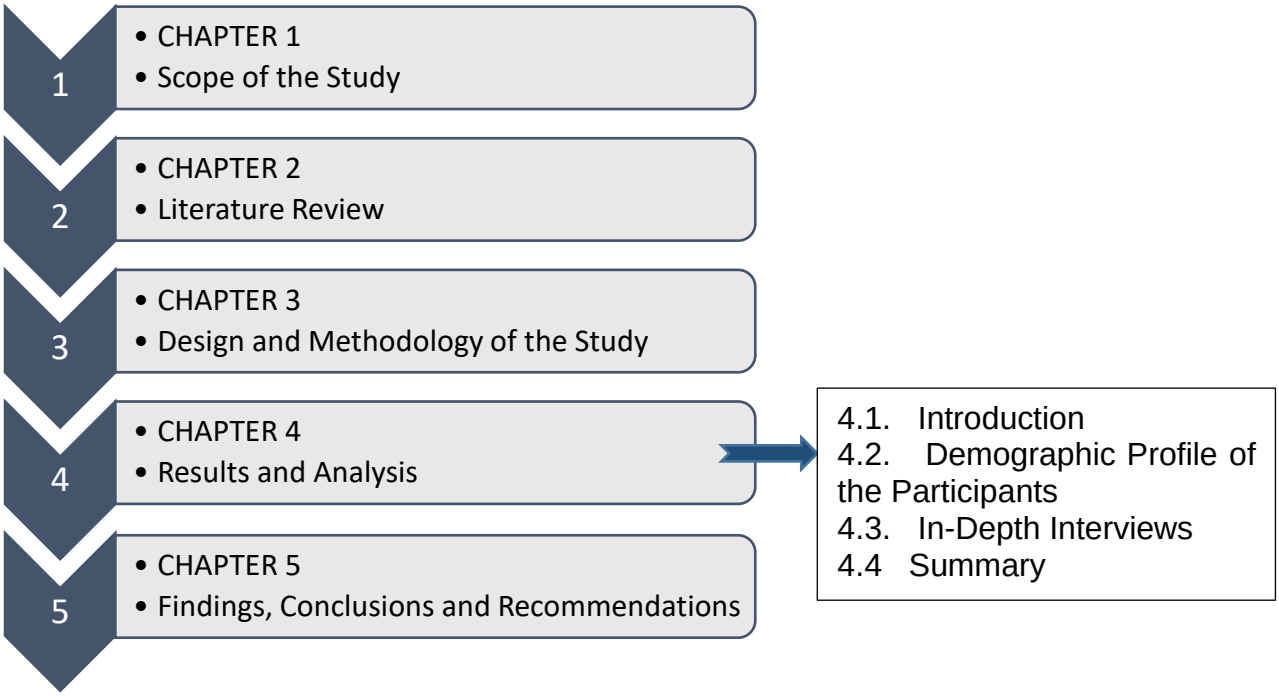
# 4. CHAPTER 4: RESULTS AND ANALYSIS

## 4.1. INTRODUCTION

In Chapter 3 the methodology and approach of this study was discussed. Following the suggested methodology and approach, Chapter 4 addresses the Main Research Question ($RQ_M$): Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities? This chapter also support the Main Research Objective ($RO_M$): To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

In order to address the $RQ_M$ and $RO_M$, the primary data for this chapter was collected focusing on $RO_3$: Conduct interviews with a selected sample of municipal employees on reasons why and how electricity meter tampering is taking place. This chapter also presents the research results by focusing on $RO_4$: Transcribe the interviews, through the use of Atlas.ti, in order to process the raw data on which appropriate data analysis methods can be applied. A summary of Chapter 4 is illustrated in Figure 4.1

*Figure 4.1: Chapter 4 Summary*



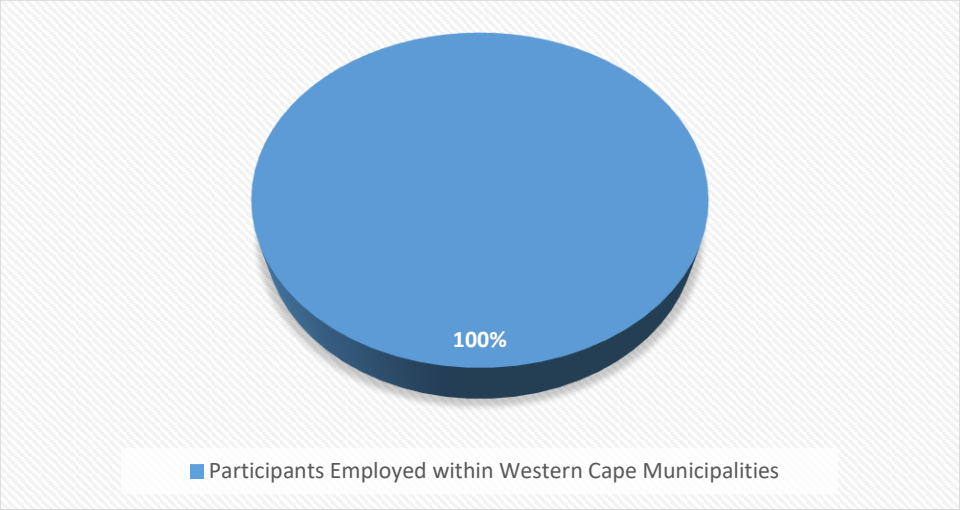

Source: Author's Own Construction (2019)

## 4.2. DEMOGRAPHIC PROFILE OF THE PARTICIPANTS

### 4.2.1. Geographic Information

A hundred percent (100%) of all the interviewed participants are based in the Western Cape and are employed within a Western Cape Municipality, as per Figure 4.2.

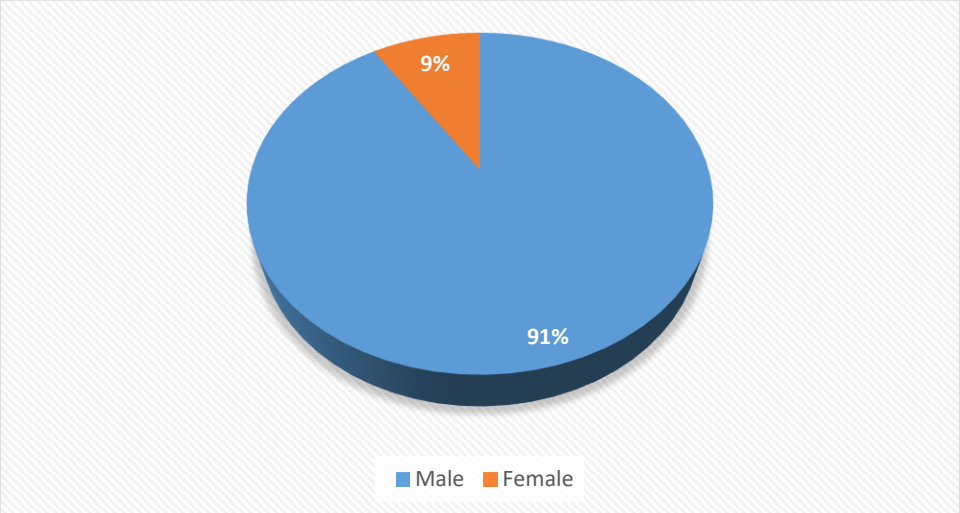
*Figure 4.2: Geographical Information*




### 4.2.2. Demographic Characteristics

The majority, ninety one percent (91%) of all the interviewed participants, were male, with a minority of nine percent (9%) being female, as illustrated in Figure 4.3. This is partly due to the fact that in the municipalities, the electrical engineering positions are mostly male dominated.

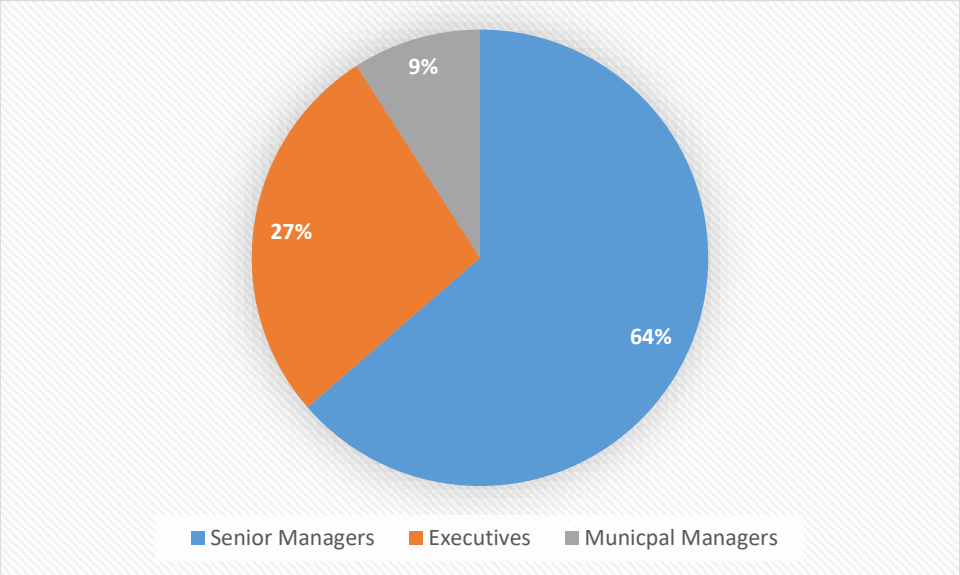
*Figure 4.3: Demographic Characteristics Gender*



### 4.2.3. Employment Information

The interviewed participants were spread across various positions held within the municipalities, with the majority being senior managers (64%), followed by executives (27%) and finally municipal managers (9%), as illustrated in Figure 4.4. The original criterion established was to at least interview middle or senior managers, therefore the study exceeded this criterion.

*Figure 4.4: Employment Information*




## 4.3. IN-DEPTH INTERVIEWS

As per Chapter 3, and with reference to Figure 4.4, senior managers, executives and municipal managers within Western Cape Municipalities were approached to participate in structured interviews with formulated open ended questions pertaining to pre-determined research objectives.

This section presents the summarised outcome of the interviews conducted with the eleven (11) identified participants within the ten (10) identified municipalities.

### 4.3.1. Economic Importance

This section of the interview aimed to establish from the participants what the economic importance of an electrical meter in an electricity network is. The question to extract this data was formulated as follows: $RQ_1$ - What is the economic importance of having an electricity meter?

*Figure 4.5: Economic Importance of an Electricity Meter*

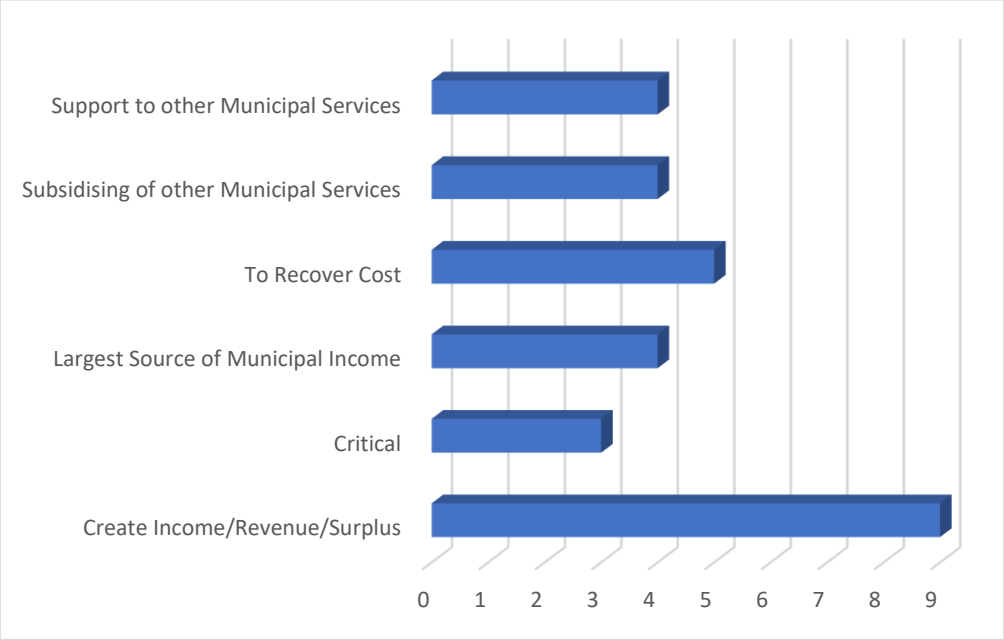



Figure 4.5 demonstrates that nine (9) out of eleven (11) participants (82%) indicated that the economic importance of an electricity meter is to create an income, revenue or what they refer to as a surplus of funds for a municipality. Five (5) out of eleven (11) participants (45%) mentioned that it is important to have an electrical meter for each customer in order for the municipality to measure and recover the cost of electricity supplied to their customers.

Further to the economic importance of a meter, it can be seen that four (4) out of eleven (11) participants (36%) remarked that electricity distribution is the largest source of income for a Municipality in the Western Cape and the same percentage (36%), confirmed that this income from electricity is used to support and subsidise other municipal services. Three (3) out of eleven (11) participants (27%) mentioned that the economic importance of an electricity meter is critical.

### 4.3.2. Types of Meters

This section of the interview was conducted to understand all the different types of meters that are used within Western Cape Municipalities. This refers to, and ties in with, Section 2.2.4 in Chapter 2, explaining types of electrical meters used throughout South Africa. The question to extract this data was formulated as follows: $RQ_2$ - What type of meters are installed in household and business premises within Municipalities of the Western Cape?

*Figure 4.6: Types of Electricity Meters*

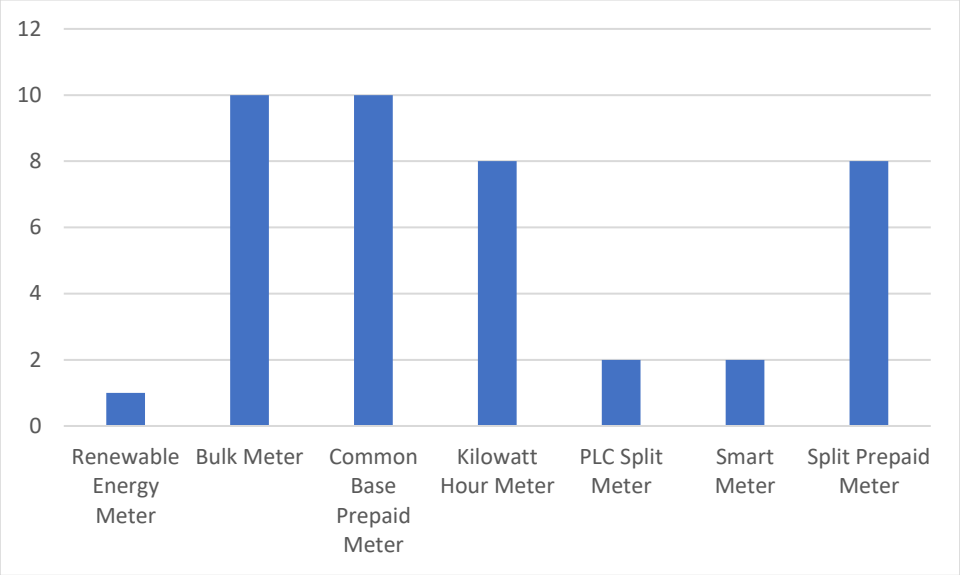



Figure 4.6 shows that the majority, ten (10) out of ten (10) Municipalities in the Western Cape (100%), use bulk meters, usually for business metering, and common base prepaid meters, mostly for business and residential use. These are closely followed by kilowatt hour meters with a count of eight (8) out of ten (10) municipalities (80%), using them in residential and business applications.

Eight (8) out of the ten (10) participative municipalities (80%) also use the more modern split prepaid meter, while only two (2) municipalities use the PLC split prepaid meters. Unfortunately also only two (2) of the municipalities (20%) have managed to engage with the newest smart meters and only one (1) municipality (10%) with renewable bi-directional energy meters, which is used when customers are generating renewable energy.

### 4.3.3. Types of Enclosures

This section of the interview wanted to establish what different types of low voltage electrical enclosures are used within Western Cape Municipalities to house the electrical meters. It is closely related to Section 2.2.5 in Chapter 2, explaining the different types of low voltage enclosures that are used in general throughout South Africa. The question to extract this date was as follows: $RQ_3$ – What type of electrical enclosures are the meters installed in?

*Figure 4.7: Types of Electrical Enclosures*

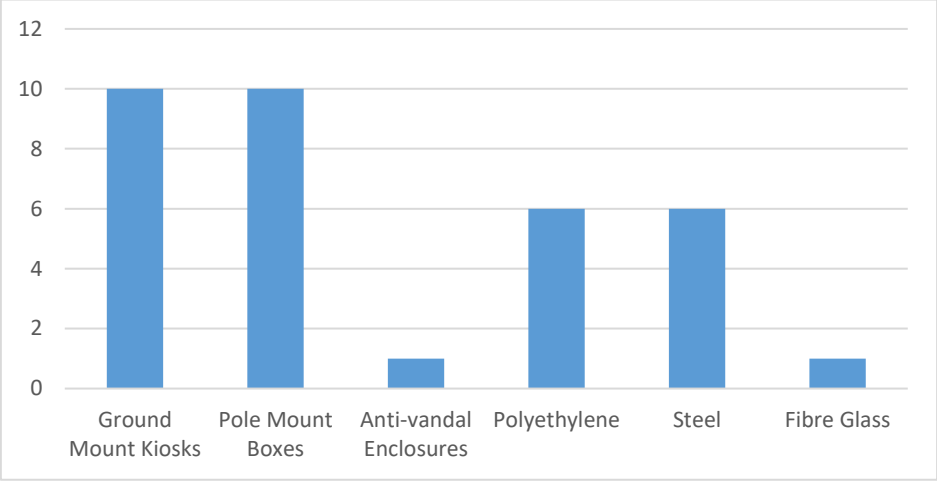



Figure 4.7 clearly points out that ten (10) out of ten (10) participative municipalities (100%) make use of ground mount kiosks as well as pole top boxes. The same accounts for their mixture of materials where six (6) out of ten (10) participative municipalities (60%) use polyethylene and steel. Fiberglass has a very low count of one (1) out of ten (10) municipalities (10%), since it is a much older material and anti-vandal enclosures also has a low count of one (1) out of ten (10) municipalities (10%) since it is a very expensive product.

### 4.3.4. Reasons for Electricity Meter Tampering

This section of the interview was used to establish what possible reasons there could be for electricity meter tampering. The open ended question to extract this data was as follows: $RQ_4$ – Why does electricity meter tampering take place?

*Figure 4.8: Reasons for Electricity Meter Tampering*

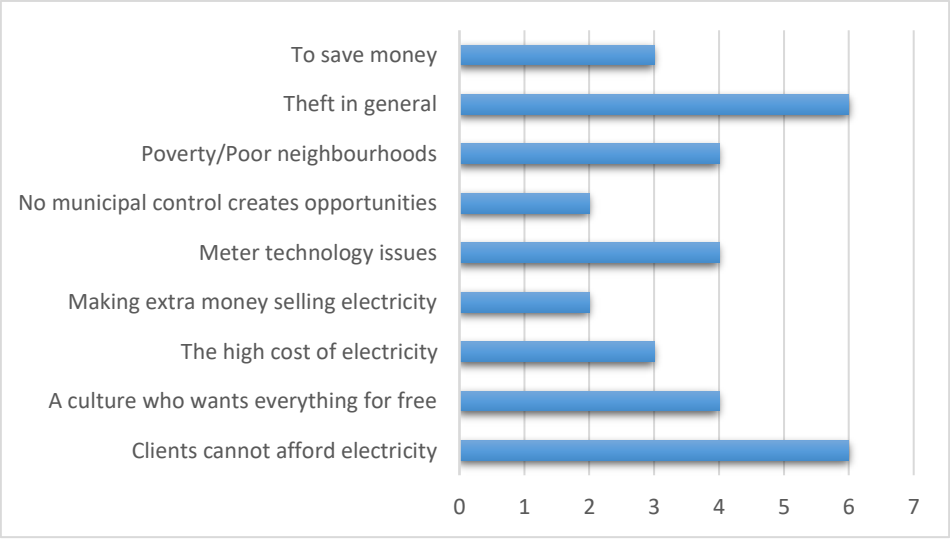


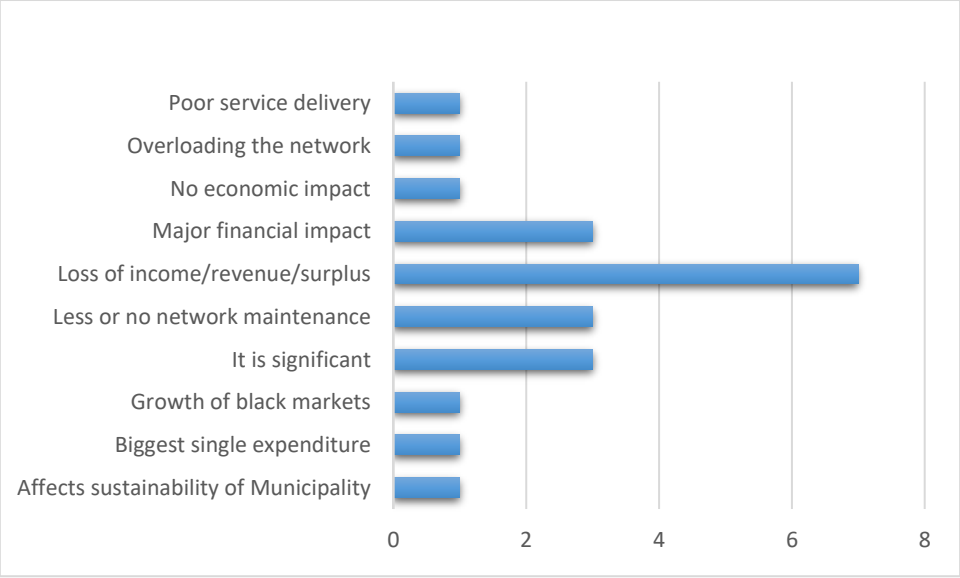
Figure 4.8 indicates that the top two (2) reasons identified by participants as to why customers tamper with their meters, with a count of six (6) out of ten (10) municipalities (60%), is the fact that clients cannot afford electricity and that of general theft. This is followed by a count of four (4) out of ten (10) municipalities (40%), stating that poverty/poor neighbourhoods, meter technology issues and a culture which wants everything for free, are added reasons for meter tampering.

To save money, and the high cost of electricity, both scored counts of three (3) out of ten (10) municipalities (30%), succeeded by reasons such as, no municipal control creates opportunities and that clients make extra money by selling electricity, with counts of two (2) out of ten (10) municipalities (20%). Chapter 5 will discuss how these reasons intervene and overlap, where the one reason can lead to the inauguration of the other.

### 4.3.5. The Economic Impact of Meter Tampering

This section of the interview was used to establish what the economic impact of meter tampering is, specifically for Municipalities situated within the Western Cape. The open ended question to extract this data was as follows: $RQ_5$ – What is the economic impact of meter tampering for a Municipality in the Western Cape?

*Figure 4.9: Economic Impact of Meter Tampering*




Looking at Figure 4.9, it can be seen that without a doubt and exceeding all other economic impacts, with a count of seven (7) out of eleven (11) the majority participants

(64%) mentioned that the loss of income, revenue or surplus funds, is the major economic impact on Municipalities within the Western Cape.

Other economic impacts on municipalities, with counts of three (3) out of eleven (11) participants (27%), include lesser or no electrical network maintenance, major financial impacts and finally the fact that meter tampering has an significant economic impact on a Municipality within the Western Cape. There are six (6) other minor mentioned economic impacts, all with a count of one (1) out of eleven (11) participants (10%). These range from impacts such as poor service delivery, overloading the network, growth of black markets and even to a point where one (1) participant mentioned that there is no economic impact on their municipality.

### 4.3.6. Possible Solutions to Decrease Meter Tampering

This section of the interview was used to establish what possible solutions Municipalities within the Western Cape have considered or implemented in order to combat electricity meter tampering. The open ended question to extract this data was as follows: $RQ_6$ – What possible solutions have been formulated to decrease meter tampering in a Municipality within the Western Cape?

*Figure 4.10: Possible Solutions to Decrease Meter Tampering*

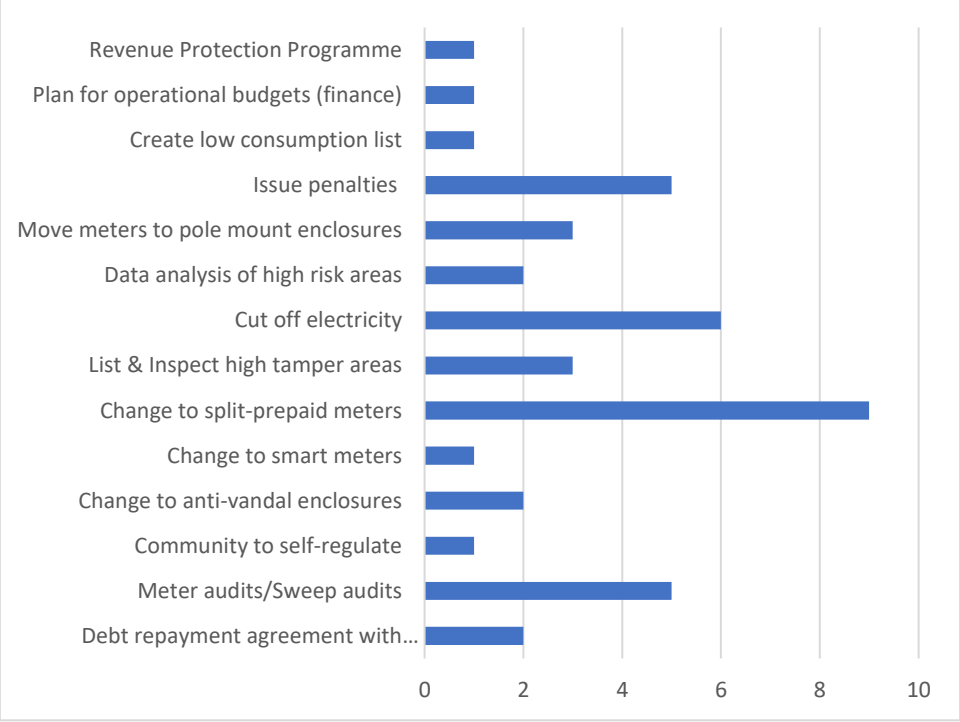


Figure 4.10 illustrates that the majority of municipalities, nine (9) out of ten (10) (90%), see changing to split prepaid meters as their solution of choice to decrease meter tampering. Six (6) out of ten (10) municipalities (60%) resort to cutting off the clients electricity while five (5) out of ten (10) municipalities (50%) choose meter tampering penalties and meter audits or sweeps as possible solutions.

Three (3) out of ten (10) municipalities (30%) are in agreement that they prefer to list and regularly inspect high tamper areas or move their meters to pole top boxes and out of reach of customers. Two (2) of the municipalities (20%), echoed three (3) of the possible solutions to implement, such as data analysis of high tamper areas, changing to anti-tamper enclosures and lastly to make debt repayment agreements with their customers. This is done in order to recover outstanding payments while the customer is still making use of electricity. Five (5) of the other possible solutions got a vote from one (1) out of ten (10) municipalities (10%) to possibly implement.

### 4.3.7. Potential Obstacles for Implementing Solutions for Meter Tampering

This section of the interview was used to establish the potential obstacles a Municipality within the Western Cape might face when trying to implement some of the possible solutions to meter tampering. The open ended question to extract this data was as follows: $RQ_7$ – What are the potential obstacles within Western Cape Municipalities for implementing the possible formulated solutions?

*Figure 4.11: Potential Obstacles for Implementing Solutions*

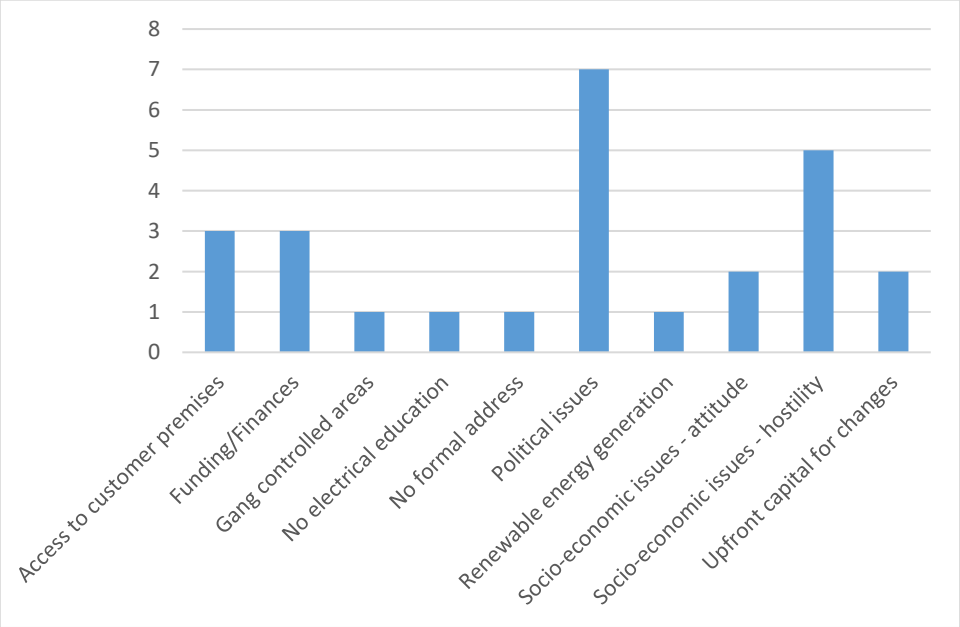


Figure 4.11 illustrates, with a count of seven (7) out of ten (10) municipalities (70%), that municipalities have political issues when it comes to implementing said solutions. Socio-economic issues of hostility from customers with a count of five (5) out of ten (10) municipalities (50%), experience this as an obstacle. Linked to that, figure 4.11 also demonstrates that allowed access for municipal staff to a customers' premises, was chosen by three (3) out of ten (10) municipalities (30%).

Counts of between ten percent (10%) or one (1) out of (10) and twenty percent (20%) or two (2) out of ten (10) municipalities, experience obstacles such as funding or upfront costs to implement possible changes, gang controlled areas where access to metered premises is impossible and customers who have no formal addresses and cannot be billed.

### 4.3.8. Advantages and Disadvantages of Implementing Selected Possible Solutions

This section of the interview was used to establish what advantages and/or disadvantages there will be for a Municipality within the Western Cape should it want to implement the suggested solutions after overcoming the above-mentioned obstacles if applicable. The open ended question to extract this data was as follows: $RQ_8$ – What are the perceived advantages and/or disadvantages of implementing the selected possible solutions within the Western Cape Municipalities?

#### a) Advantages

*Figure 4.12: Advantages of Adopting Possible Solutions*

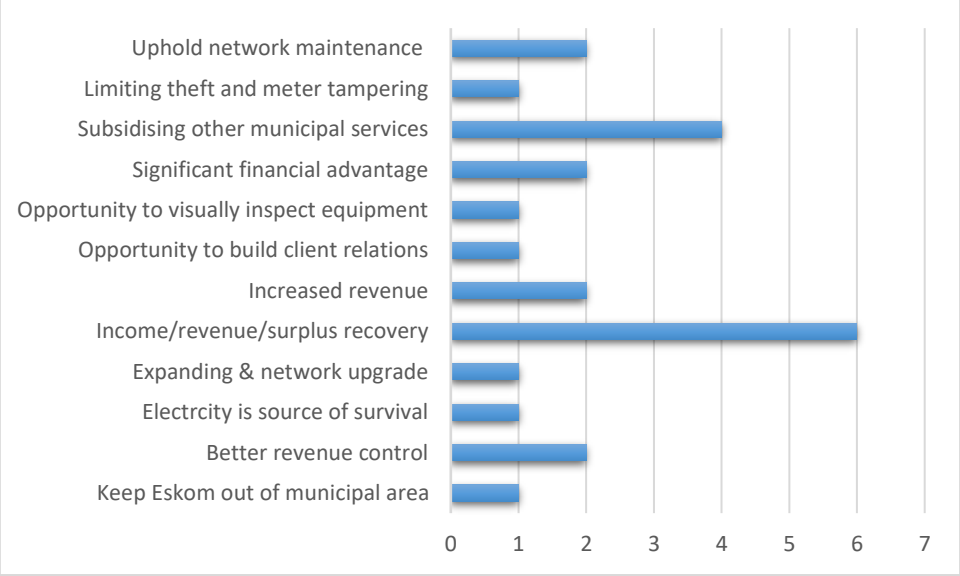


Figure 4.12 suggests that the biggest advantage for a municipality to adopt the proposed possible solutions would be to recover income, revenue or the surplus funds. Six (6) out of the ten (10) municipalities (60%) indicated that this was the case. Four (4) out of the ten (10) municipalities (40%) indicated that being able to subsidise other municipal services with the recovered income is the second biggest advantage.

This is followed by the fact that two (2) out of ten (10) municipalities (20%) mentioned that there is increased revenue and revenue control, also that there is a significant financial advantage and lastly that the recovered revenue will help to maintain the electricity network. One (1) out of ten (10) municipalities (10%) made various singular comments on what other advantages there are for a municipality.

**b) Disadvantages**

*Figure 4.13: Disadvantages of Adopting Possible Solutions*

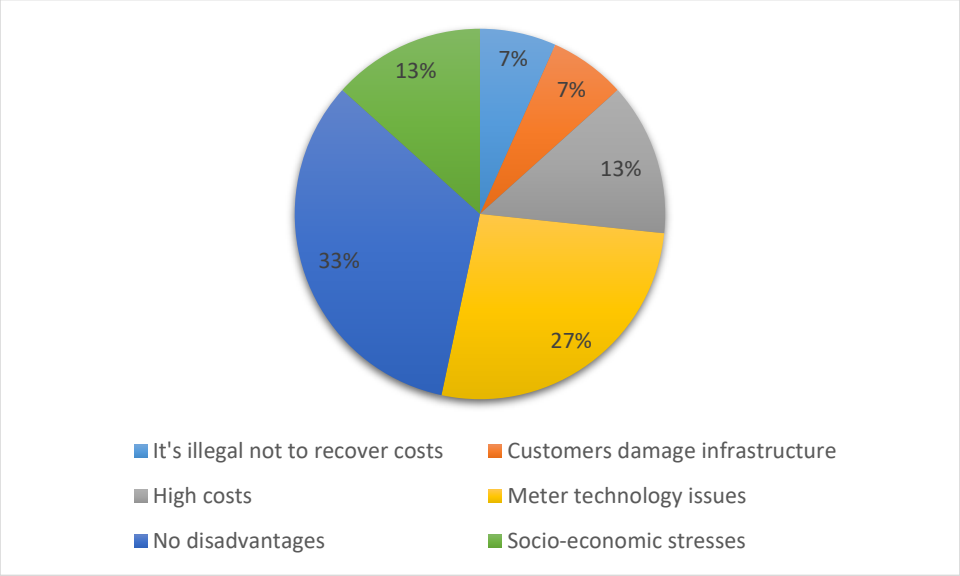



Figure 4.13 reveals that although by an only slight margin of just five percent (5%), thirty three percent (33%) of municipalities indicated that there is no disadvantages to implementing the proposed possible solutions. The factor that follows the closest to this percentage, is the twenty seven percent (27%) of municipalities who want to implement meter changes as a possible solution. These were the two main issues with current and previous meter technology as a disadvantage.

Socio-economic stresses and the high cost of implementing solutions both scored thirteen percent (13%), pursued by seven percent (7%) of municipalities who commented that other disadvantages of implementing proposed solutions, are customers who damage electricity network infrastructures and the fact that according to the laws of South Africa, it is illegal for a municipality not to try and recover their electricity costs.

## 4.4. SUMMARY

Chapter 4 addressed the Main Research Question ($RQ_M$): Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities? and the corresponding Main Research Objective ($RO_M$): To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

In order to achieve the above mentioned $RQ_M$ and $RO_M$, primary research was conducted following the research methodology and approach as stated in Chapter 3, where after the data was analysed and discussed. A total of eleven (11) participants from ten (10) different Western Cape Municipalities was interviewed using eight (8) structured open ended questions. The findings were visually presented in the form of pie, column and bar charts as well as explained in text underneath the charts. There was a total of eight (8) questions which are aligned to the determinants discussed in Chapter 2.

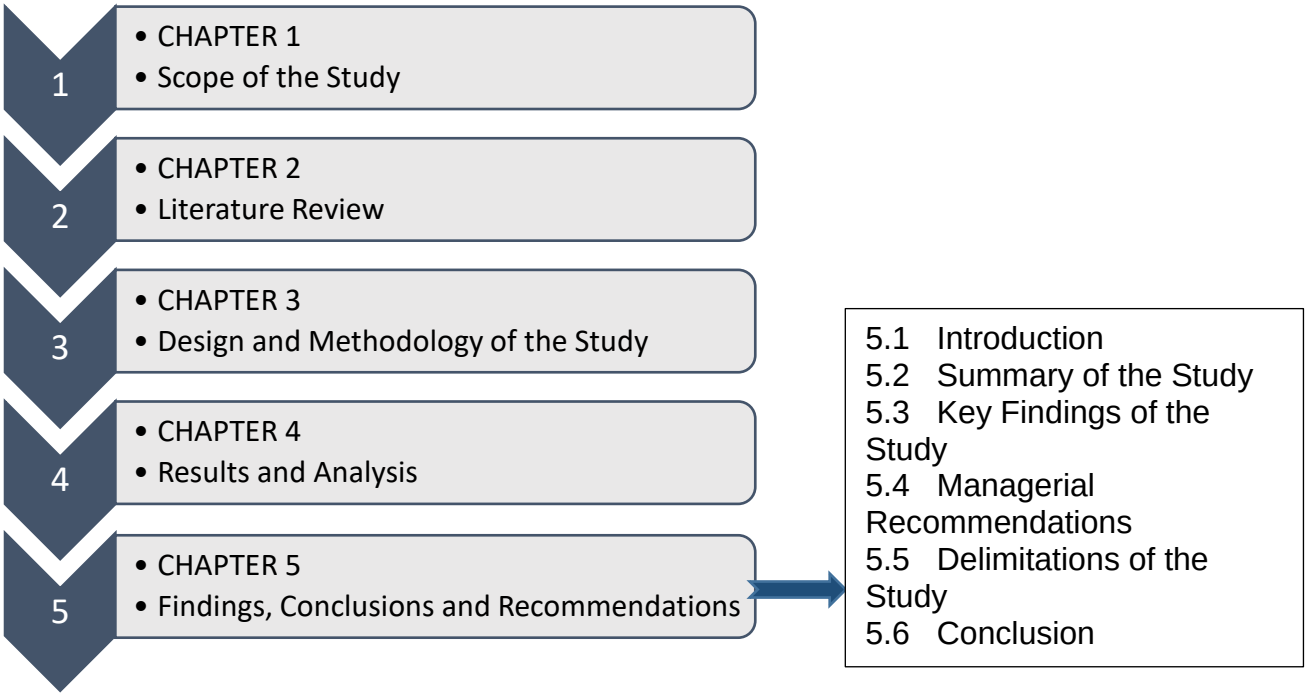
# 5. CHAPTER 5: KEY FINDINGS, RECOMMNEDATIONS AND CONCLUSION

## 5.1. INTRODUCTION

In Chapter 4, the interviews (primary data) were transcribed and with the help of Atlas.ti, coded and classed into code groups for analysis and presentation of the results. The Main Research Question ($RQ_M$): Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities? was addressed and the chapter also supported the Main Research Objective ($RO_M$): To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

Chapter 5 is the final chapter of the study and will discuss the findings of analysing the primary data as well as make recommendations and a conclusion. Chapter 5 addresses $RQ_6$: What possible solutions have been formulated to decrease meter tampering within a Municipality in the Western Cape? which corresponds to $RO_5$: Interpret the findings, make recommendations and a conclusion. A summary of Chapter 5 is illustrated in Figure 5.1

*Figure 5.1: Chapter 5 Summary*




Source: Author's Own Construction (2019)

## 5.2. SUMMARY OF STUDY

### 5.2.1. Chapter 1: Introduction and Problem Statement

Chapter 1 introduced the study and gave the reader an overview including an explication of all the research questions and objectives. The chapter also had a main goal which was to define the problem statement: A primary research objective was set with the aim to develop a viable strategy, to improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

Furthermore, the chapter presented the main research question $RQ_M$: Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities? which corresponds to the $RO_M$: To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

### 5.2.2. Chapter 2: Literature Review

The objective of Chapter 2 was to conduct secondary research or collect secondary data in the form of a literature review. Secondary data was gathered and studied through the review of academic journals, published books, articles and databases from formal websites in order to present data in the form of a literature review.

Chapter 2 addressed research questions $RQ_1$, $RQ_3$ and $RQ_4$ together with the corresponding research objective $RO_1$. $RQ_1$: What is the economic importance of having an electricity meter? $RQ_3$: What type of electrical enclosures are the meters installed in? $RQ_4$: Why does electricity meter tampering take place? These three (3) questions all correspond to $RO_1$: Conduct a literature study around the management of electricity and the challenge of electricity meter tampering.

### 5.2.3. Chapter 3: Research Design and Methodology

Chapter 3 commenced with defining what research is, followed by the research design for the study. The chapter provided insight about the chosen research paradigm, approaches and explained the research methodology. The chapter also included sections that address the data sampling design, the data collection methods, data analysis process and participants of the study.

Research questions, $RQ_2$, $RQ_5$, $RQ_7$ and $RQ_8$, and corresponding research objectives $RO_2$, $RO_3$ and $RO_4$, were addressed. The chapter was concluded referring to all applicable ethical issues and how they comply with the NMU Ethical Clearance guidelines.

### 5.2.4. Chapter 4: Results and Analysis

Chapter 4 presented all the primary data gathered during the interviews conducted for the study. The chapter also addressed $RQ_M$: Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities? which corresponds with $RO_M$: To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

### 5.2.5. Chapter 5: Key Findings, Managerial Recommendations and Conclusion

Chapter 5 furnishes the reader with a summary of the study by presenting the key findings of the primary data collected together with the findings of the literature review in order to make managerial recommendations. The chapter continues to discuss the limitations of the study as well as to present a conclusion.

Finally, the chapter addresses $RQ_6$: What possible solutions have been formulated to decrease meter tampering within a Municipality in the Western Cape? and delivers the corresponding $RO_5$: Interpret the findings, make recommendations and conclude

## 5.3. KEY FINDINGS OF THE STUDY

Chapter 2 introduced determinants of this study. The key findings, based on these determinants, are summarised in this section.

### 5.3.1. Economic Importance

Section 2.2.4 established that Eskom mostly generates and transmits electricity to distributors such a local regional municipalities. Therefore, the municipality purchases electricity from Eskom and sells it on to their customers within their region.

Electricity meters are used to measure the amount of electricity used within a network, with the result that the municipality can bill their customers and collect the applicable payments in order to generate revenue for the municipality (Eskom, 2019).

Looking at the primary data collected during interviews, the majority of participants, nine (9) out of the eleven (11) or eighty one percent (81%), echoes the statement made by Eskom and said that the economic importance of an electricity meter is to measure the electricity used in order to bill the clients and in doing so, create an income, revenue and or a surplus of funds for the municipality.

When analysing the rest of the primary data, it was found that the rest of the participant comments are all intertwined and are parallel to what the majority of participants and Eskom stated. Forty five percent (45%) of the participants confirmed that the economic importance of an electricity meter for a municipality is to recover costs for electricity supplied to customers. Thirty six percent (36%) mentioned factors such as subsidising other municipal services, support to other municipal services, and that electricity sales are the largest source of income for a municipality. Twenty seven percent (27%) agreed that electrical meters and measuring electricity, is economically critical for a municipality.

To explain the term “intertwined comments” as mentioned earlier, it is important to follow the comment thread. In other words, as per any other business, a municipality must generate an income or revenue. The literature states that: Electricity utilities are seen as a typical business with significant credit sales (Aminu & Rahman, 2010). Participants explained that instead of using the terms income or revenue, municipalities prefer to use the term “creating a surplus” when referring to the recovery of electricity supply costs.

Often selling electricity is one the largest sources of income for a municipality, and measuring the electricity supplied is of critical importance in order to establish the costs associated with it. In order to calculate what surplus has been generated to subsidise or support other necessary municipal services, it is clear that an electricity meter is of utmost economic importance to a municipality.

### 5.3.2. Types of Meters

Blalock (2014), confirms that the first electrical meter was invented in 1888 and that meter technology kept progressing throughout the 20th and 21rst century, producing various types of meters. The most popular meters used in South Africa were identified as the Kilowatt Hour Meter (Thiele, 2019), the Common Base and Split Prepayment Meter (Eskom, 2019), Bulk Meter (JKNV Energy, 2019) and the Smart Meter (Energy.gov, 2019).

Analysis of the primary data indicated that a hundred percent (100%) or ten (10) out of (10) municipalities, use bulk and common base prepaid meters. The bulk meters are generally used to measure large electricity users such as in industrial or commercial applications within a municipality. The percentage of municipalities that use common base prepaid meters is very high since this is the most affordable newer generation meter available after the original kilowatt hour meter. It is no surprise that the next count to follow is that eighty percent (80%) or eight (8) out of ten (10) municipalities, also have kilowatt hour and split prepaid meters.

As mentioned in Chapter 2, during the 19th century when electrical networks were installed and electricity had to be measured, the kilowatt hour meter was invented. Subsequently most of the local regional municipalities (80%), still have some of these meters embedded in their network and only change them when necessary to either common base or split prepaid meters. The analysis also indicates that eighty percent (80%) of municipalities that want to change their out-dated original kilowatt hour meters, due to certain control and tampering issues, prefer to switch over to split prepaid metering.

In Section 2.2.4, it was stated that there are various meters on the market, some with more advanced technology than others and twenty percent (20%) or two (2) out of ten (10) municipalities, either have installed or are experimenting with the newer technology meters, such as smart meters. Although the technology is very helpful in the recovery of surplus funds, initial financial costs of the meters seem to play a big role in the municipal decision making process. One (1) municipality (10%) mentioned that they have welcomed customers in their network who generate their own renewable energy, Section 2.2.2, and therefore have installed bi-directional meters to measure renewable energy. This meter operates in both directions, meaning that it

measures normal electricity used from the municipal network as well as to measure electricity generated by the customer which is fed back into the municipal network. The customer is then billed for the difference in consumption and generation.

However, the findings confirm that overall, the majority of municipalities within the Western Cape, eighty (80%) to one hundred percent (100%), agree with the literature review about the most popular types of meters used by electricity networks in South Africa.

### 5.3.3. Types of Enclosures

Section 2.2.5 makes reference to two (2) different types of enclosures, such as ground mounted kiosks and pole mounted boxes. This section also states that the kiosks and boxes can be manufactured for example, out of various different raw materials such as steel, polyethylene, dough moulded plastic and fiberglass (Polybox, 2019).

The primary data in Chapter 4 confirms that ten (10) out of ten (10) municipalities(100%) use both ground mounted kiosks and pole mounted boxes. The spread between the enclosures is determined by whether the municipality prefers to install their electrical distribution network underground, in which case they will make use of ground mounted kiosks, or if they prefer to install it overhead, in which case they will make use pole mounted boxes. In general, municipalities prefer to install their network underground within the urban areas and overhead when supplying rural areas with electricity. Firstly, especially in rural areas, overhead network installation is more economical and secondly, the municipality tries to avoid giving customers the opportunity to steal electricity and tamper with meters by installing the electrical cables and low voltage switchgear high off the ground on poles.

Further findings support the theory that enclosures can be manufactured out of different materials. Six (6) out of ten (10) municipalities (60%), consistently make use of at least two of the four materials such as steel and polyethylene. The spread of materials is typically determined by the areas within a municipal region, but there are also examples of the opposite. In general, areas which are targeted by high vandalism or theft, will receive steel enclosures. However, because steel has a high recycling value, it has been targeted by those who want to vandalise and make money out of selling pieces of the enclosures themselves. Steel enclosures are also somewhat more expensive than any of the other materials (Polybox, 2019).

Polyethylene enclosures are generally used in more urban areas as ground mounted kiosks, and consistently in rural areas when the electrical network is overhead and pole top boxes are used. Polyethylene is also a more affordable option than for example streel, and has no recycling value making it unattractive to those who want to vandalise enclosures (Polybox, 2019).

The findings indicate that only one (1) out of the ten (10) municipalities (10%) chooses or still uses fiberglass enclosures. Fiberglass is a very outdated raw material with a huge degree of health and safety issues. Subsequently as society has developed and everyone involved became more aware of environmental and health issues, fiberglass manufacturing is getting less and less. Therefore, when the time comes for municipalities to upgrade or revamp their electricity network, they choose other products manufactured from more environmentally and health friendly materials and eliminate fiberglass manufacturing. None, or zero (0) out of the ten (10) municipalities (0%), mentioned that they use any dough moulded (DMC) enclosures. Although none of the municipalities mentioned the use of this material during the collection of the primary data, the study cannot confirm with surety that none of them have DMC products installed within their networks.

The count for anti-vandal enclosures used within Western Cape Municipalities is only ten percent (10%) since these enclosures are very expensive and municipalities generally do not have the surplus funds to change over to these. Research and development on anti-vandal enclosures are an ongoing process in order to find less expensive manufacturing methods as well as new design ideas to try and limit vandalism and theft.

### 5.3.4. Reasons for Electricity Meter Tampering

In Chapter 2, Czechowski & Kosek (2016) mention that the main motives for NTLs, including electricity meter tampering, is the desire to save money. Thirty percent (30%) or three (3) out of ten (10) Western Cape Municipalities supported this statement. Czechowski & Kosek (2016) continue to explain that meter tampering should be considered under four categories, such as economy, society, infrastructure and legal.

- **Economy**

South African citizens are currently struggling with a harsh economic environment; despite this, the National Energy Regulator (NERSA) approved a 9.41% tariff increase to Eskom. Eskom projects the tariff increase onto their distributors, such as the local regional municipalities (Eskom, 2019). The municipalities have to recover their costs for supplying electricity to their customers and therefore pass the tariff increase down to the end user who bears the brunt (Czechowski & Kosek, 2016).

After analysing the primary data gathered from the municipalities within the Western Cape, the majority of six (6) out of ten (10) municipalities (60%) agreed with the statement above and stated that their customers cannot afford the electricity tariffs. Electricity has simply became too expensive for their customers, especially those who live in the rural areas. The direct effect of not being able to pay for electricity leads to the next major finding, and that is that of outright electricity theft. Six (6) out of ten (10) municipalities (60%) confirmed that they experience electricity theft within their electrical network.

TETRA TECH (2012) states that overall poverty is a big contributing factor to the economic issue. Four (4) out of ten (10) Western Cape Municipalities (40%) agreed that poor neighbourhoods and poverty contribute to electricity meter tampering within their municipalities. One major contributing factor to poverty and poor neighbourhoods in general throughout South Africa and local regional municipalities, is the lack of economic growth and the high unemployment rate.

When all of the economic findings are staggered one after the other, it is very obvious that the one finding leads to the other with the end result being that of electricity meter tampering. The harsh economy and high electricity tariffs make electricity expensive. The customers, especially in poor neighbourhoods, cannot afford the electricity and therefore resort to electricity meter tampering in order to try and save money. Unfortunately this is classified as theft with very harsh consequences.

- **Society**

Czechowski & Kosek (2016) discuss the fact that if illegal customers are not apprehended, fined or jailed, and legal customers have to experience tariff hikes because more electricity is used, a situation is created for the legal customers to join the illegals. Although none of the findings supported this theory, forty percent (40%) or four (4) out of ten (10) municipalities, did mention that they have a culture of

customers who want everything for free. The social tensions ranging throughout South Africa and previous political agendas spill over to form mentalities in customers' minds that electricity is a given right, but that someone else must pay for the service.

- **Infrastructure**

Pabla (2011) explains that municipal networks and the equipment installed within the networks can encourage anyone with malicious intentions to tamper with electricity meters. The analysis presented in Figure 4.8 confirms that four (4) out of ten (10) Western Cape Municipalities (40%) support the theory and state that meter technology issues play a big part in provoking potential meter tampering. Examples include the problems with the algorithm and 20 digit codes that determine if the tokens for prepaid electricity were used. The time limitation for this algorithm is 2024 when these meter systems must be upgraded. Furthermore, municipalities also mentioned issues with the proprietary meter system where the internal memory of the meter can allow customers to re-enter tokens that have already been entered. When customers explore this option, it is still regarded as electricity meter tampering and classified as outright electricity theft. Citiq (2019) confirms that one of oldest ways to tamper with a kilowatt hour meter is to fit two strong magnets to the sides of the meter, which slows down the rotating disc and registers less electricity usage.

- **Legal**

SARPA (2019) states that due to the lack of legal control and policies, the activity of meter tampering is enhanced. This statement was supported by twenty percent (20%), or two (2) out of ten (10) municipalities, who acknowledged that little or no municipal control creates opportunities for their customers to tamper with their electricity meters and therefore steal electricity.

### 5.3.5. The Economic Impact of Meter Tampering

First and foremost it is crucial to remember that a municipality must be appreciated and seen as a business. Therefore, when examining the issues of electricity meter tampering from a business perspective, the results indicate huge economic losses for the municipality (Smith, 2004). This statement is supported by the fact that the primary data analysis confirms that seven (7) out of ten (10) Western Cape Municipalities (70%), agree that the biggest economic impact of electricity meter tampering is the

loss of income, revenue or surplus funds. A business that does not have revenue is doomed to failure, therefore a municipality that cannot recover all of its revenue due to electricity meter tampering, cannot function as a municipality or a full service provider (WCG, 2019).

Smith (2004) continues and states that some consumers complain that large municipalities give poor service delivery and make too much money, therefore electricity meter tampering will not have a drastic economic effect on the municipality. However, thirty percent (30%), or three (3) out of the ten (10) municipalities, confirmed that electricity meter tampering has a significant and major financial impact on the municipality, which leads to poor service delivery and little or no network maintenance since there are no available funds to perform these actions. Ten percent (10%) of participants confirmed that in some cases, electricity meter tampering leads to overloading of the electrical network, as the municipality cannot gauge or estimate how many consumers are making use of the network.

Electricity meter tampering has a huge economic impact and knock-on effect considering that ten percent (10%), or (1) out of ten (10) municipalities, confirmed that electricity is the single biggest expenditure a municipality has to endure. This also ties up with section 5.3.1 on the discussion about the economic importance of having an electricity meter. Since a municipality charges for electricity supplied to customers, which is a huge expense, meter tampering and the loss of surplus funds has serious consequences on the business management of the municipality. Ten percent (10%) of municipalities mentioned that electricity meter tampering threatens the sustainability of the municipality. Ruiters (2018), clearly supports this finding and states that twenty-three (23) of the largest regional municipalities only managed to meter and collect sixty-percent (60%) of the electricity they distributed. By the end of 2006 they faced serious cash flow problems and cash flow problems lead to sustainability issues.

Municipalities need an income, revenue or surplus funds in order to pay their purchases of electricity supply from Eskom and supply their customers with clean electricity, maintain and possibly expand their electrical network and support or subsidise other municipal services offered. If there is no income, revenue or surplus generated or recovered, the municipality is facing a dead end. Nevertheless, one (1) out of the ten (10) Western Cape Municipalities interviewed (10%), confirmed that

electricity meter tampering has no economic impact on them. The study can only accept this because it is a smaller sized municipality with no real threat of electricity meter tampering.

Further analysis of this section in Chapter 4 also highlighted that one (1) out of the ten (10) municipalities (10%) experienced another economic effect of electricity meter tampering, specifically referring to the growth of black markets. This municipality is experiencing the establishment of more and more informal Spaza shops within the rural areas. These shops have numerous electrical appliances and therefore use much more electricity than what was allocated to the premises. This “overload” heightens network stresses and are also not calculated for in the network, contributing to the economic impact issues on the municipality.

### 5.3.6. Possible Solutions to Decrease Meter Tampering

In Chapter 2 under Section 2.4.4, the literature identified nine (9) initiatives to address the problem of electricity meter tampering. The primary data that was collected and analysed supports six (6) of these initiatives to decrease electricity meter tampering. The interviewed Western Cape Municipalities added one (1) initiative not mentioned in the theory. To show the direct relationship between the theory and the primary data collected, the study presents the findings as follows:

- Eisenbeiss (2015) stated that most of the electricity networks in the Western Cape are aged and need new technology upgrades. Traditional electromechanical and common base prepaid meters make up a large portion of the networks and have generated a variety of traditional tampering methods (Eisenbeiss, 2015). Firstly, the primary data in Section 5.3.2, Types of Meters, shows that a hundred percent (100%) of participants confirmed this statement. Secondly, looking at the analysis in Figure 4.10, nine (9) out of ten (10) municipalities, or ninety percent (90%), support the theory of Eisenbeiss and state that changing to newer technology split prepaid meters must most definitely be seen as a possible solution for meter tampering. The reason why this is a strong consideration is that the customer interface unit (CIU) is situated inside the house but the meter itself is outside the customer’s premises and thus less exposed to tampering. Furthermore, three (3) out of ten (10) municipalities (30%) took the next step to try and decrease meter tampering by

installing the meter unit of the prepaid split meter not just outside of the customers' premises but also on top of a pole in a pole top box. This option also supports the previous discussion about removing the opportunity or invitation for customers to tamper with their meters.

The Eisenbeiss theory receives further support by the fact that one (1) out of the ten (10) municipalities (10%) agreed that changing to the latest meter technology, which is smart meters, can be a possible solution to decrease meter tampering. Although only one (1) of the municipalities mentioned this option, the majority of them are aware of the latest smart meters but currently do not pay a lot of attention to them. The reason for that is because the new technology meters are very costly, plus operationally the municipality needs a monitoring office to receive and analyse all the information received from the meters, which adds more cost to the electricity network.

- Although changing to different meters seemed like a fool proof solution, those determined to tamper with electricity meters, shifted their focus to breaking into or vandalising the low voltage electrical enclosures in order to access the energy management unit (EMU) of the meter. This led to a drive from electrical enclosure manufacturers to develop and manufacture anti-vandal and smart kiosks (TETRA TECH, 2012). Two (2) of the ten (10) municipalities (20%) supported the theory of changing their standard low voltage enclosures to anti-vandal enclosures. These are enclosures that are made either by thicker raw materials or have specially designed locking mechanisms in order to try and prevent entry into the enclosure. None of the Western Cape Municipalities referred to the smart kiosks as stated in the theory and therefore these are not currently considered as a possible solution to decrease electricity meter tampering.

- Czechowski & Kosek (2016) mention that municipalities can mainly try to counteract the problem of meter tampering with increased tariffs, penalties and legislative controls. This statement is supported by five (5) out of ten (10) municipalities (50%), who apply penalties. In general, a customer who is caught

tampering with their meter for the first time, will pay a penalty of approximately R 3000. Should that same customer be caught a second time with meter tampering, the penalty imposed on them will double to R 6000. However, should that same customer be caught for a third time, the municipality exercises their legislative right and immediately cuts their electricity supply plus removes their electricity supply cable feeding their premises. The customer must then go through a process to reapply for electricity supply and pay for all the associated fees. Six (6) out of ten (10) municipalities (60%) make use of their legislative right to cut off a customer's electricity supply as a possible solution to decrease electricity meter tampering.

- Czechowski & Kosek (2016) further mention that a municipality can also appeal to their customers to look out for those who tamper with meters and offer them rewards. Not all the municipalities offer rewards but one (1) out of the ten (10) municipalities (10%) supports this theory and has implemented a structure for the communities to self-regulate as a possible solution to meter tampering. Basically, if one customer is caught tampering with his/her electricity meter within a neighbourhood, the municipality cuts off everyone's electricity in that neighbourhood. The idea is that when customers realise or know that other customers tamper with their meters, they either report them to the municipality or tell them to stop in order to save themselves from being cut off. This has proven to be a very effective option to decrease electricity meter tampering.

  According to Power Measurement (2019), metro, district and local regional municipalities should add a separate revenue protection department whose sole purpose it to take note of, monitor and regulate meter tampering activities. One (1) out of the ten (10) municipalities (10%) support this theory and have stated that they have implemented a revenue protection department to purely focus on revenue protection as part of the options to decrease electricity meter tampering. The municipality did however, confirm that there are certain specialities needed in order to establish such a department. These specialities include people with high level technical skills, preferably with a four year diploma or degree, people with law enforcement skills and qualifications, people

with detective skills, people with data analysis skills and people who can negotiate with customers.

Municipalities can outsource and make use of revenue protection companies who perform functions such as analytical reviews of consumption patterns, utility billing analysis, site inspections, meter audits, tamper investigations, tariff expertise, legislation enforcement etcetera (Power Measurement, 2019). Although only one (1) municipality has implemented a complete revenue protection department, and with reference to the above mentioned functions, the study did find that various municipalities do perform several of the functions pertaining to a complete revenue protection programme and therefore support aspects of the theory. Out of the ten (10) municipalities interviewed, one (1) (10%) said that they create a low consumption list, three (3) (30%) list and inspect high tamper areas, two (2) (20%) do data analysis of high risk areas and five (5) (50%) do meter or sweep audits in order to detect electricity meter tampering.

Due to various factors such as the size of the municipality or available finances, it is not always possible for a municipality to implement a full revenue protection department. However, one (1) out of ten (10) municipalities (10%) did mention that the finance problem can be bridged when careful planning for operational budgets is done. Obviously the first question should be if the municipality has good liquidity and is recovering all its revenue before more financial planning can be done.

- SARPA works together with Eskom, metros, district and local regional municipalities to combat all illegal activities involved with electricity use (SARPA, 2019). None of the municipalities mentioned SARPA in any of the interviews but the theory is supported by the fact that local regional municipalities in the Western Cape do register and are members of SARPA and therefore can make use of their services.

- Another possible solution to decrease meter tampering not supported by theory but implemented by two (2) out of ten (10) municipalities (20%), is to reach a debt repayment agreement with customers who have fallen behind on their electricity account payments and who do not want their electricity supply to be suspended. Clients will have a prepaid meter installed and when purchasing electricity, let us assume for R100, will receive electricity units for R60 and the rest, R40, goes towards repaying their outstanding debt. This way, the client can still make use of electricity while the municipality is recovering their debt.

### 5.3.7. Potential Obstacles for Implementing Solutions for Meter Tampering

Jamal (2015), states that in the IEP, the Department of Energy noted a further increase in the generation and operational costs of the electrical networks, placing more financial burdens on municipalities. Figure 4.11 depicted three (3) out of the (10) municipalities (30%) support the statement that funding or finances can be an obstacle to implement previously mentioned possible solutions. Most of the solutions involve new technology meter purchases, the implementation of monitoring rooms with extra staff, the establishment of a full revenue protection department with all its specialities, and so on, which involve large financial outlays. Thus, seeing that municipalities already owe Eskom in excess of R 13-billion (EE Publishers, 2018), finding available finances to implement solutions is definitely an obstacle. In fact, analysis found that two (2) out of ten (10) municipalities (20%) support this issue further by stating that upfront capital needed to make changes is a definite obstacle for implementing solutions.

The majority of municipalities, seven (7) out of ten (10) (70%), mentioned that political issues play the biggest role in preventing the implementation of possible solutions for meter tampering. In general, especially in the rural areas or poor neighbourhoods, after a customer is caught tampering with his/her electricity meter and potential solutions must be implemented, such as replacing the meter with an anti-tamper meter and moving the meter outside of their premises, there are socio-economic issues that appear. Fifty percent (50%) or five (5) out of ten (10) municipalities, experience hostility from customers, twenty percent (20%) or two (2) out of ten (10) municipalities experience attitude issues from customers and thirty percent (30%) or three (3) out of ten (10) of municipal staff are blocked where customers refuse to give them access to

their premises. When these three socio-economic behaviours seem not to deter the municipal staff, the customers go to their political area representatives in order to try and stop the municipal changes and possible solutions. The politicians want these customers to vote for them, therefore they are prepared to take these issues to the municipal or town committee and drive their customers' wishes to try and protect their constituents.

The main aim of Eskom's Operation Khanyisa is to raise awareness of, and educate the South African nation about, the impact and consequences of electricity theft (Eskom, 2014). Figure 4.11shows that a minority of only ten percent (10%) or one (1) out of ten (10) municipalities agrees that customers should be educated. However, the published results of Operation Khanyisa as per Section 2.4.4, clearly shows that municipalities should invest and take the time to educate their customers and not to let this be an obstacle in order to implement more solutions. An educated society will not see the education as a burden and once they know what the impact and consequences of electricity theft are, they should easily adhere to implementing more solutions to decrease the possibility of electricity meter tampering.

No literature was found to support the following comments from at least ten percent (10%) or one (1) out of ten (10) municipalities. Firstly, ten percent (10%) of municipalities mentioned that gangs control many of the rural areas and will not allow municipal staff to enter these areas, or the gangs vandalise the staff vehicles and steal their tools after entering these areas. Obviously, staff safety is of major concern, therefore this is a sure obstacle when trying to enter an area to implement potential solutions. Secondly, also ten percent (10%) of municipalities mentioned that many of the customers in the rural area do not have a formal address. This makes it very difficult to control or address any billing or meter tampering issues and this is seen as an obstacle for implementing possible solutions.

Baker & Phillips (2018) state that new alternative economic off-grid electricity generation methods should be introduced to the developing areas within the municipal region (Baker & Phillips, 2018). Although the literature mentions this as a possible solution to support the electricity network capacity, one (1) out of ten (10) municipalities (10%) expressed that renewable energy generation can be an obstacle for implementing other possible solutions. It has already been established that any

changes in the network require finances and that one of the major ways a municipality generates revenue is by supplying or rather, selling electricity to their customers. Should more and more customers change to renewable energy generation, it could create an income problem for the municipality, therefore, while the renewables will help the network grid capacity, they are also seen as an obstacle.

### 5.3.8. Advantages and Disadvantages of Implementing Selected Possible Solutions

Further findings in Figures 4.12 and 4.13 present the advantages and disadvantages mentioned by Western Cape Municipalities when or if they should adopt the recognised possible solutions for electricity meter tampering.

**a) Advantages**

The primary data analysis in Figure 4.12 finds that the ten (10) interviewed municipalities identified twelve (12) advantages for implementing the possible solutions to decrease meter tampering. Although the majority of advantages are the same indicators as per the discussions under Section 5.3.1, Economic Importance, and Section 5.3.5, The Economic Impact of Meter Tampering, it is important to mention that six (6) out of ten (10) municipalities (60%) recognised the two major advantages of implementing solutions to meter tampering. These are the recovery of municipal income, revenue or surplus funds and that of subsidising other municipal services. As mentioned earlier, a municipality must be seen as a business, there to deliver services but also to create revenue.

**b) Disadvantages**

The primary data analysis in Figure 4.13 finds that thirty three percent (33%) of municipalities expressed that there are no disadvantages to implementing the possible solutions to decrease electricity meter tampering. This is a good indication of them agreeing with the proposed solutions and seeing the benefit of implementing them.

The remaining sixty seven percent (67%) of the interviewed municipalities are scattered among various comments which indicates different perceptions among managers of the proposed solutions and what the effect on the municipality will be. High costs and socio-economic stresses as mentioned and explained earlier in this chapter, are shared by thirteen percent (13%) of the municipalities. Seven percent

(7%) are afraid that customers will damage more of their electricity network when they implement possible suggested solutions. This scenario might happen if a municipality does not have full control over its network or have weak legislation in order to take firm actions against those who want to vandalise and tamper.

An interesting finding in the analysis is that twenty seven percent (27%) of municipalities stated that meter technology could hold a disadvantage for the municipality when implementing the suggested solutions. This would be more applicable to the solution as mentioned earlier in Section 5.3.6, when municipalities want to change to different meters as a solution to decrease electricity meter tampering.

Although seven percent (7%) of municipalities reiterated as per earlier discussion, that it is illegal for them to supply a service such as electricity without trying to recover the costs, this study determined that this comment has no bearing on the topic of disadvantages to a municipality.

## 5.4. MANAGERIAL RECOMMENDATIONS

Section 5.3 discussed the key findings of the study, after the primary data was collected and analysed in Chapter 4. That section also compared the findings to the literature review in Chapter 2. This section contains managerial recommendations to make sure that there is no disparity between the Chapter 2 literature review and the findings from the primary data collected through interviews.

The aim of these recommendations is to develop strategies to manage the provision of electricity within Western Cape Municipalities and therefore address the research problem: A primary research objective was set with the aim to develop a viable strategy, to improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

### 5.4.1. Economic Importance

Earlier in this study it was established that local regional municipalities are the distributors of electricity for a generator such as Eskom. However, the municipalities must still purchase electricity from the generator and then sell and distribute that electricity on to their customers within their region. This service delivery creates an

income, revenue or surplus for the municipality. The literature states: The sale of electricity is the main form of revenue for an electricity generation, transmission and distribution utility (Arango et al., 2017). A municipality can only establish the amount of electricity sold and determine the amount of credit sales, if it measures the service provided. The data states: Thirty six percent (36%) agreed that electricity is the largest source of income for a municipality. The majority of participants, eighty one (81%), echo the literature and confirmed that the economic importance of an electricity meter is to measure the electricity used in order to bill the clients and in doing so, create an income, revenue and/or a surplus of funds for the municipality.

Recommendation: It is critical for municipalities to ensure that all electricity supplied to any of their customers is properly measured with adequate metering. The only way for a municipality to determine how much electricity was sold and therefore determine the economic effect, is by metering the electricity.

### 5.4.2. Types of Meters

In Section 5.4.1, the study determined that the metering of electricity supply is critical to any municipality. There are various type of meters that a municipality can install. The literature states the five (5) most popular meters are: Kilowatt hour meters (Blalock, 2014), Common Base Prepaid and Split Prepaid Meters (Eskom, 2019), Bulk Meters (JKNV Energy, 2019) and Smart Meters (Energy.gov, 2019). The data states: Between eighty (80%) and a hundred percent (100%) of municipalities support the literature and use bulk, kilowatt hour, common base prepaid and split prepaid meters. A minority of ten percent (10%) have installed smart meters.

Recommendations: When referring to meter tampering, it is recommended that municipalities change from the older type meters, such as kilowatt hour and common base prepaid meters to the newer technology meters such as split prepaid or smart meters that have bi-directional communication and anti-tamper capabilities. This will limit the opportunity for customers to tamper with the meters as previously discussed in this chapter. The operation of these meters requires a control and monitoring room which contributes to the high costs. Municipalities who find it too expensive to change to these type of meters must make sure that their current meters are properly calibrated, in full working order and inspected on a regular basis.

### 5.4.3. Types of Enclosures

Following on from Section 5.4.3, once the municipality has identified the specific type of electricity meters in its network, it can determine the enclosures to house the meters in. The literature introduced ground mounted kiosks as well as pole top boxes and raw materials such as steel, polyethylene, DMC and fibre glass. The data states: Between sixty (60%) and a hundred percent (100%) of municipalities support the literature and use ground mounted kiosks and pole mounted boxes manufactured from polyethylene and steel. Ten percent (10%) support anti-vandal kiosks.

Recommendations: Any municipality should do an analysis of their different areas, be it rural or urban, and identify if there are any high meter tampering areas or areas that are prone to vandalism. It is difficult to state that high vandalism areas should receive steel enclosures since steel has a recycling value and is often vandalised not to tamper with the meters but rather to resell the steel. On the other hand, polyethylene has no resale value but is also vandalised to tamper with the meters or switchgear. There are a whole list of comparisons, some good and some bad, between the different raw manufacturing materials for enclosures. Instead, municipalities should start investigating and moving in the direction of anti-vandal kiosks and smart kiosks which have tamper alarms and communication properties in order to alert the municipality of any wrong doings. These kiosks also require a monitoring and control room which contributes to the cost of such a change. Municipalities who find it too expensive to change to these types of kiosks should try and make use of more pole top boxes in order to move their meters completely away from the customers and therefore try and eliminate the opportunity to tamper or vandalise.

### 5.4.4. Reasons for Electricity Meter Tampering

There are various reasons for meter tampering, such as the economy, socio-economic issues, infrastructure and legalities, motivating why customers tamper with electricity meters. The literature states: Czechowski & Kosek (2016) mention that the main motive for NTLs including electricity meter tampering, is the desire to save money. The data states: Thirty percent (30%) of municipalities support the literature that customers want to save money. However, the other eight (8) reasons mentioned by municipalities in Figure 4.8 give an indication that municipalities experience various incidents and then build their comments around the question of why electricity meter tampering takes

place. The majority of sixty percent (60%), do however, agree that clients cannot afford the escalating electricity tariffs.

Recommendations: If electricity was free for everyone, there would be no reason why anyone should tamper with an electricity meter for any of the other reasons that were mentioned by the municipalities. Unfortunately electricity is a service provided by a municipality which must recover its costs. It is difficult to give a recommendation when it comes to affordability, in view of the economic climate in South Africa together with the high unemployment rate, which both influence customer's lives and what they can afford. Any recommendations go hand in hand with various other issues. The study can recommend that municipalities should try and negotiate decent tariffs with the generator, but the generator itself, which is Eskom, is struggling to make ends meet and has asked NERSA for repetitive tariff hikes to try and cover their costs. The study can also recommend that municipalities must at least maintain their infrastructure but to do that, they must recover their revenue. Less revenue means less, or no, industrial expansion which means fewer jobs. If there are high unemployment rates and customers cannot earn money, they cannot pay for electricity and turn to electricity theft or meter tampering. The result is that the municipalities cannot cover their costs and in return cannot pay their Eskom bill. This creates a vicious cycle of events that keeps repeating itself.

### 5.4.5. The Economic Impact of Meter Tampering

The literature states: The sale of electricity is the main form of revenue for an electricity generation, transmission and distribution utility (Arango et al., 2017). Therefore when it comes to the economic impact that electricity meter tampering has on Western Cape Municipalities, the data states: Seventy percent (70%) acknowledged that the greatest impact is the loss of income, revenue or the surplus funds. The impact is significant and affects the sustainability of the municipality.

Recommendations: The recommendations of how to eliminate or decrease the economic impact of electricity meter tampering will be discussed in the following Section, 5.4.6 – Possible Solutions to Decrease Meter Tampering.

### 5.4.6. Possible Solutions to Decrease Meter Tampering

In Section 5.3.6 (Key Findings of the Study) the literature suggested a vast array of possible solutions to decrease meter tampering and sixty percent (60%) of those suggestions was supported by findings from the primary data. To name a few: Eisenbeiss (2015) states that most of the electricity networks in the Western Cape are aged and need new technology upgrades. Czechowski & Kosek (2016) mention that municipalities can mainly try to counteract the problem of meter tampering with increased tariffs, penalties and legislative controls. The increased tariffs suggestion goes completely against what the study already highlighted in Section 5.4.4 under the Reasons Why Electricity Meter tampering takes place. According to Power Measurement (2019), metro, district and local regional municipalities should add a separate revenue protection department, etcetera.

Recommendations: Although there are fourteen (14) mixed comments from various municipalities covering different possible solutions, they all have merit and so do the other forty percent (40%) of suggestions from the literature in Chapter 2. Therefore, a municipality should summarise and analyse their situation and choose one or a few of the possible solution options to implement. They should communicate with other municipalities, not just in the Western Cape but also nationally or even globally. They must be transparent in what they have implemented or want to implement and ask for guidance from one another in order to eliminate possible solutions that have been implemented and either have failed, been successful or might be too costly to implement. The leading recommendation is that it is time for municipalities to come together, communicate and share situations, ideas and possible solutions in order to ring fence the issues and possible solutions associated with electricity meter tampering.

### 5.4.7. Potential Obstacles for Implementing Solutions for Meter Tampering

Once again there are numerous suggestions from the literature as well as municipal comments about potential obstacles for implementing the suggested solutions to decrease electricity meter tampering. To highlight one of the literature statements: Jamal (2015) states that in the IEP, the Department of Energy noted a further increase in the generation and operational costs of the electrical networks placing more financial burdens on municipalities. The corresponding data states: Thirty percent

(30%) of the municipalities support the literature with the fact that funding or finances can be an obstacle to implement mentioned possible solutions. The scattered comments from the municipalities are an indication that they have different obstacles when it comes to implementation of potential solutions. However, seventy percent (70%) of municipalities experience political issues and fifty percent (50%) experience socio-economic hostility. Section 5.3.6 discusses all the critical cross field outcomes between the primary data findings and the literature.

Recommendations: There are ten (10) possible obstacles echoed by the ten (10) interviewed municipalities, although the political issues and socio-economic hostility scored the highest. These issues go hand in hand when municipalities make changes to counter illegal activities such as electricity meter tampering. Customers become hostile because of the changes and then approach their political leaders to counter the municipality. This study recommends that municipalities take the time to start educating their customers about the use of electricity, the measures to decrease illegal activities and the consequences of illegal activities such as electricity meter tampering. The education process will also help to form a relationship between municipalities and their customers so that when changes are implemented, hostility will not be an issue and the politicians can be separated from the operations of the municipality. Education and establishing relationships can also assist with access to gang controlled areas as well as customer's premises. Municipalities might be in a position where they can negotiate with customers without any violent behaviour and go about doing what they need to do.

### 5.4.8. Advantages and Disadvantages of Implementing Selected Possible Solutions

#### a) Advantages

The primary data delivered twelve (12) different advantage comments from the participative municipalities, but when the selected possible solutions are implemented, sixty percent (60%) agreed that it will have a significant effect to recover their income, revenue or surplus.

Recommendation: This study is of the opinion that although the comments about advantages from municipalities are scattered, the majority of municipalities will benefit from implementing any of the possible suggested solutions. Therefore, to revert to the

discussion in Section 5.4.6, municipalities must explore all their options and choose specific possible solutions that will benefit their situation.

**b) Disadvantages**

The primary data delivered six (6) different disadvantage comments from the participative municipalities but the two (2) with the highest scores should be highlighted. The majority, thirty three percent (33%) of municipalities agreed that there is no disadvantage to a municipality for implementing the possible solutions. This is followed by a count of twenty seven percent (27%) of municipalities who agreed that meter technology can be a disadvantage.

Recommendations: Although municipalities echoed six (6) different disadvantages, when scrutinising these disadvantages the one identified with the highest merit is that there are no disadvantages in implementing some or all of the possible solutions. The recommendations for the rest of the disadvantages are as follows:

- Meter technology issues – municipalities should investigate all meter options and compare and analyse the results sharing them with other municipalities to get guidance. This way they can eliminate the good from the bad technology.
- High cost – municipalities must plan for changes through operational and managerial budgets. They can also establish a team to investigate more economical options which can deliver the same results.
- Socio-economic stresses – these stresses should be alleviated when municipalities educate and establish relationships with their customers.
- Customers damage infrastructure – when customers are educated about the use of electricity, the measures to decrease illegal activities and the consequences of illegal activities, such as electricity meter tampering, it may help prevent customers from participating in vandalism of the electrical network.
- It’s illegal not to recover costs – municipalities supply a service and by law have to recover the costs of supplying that service. Customers might see this point as a disadvantage since they have to pay for the service, but municipalities can only benefit by recovering their costs.

## 5.5. DELIMITATIONS OF THE STUDY

This study is authentic and enclosed all of the theory related to the topic; however, due to cost and time constraints only ten (10) out of the thirty (30) municipalities

(33.3%) within the Western Cape could participate. In order for this study to be representative of a larger population, the same study should be conducted again, this time targeting a larger population across all the Municipalities within the Western Cape.

This study was conducted using only qualitative research and as a result no statistics were used to build a conceptual model. Future research would need to collect primary data in order to add a quantitative section to the findings, thus making the research more conclusive.

## 5.6. CONCLUSION

The objective of this study was to improve the management of electricity provisioning by Municipalities within the Western Cape by investigating how the challenge of electricity meter tampering can be addressed. A questionnaire was constructed on the basis of secondary data that was gathered and presented in the form of a literature review. The questionnaire was used to gather primary data from identified participants pertaining to the main study objective.

Based on the ROs, this study accomplished the following results:

- Conduct a literature study around the management of electricity and the challenge of electricity meter tampering.
- Construct a research design to investigate why and how electricity meter tampering takes place.
- Conduct interviews with a selected sample of municipal employees on reasons why and how electricity meter tampering is taking place.
- Transcribe the interviews, through the use of Atlas.ti, in order to process the raw data on which appropriate data analysis methods can be applied.
- Interpret the findings, make recommendations and draw a conclusion.

This study was concluded with managerial recommendations being made and as such adequately addressed the research problem: A primary research objective was set with the aim to develop a viable strategy, to improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed. Furthermore the $RQ_M$: Which strategies can be developed to manage the provision of electricity within Western Cape Municipalities?

and the ROM: To improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed, were also appropriately addressed.

The managerial recommendations were applied to the various sections and can be expanded through more extended future research. Limitations pertaining to the study were also addressed calling for research over a larger population covering the same questions and objectives. If Western Cape Local Regional Municipalities choose, or are in a position to implement all or some of the suggested possible solutions and recommendations made, they should see positive results in combating the economic effects of electricity meter tampering.

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**ANNEXURES**

# ANNEXURE A: Ethics Clearance Document

NELSON MANDELA
UNIVERSITY

[illegible]

Chairperson: Faculty Research Ethics Committee (Human)
Tel: +27 (0)41 504 2504

Ref: [H19-BES-BUS-058] / Approval]

13 August 2019

Prof C Arnolds
Department: Graduate School

Dear Prof Arnolds,

**TITLE OF STUDY: THE ECONOMIC IMPACT OF ELECTRICAL METER TAMPERING WITHIN WESTERN CAPE MUNICIPALITIES (MBA)**

PRP Prof C Arnolds
PI PJ Brink

Your above-entitled application served at the *Faculty Ethics Committee of the Faculty of Business and Economic Science, (19 July 2019)* for approval. The study is classified as a negligible/low risk study. The ethics clearance reference number is **H19-BES-BUS-058** and approval is subject to the following conditions:

1. The immediate completion and return of the attached acknowledgement to Lindie@mandela.ac.za, the date of receipt of such returned acknowledgement determining the final date of approval for the study where after data collection may commence.
2. Approval for data collection is for 1 calendar year from date of receipt of above mentioned acknowledgement.
3. The submission of an annual progress report by the PRP on the data collection activities of the study (form RECH-004 to be made available shortly on Research Ethics Committee (Human) portal) by 15 December this year for studies approved/extended in the period October of the previous year up to and including September of this year, or 15 December next year for studies approved/extended after September this year.
4. In the event of a requirement to extend the period of data collection (i.e. for a period in excess of 1 calendar year from date of approval), completion of an extension request is required (form RECH-005 to be made available shortly on Research Ethics Committee (Human) portal)
5. In the event of any changes made to the study (excluding extension of the study), completion of an amendments form is required (form RECH-006 to be made available shortly on Research Ethics Committee (Human) portal).
6. Immediate submission (and possible discontinuation of the study in the case of serious events) of the relevant report to RECH (form RECH-007 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any unanticipated problems, serious incidents or adverse events observed during the course of the study.
7. Immediate submission of a Study Termination Report to RECH (form RECH-006 to be made available shortly on Research Ethics Committee (Human) portal) upon unexpected closure/termination of study.
8. Immediate submission of a Study Exception Report of RECH (form RECH-009 to be made available shortly on Research Ethics Committee (Human) portal) in the event of any study deviations, violations and/or exceptions.
9. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Research Ethics Committee (Human).

Please quote the ethics clearance reference number in all correspondence and enquiries related to the study. For speedy processing of email queries (to be directed to Lindie@mandela.ac.za), it is recommended that the ethics clearance reference number together with an indication of the query appear in the subject line of the email

We wish you well with the study.

Yours sincerely

Prof M van Eyk

Cc: Department of Research Capacity Development
Faculty Research Co ordinator: Lucia van Ransburg

## ACKNOWLEDGEMENT OF CONDITIONS FOR ETHICS APPROVAL

I, **Prof C Arnolds** (PRP) of the study entitled **THE ECONOMIC IMPACT OF ELECTRICAL METER TAMPERING WITHIN WESTERN CAPE MUNICIPALITIES (H19-BES-BUS-058)**, do hereby agree to the following approval conditions:

1. The submission of an annual progress report by myself on the data collection activities of the study by 15 December this year for studies approved in the period October of the previous year up to and including September of this year, or 15 December next year for studies approved after September this year. It is noted that there will be no call for the submission thereof. The onus for submission of the annual report by the stipulated date rests on myself.

2. Submission of the relevant request to Faculty RECH in the event of any amendments to the study for approval by Faculty RECH prior to any partial or full implementation thereof.

3. Submission of the relevant request to Faculty RECH in the event of any extension to the study for approval by Faculty RECH prior to the implementation thereof

4. Immediate submission of the relevant report to Faculty RECH in the event of any unanticipated problems, serious incidents or adverse events

5. Immediate discontinuation of the study in the event of any serious unanticipated problems, serious incidents or serious adverse events.

6. Immediate submission of the relevant report to Faculty RECH in the event of the unexpected closure/discontinuation of the study (for example, de-registration of the PI)

7. Immediate submission of the relevant report to Faculty RECH in the event of study deviations, violations and/or exceptions.

8. Acknowledgement that the study could be subjected to passive and/or active monitoring without prior notice at the discretion of Faculty RECH

Signed: _____ Date: 13/11/2019

# ANNEXURE B: Questionnaire/Interview Guide

**Date:** ……..……

**Institute Code:** ……

**Participant Code:** ……

**Participant Gender:** **male / female**

**Participant Position:** **senior / middle management**

**Consent form signed:** **yes / no**

**PRIMARY OBJECTIVE OF THE STUDY**

The primary research objective of this study is to improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

**Question 1**

What is the economic importance of having an electricity meter?

……

……

……

……..

**Question 2**

What type of meters are installed in household and business premises within Municipalities of the Western Cape?

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……

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……..……

**Question 3**

What type of electrical enclosures are the meters installed in?

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……

……
……

**Question 4**

Why does electricity meter tampering take place?

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……..

**Question 5**

What is the economic impact of meter tampering for a Municipality within the Western Cape?

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**Question 6**

What possible solutions have been formulated to decrease meter tampering in a Municipality in the Western Cape?

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……..……

**Question 7**

What are the potential obstacles within Western Cape Municipalities for implementing the possible formulated solutions?

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……

**Question 8**

What are the perceived advantages and disadvantages of adopting the selected possible solutions within the Western Cape Municipalities?

1) Advantages

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2) Disadvantages

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# ANNEXURE C: Written information sent to Senior/Middle Manager prior to participation

**Project Title**

The Economic Impact of Electrical Meter Tampering within Western Cape Municipalities.

**Project Information Statement**

My name is Pierre Brink, and I am a Master's degree student at the Nelson Mandela University. I am conducting research for my treatise on the project title, as mentioned above, under the supervision of Prof Mohamad Bayat. I invite you to consider taking part in this research. This study will meet the requirements of the Research Ethics Committee (Human) of the Nelson Mandela University.

**Research Objective**

The primary objective of this study is to improve the management of electricity provisioning in the Western Cape by investigating how the challenge of electricity meter tampering can be addressed.

**What is the research problem?**

Electrical meter tampering and the economic impact it has, is a massive global, national and provincial problem. Although there are studies and published statistics for South Africa, there is a lack of focus and results on a regional municipal utility level.

In order to accomplish the above-mentioned primary objective, the following secondary research objectives will be pursued:

1. Conduct a literature study around the management of electricity and the challenge of electricity meter tampering.
2. Construct a research design to investigate why and how electricity meter tampering takes place.

3. Conduct interviews with a selected sample of senior/middle municipal representatives on reasons why and how electricity meter tampering is taking place.

4. Transcribe the interviews, through the use of Atlas.ti, in order to process the raw data on which appropriate data analysis methods can be applied.

5. Interpret the findings, draw conclusions and make recommendations.

**Data Collection**

Primary data collection for this study will be collected through pre-arranged, structured interviews, asking nine (8) open-ended, descriptive, non-directional questions. The interview should take no longer than 45 minutes. All interview answers will be captured in writing and with your consent will also be audio-recorded by cellular phone in order to transcribe and process data for analysis through the Atlast.ti software system.

**Reporting**

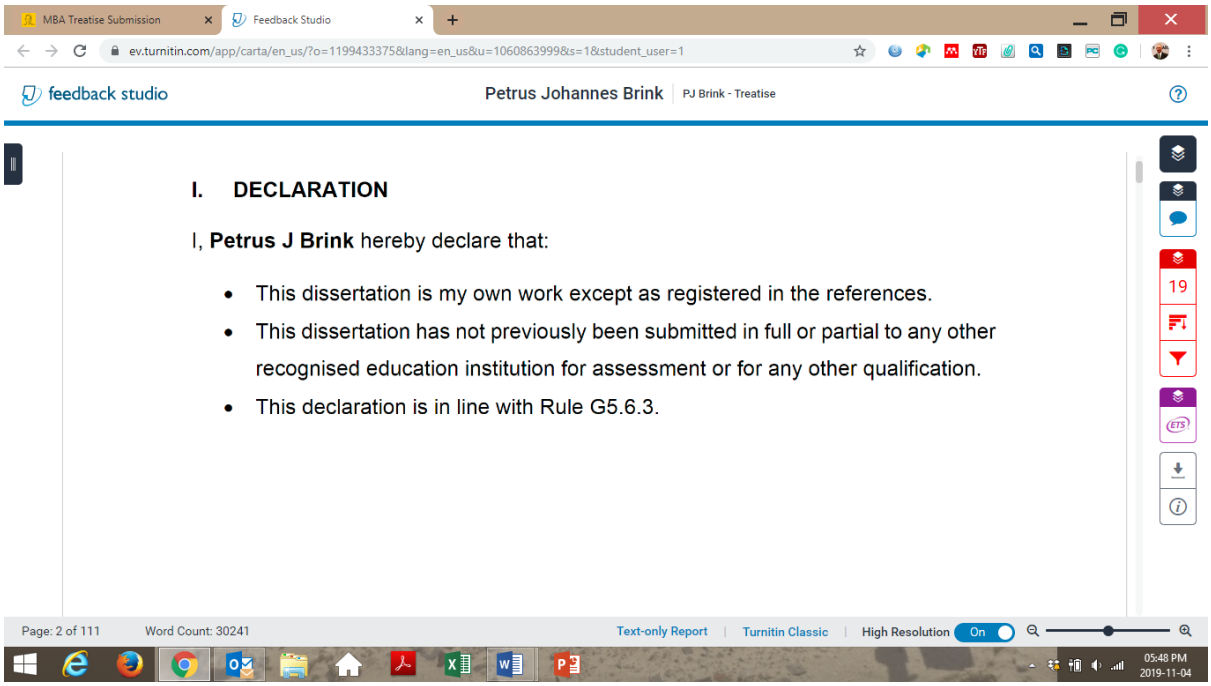
After analysis, this study will present the findings to the municipal manager through interpretations, make managerial recommendations and conclude the study based on the statistical results.

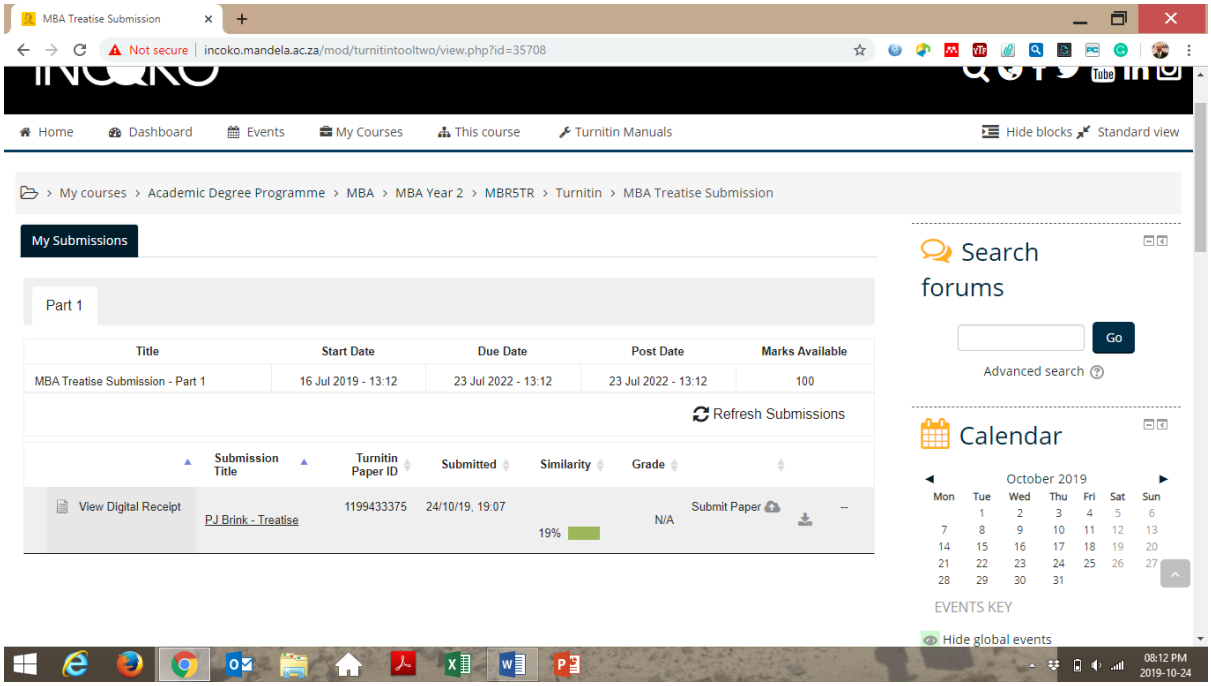
I would appreciate your consideration as nominated senior/middle manager (electricity department) of ……..…… Municipality to participate in this research. Please complete and return the attached consent form, should you choose to participate.

Thank you for taking the time to read this information.

| | |
|---|---|
| …… | …… |
| PJ Brink | Prof MS Bayat |
| Researcher | Supervisor |
| Nelson Mandela University | Nelson Mandela University |

# ANNEXURE D: Turn-it-in Report



# Editing Service: Lee Kemp

14 Carlisle St

Mount Croix

Port Elizabeth

6001

11 Novemb er2019

082 723 5408

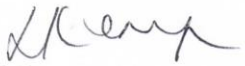
**TO WHOM IT MAY CONCERN**

**EDITING OF REPORT: Mr P. Brink**

This serves to confirm that I edited Mr Brink's MBA treatise.

The editing covered all aspects of language, punctuation in-text referencing and layout. I also crosschecked in-text referencing against the reference list.

Yours faithfully



Ms L. Kemp

**B. A. (Hons English); MBA**