Implementation framework for microgrids as an energy solution to uplift rural communities in the Eastern Cape

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Implementation framework for microgrids as an energy solution to uplift rural communities in the Eastern Cape

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DECLARATION

I, Sibulelokuhle Xulaba, declare that the entire body of work contained in this research assignment is my own original work; that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Nelson Mandela University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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In Loving Memory of

Babalo Xulaba

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ABSTRACT

People in remote areas of most developing countries still face economic and environmental challenges despite our more accessible world of technology. Access to reliable and sustainable electricity is the most challenging developmental issue faced by rural communities in South Africa, as grid expansion has dwindled due to business challenges experiences by the state power producer, Eskom. Unless businesses and homeowners in unconnected areas use generators, which are costly to run and environmentally unfriendly, most will continue to remain without electricity for the foreseeable future. The purpose of this study therefore is to provide a model for the successful implementation of renewable energy microgrids to overcome poverty and promote economic development in rural areas of the Eastern Cape.

The data for the study was collected from three district municipalities in the rural areas of the Eastern Cape. The province is divided into homeland and farms, with the farms that were sampled for the study situated on State-owned land. The sample group comprised small businesses operating in these rural areas. The study used a mixed-method research design, the methodology being found to be the most suitable for the study. The study uses a questionnaire-variant convergent design that consisted of a mixture of open-ended and close-ended questions.

The sample group was situated in areas with limited electricity or internet access, therefore face-to-face structured interviews were conducted. Meta-inference was used for data interpretation, and a combination of quantitative and qualitative data analysis methods was used to analyse the data. For the open-ended questions, thematic analysis was used, whilst descriptive statistics were used for the closed-ended questions.

The study found that most businesses operating in rural areas do not have access to electricity. Those businesses which do not have electricity must make use of diesel-powered generators to continue to trade, which makes their businesses unprofitable. They spend a large proportion of their earnings purchasing fuel to achieve the desire thermal comfort for their stock, or to pump water via boreholes or piped dam structures.

The study showed that implementing a renewable energy microgrids provides a viable option, supporting the literature reviewed. This will promote economic development in these areas of the Eastern Cape. Developing and enhancing the standard of living can assist in reducing the number of people migrating to urban areas whilst providing an opportunity to increase farm yields, grow rural business and change the lives of the poor for the better.

Keywords:

District Municipalities, Microgrids, Renewable energy, Rural communities, Rural economic development.

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating current
DER	Distributed energy resources
DFID	Department for International Development
DM	District municipality
ENRD	European Network for Rural Development
LM	Local municipality
NMBMM	Nelson Mandela Bay Metropolitan Municipality
OECD	Organisation for Economic Co-operation and Development
ORTDM	OR Tambo District Municipality
PV	Photovoltaic
SBDM	Sarah Baartman District Municipality
USC	Unit for Statistical Consultation

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CHAPTER 1
THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION

Rural energy and development experts have recognised that electrification in rural areas of developing countries should be accompanied by complementary services. Rural area residents are frequently not aware of the economic potential of electricity and therefore cannot be expected to consider the grid connection decisions and the rational use of electricity in an economic sense (Peters, Harsdorff and Ziegler, 2009).

Most of the rural areas are underdeveloped and have none, or very limited, access to electricity. The idea of not only providing electricity for them but also looking at how electrification can boost their economy and promote development is what people in rural areas need to ensure a more promising future. Cook (2013) states that rural electrification has the potential to act as a catalyst for rural development.

The Organisation for Economic Co-operation and Development (2018) report states that these areas possess more potential for global opportunities than meets the eye. The report focuses on opportunities such as developing new energy sources that meet climate change challenges, innovation in food production for growing populations and the provision of natural resources that will enable the next production revolution. There is more emphasis on how rural areas consist of diversified economies beyond agriculture and other natural resource-based sectors. Some of these diversified rural economies include tourism, the production of renewable energy, arts and cultural industries and services associated with natural resources-based sectors such as manufacturing and agro-processing.

Kanagawa (2008) states that poverty has been a major obstacle for sustainable development. The author describes poverty as low attainment of social services such as education, health, and nutrition, in addition to economic deprivation. One of the ways to cope with the multi-dimensional aspects of poverty is to promote opportunities and one of the opportunities is access to modern energy such as electricity (Kanagawa, 2018). Microgrids are considered a potential source of electrification in rural areas as generation is geographically close to the loads, reducing transmission construction requirements and cost. Microgrids are also a flexible utilization of distributed generation, increasing the reliability of critical loads, providing better reactive power management, and optimizing the operation at the distribution level (Kermani *et al.,* 2015).

South Africa has abundant solar energy and the use of solar PVs to generate electricity is an optimal solution for microgrids in rural areas. Rural areas in South Africa lack infrastructure, therefore the installation of microgrids in these areas would require a point of central distribution in each location.

The use of public centres, such as community centres, schools and clinics, has been considered as potential central distribution point as the panels and supporting infrastructure can be housed on and in these existing structures.

The provision of electricity in rural areas would not only improve the standard of living in these areas but would also give an opportunity to upgrade and maintain access roads and infrastructure. Furthermore, households in these areas do not use vast amounts of electricity; their electricity is mostly used for cooking, lighting, and appliances. Using solar PVs microgrids in rural areas would not only bring electricity but the energy that is generated could provide excess-generated solar energy. Excess energy generated from the microgrid can be harnessed to supply these households' creating opportunity for other forms of development that could occur in these areas.

The purpose of this study is therefore to use the concept of renewable energy microgrids to provide electrification to rural areas of the Eastern Cape and to utilise the availability of electricity in these areas to create economic opportunities that will promote individual and area development.

1.2 THE STATEMENT OF THE PROBLEM

Microgrids are viewed as optimal solutions for rural electrification. Owing to the underdeveloped state of rural areas in the Eastern Cape, the use of renewable energy to provide electricity can assist these communities by bringing economic and social development. The installation of microgrids can create an enabler to foster new opportunities that can assist with the expansion and growth of the rural economy. This can create various new rural economic sectors to enhance the existing dominant sector, namely agriculture. This can affect the rural economy positively and improve the livelihood of the inhabitants by creating more job opportunities.

The lack of electrification in rural areas has resulted in limited opportunities for economic development. This has stagnated the upliftment of these areas, thereby creating fewer economic opportunities to reduce poverty and unemployment. The study therefore seeks to evaluate the use of renewable energy microgrids as a mechanism to enable development in the rural communities of the Eastern Cape.

1.3 THE STATEMENT OF SUB-PROBLEMS

1.3.1 Sub-problem 1

Rural areas lack a sustainable energy supply.

1.3.2 Sub-problem 2

Rural areas have increased poverty and inequality levels.

1.3.3 Sub-problem 3

Energy supply in rural areas is costly.

1.3.4 Sub-problem 4

The lack of development in rural areas increases economic migration.

1.3.5 Sub-problem 5

A lack of reliable energy infrastructure is a financial risk to rural business.

1.4 THE HYPOTHESES

1.4.1 Hypothesis 1

Renewable energy microgrids can provide sustainable energy for rural areas.

1.4.2 Hypothesis 2

Increasing economic opportunity leads to a reduction in poverty and inequality.

1.4.3 Hypothesis 3

Microgrids provide a cost-effective energy supply.

1.4.4 Hypothesis 4

Microgrids would enable increased economic development in rural communities.

1.4.5 Hypothesis 5

Microgrids would reduce investment risks in rural businesses.

1.5 DELIMITATIONS OF THE STUDY

This study does not cover any background study or information about solar PV installation in rural areas and it will also not cover any financial, economic and social benefits from this technology.

The study is limited to within the boundaries of the Eastern Cape Province.

1.6 THE DEFINITION OF KEY TERMS

1.6.1 Microgrid

A microgrid is a regional or communal energy system comprising distributed energy sources (renewable and non-renewables) often in order to optimize power quality, reliability, efficiency, and sustainability with accompanying economic and environmental benefits.

1.6.2 Rural area

Rural area is an area of land outside densely populated urban areas in a town or city. These areas usually have a low population density as compared to urban areas.

1.6.3 Renewable energy

Renewable energy is energy collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves and geothermal heat.

1.6.4 Rural non-farm activities

Rural non-farm economy may be defined as comprising all those activities associated with waged work or self-employment in income-generating activities that are not agricultural, but which generate income in rural areas.

1.6.5 Category A Municipality

Classified as metropolitan, municipalities that govern large densely urbanised regions that encompass multiple centres with close economic linkages.

1.6.6 Category B Municipality

Is classified as a municipality that has the same municipal executive and legislative authority in its area together with a category C municipality within whose area it falls.

1.6.7 Category C Municipality

Is classified as a municipality that has municipal executive and legislative authority in an area which includes more than one municipality.

1.7 THE AIM OF THE STUDY

The aim of the study is to investigate whether the use of renewable energy micro grids can provide sustainable, reliable energy to enable economic development in rural communities of the Eastern Cape.

1.8 THE ASSUMPTIONS

The assumptions made on this study are the following:

- Renewable energy technology is already being installed in rural areas.
- There will be a gradual migration from petrol-fuelled cars to hybrid/electric powered cars in South Africa.
- Skills and business training will be offered to the people of these rural communities.

- Small and medium enterprises (SMEs) will be set to perform non-rural farm economic activities.

1.9 THE IMPORTANCE OF THE STUDY

The study is important as it hopefully provides model for the successful implementation of microgrid electrical networks and a means for combating poverty and development promotion in rural economies like the Eastern Cape of South Africa. Renewable energy micro grids can assist countries meet their policy for secure, reliable and affordable energy. Rural areas in the Eastern Cape have been underdeveloped for a very long time and the use of electricity for domestic purposes can improve and have a positive effect on the quality of life and standard of living in rural areas. The industrious use of energy in rural areas, on the other hand, can increase rural productivity and economic growth, which can reduce the high rate of unemployment in rural areas. A thriving rural economic which has high productivity, better revenues and low unemployment rate can assist with reducing the rate of migration from poor rural areas to urban areas.

1.10 OBJECTIVES

The objectives of the study are to:

- Identify a sustainable electrical energy supply for rural areas.
- Identify economic opportunities to reduce poverty by increasing the rate of employment in rural communities.
- Identify a cost-effective energy supply to rural areas.
- Identify rural economic activities that can reduce economic migration in rural communities; and,
- Explore factors that can contribute to a financially stable infrastructure framework for rural economic development.

SUMMARY

Having access to affordable and clean energy is one of the sustainable development goals. Rural areas in most parts of South Africa still do not have access to electricity. The promotion of electricity in rural areas is important as it enables these areas to improve their standard of living, enhance production, income expenditure and education outcomes. The purpose of this study is to use the concept of renewable energy microgrids to provide electricity in the rural areas of the Eastern Cape and then utilise the availability of the electricity in these areas to create economic opportunities that will promote development.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Microgrids are gaining popularirty in Africa as an alternative to conventional power grids. Grid electricity is the general approach and almost 70% of households are already connected. The 30% remainder are still without electricity and 51% are households in the deep rural areas (White & Koopman, 2012). Renewable energy technologies can assist countries in meeting their policy goals for secure, reliable and affordable energy. Microgrid systems are significant because they enable local self-reliance in electricity. Microgrids also create smaller and new generating units that are more efficient and less polluting. The money spent on electricity on microgrids gets dispersed more widely, therefore creating a more vibrant and robust economy (Muradov, 2012).

As stated above, the use of microgrids has the potential to create economic change in rural areas. A study conducted in Europe by the European Network in Rural Development (ENRD, 2017) shows that rural areas can be divided into four structural macro regional typologies, namely agricultural regions, consumption countryside region, diversified region with strong manufacturing base, and diversed regions with strong market services. This study will therefore adopt the above stated zoning criteria for rural areas and determine how microgrids can be customized to suit the geographical, demographic and economic conditions of the rural areas involved in the study. Dividing rural areas into the respective categories will assist in determining what type of economy can be established in that area, the type of infrastructure needed and the size of the microgrid that can be installed in each respective area.

2.2 MICROGRIDS

The future of network technologies includes microgrid technology at a small-scale distribution power generation system and a combination of a power electronic system. A micro grid's core function is to ensure a stable operation during faults and various network disturbances. The concept of microgrids is a step in the direction of achieving a greater degree of local control and autonomy. A microgrid is a power system configuration, which provides clear economic and environmental benefits as compared to the expansion of modern power systems. This reinforces the idea that the development of a microgrid concept and technologies requires a considerable effort to resolve numerous economic, commercial, and technical challenges (Hatziargyriou, 2005).

Microgrids provide advantages such as offering sustainable solutions to supply power in case of an emergency and power shortage during interruptions in the main grid. Plug-and play functionality which has a feature for switching to a suitable mode of operation to be either grid connected, or

island operated. They also provide voltage and frequency protection during islanding operated and the capability to resynchronize the microgrid connection to the main grid safely. Lastly, microgrids can also operate independently without connecting to the main distribution grid during islanding mode, all loads must be supplied and shared by distribution generations. A microgrid consists of a static transfer switch, distributed critical loads, noncritical loads and multiple distributed energy resources units with various power electronic interfaces. They can be classified into three types based in the type of supply and their locations, namely the utility interface microgrid, commercial and industrial microgrid and lastly the remote microgrid.

The operation of a microgrid is different from traditional electric power systems. The system could be structured differently for each applicable scenario for that specific area (Wang *et al.,* 2011). Microgrids can consist of a combination of various renewable energy technologies such as photovoltaic, wind and fuel cell to generate electricity. A microgrid system has distributed generation units with inverters and control systems which enables flexible operations. Salam *et al.* (2008), states that the microgrid concept permits a high penetration of distributed generation without remodelling the entire distribution system. The distributed generation and corresponding loads can also be autonomously separated from the distribution system to isolate the microgrid's load from disturbances during distribution. This will cause the microgrid to disconnect when the quality of power from the grid falls below certain standards.

Microgrids are designed in a way that makes it easy to separate and reconnect easily from the main grid when the main grid experiences technical problems. A microgrid connected to the main grid has the potential to function as a constant power source that can be controlled when injecting the required power into the network. A microgrid that operates independently is identified by the opening static switch which disconnects when the microgrid from the main grid. In this independent grid, sources are controlled supply all the power needed by the local loads while maintaining the voltage and frequency within the acceptable operation limits. Microgrids with photovoltaic power, storage energy and electric loads form a valid mode connecting power system. In microgrids, energy storage systems connect photovoltaic power by an AC bus bar. The energy storage system can compensate photovoltaic power fluctuation, especially when the micro grid deviates from online mode.

Salam (2008) states that the main technical challenges of a microgrid are the control of power flow and the network voltage by the power electronic converter. Other technical challenges include the following voltage and frequency control, islanding, p-q inverter control, voltage source inverter control and protection. According to Sivachandran and Muthukumar (2014), reason for connecting a micro grid to a main grid include availability, microgrids can act as an additional source to power grids. Secondly, operations and stability, the direct connection of AC microgrids to a large power grid facilitates a stable operation, if the power grid acts as a stiff source to the microgrid. And lastly, economics- microgrids are planned with extra capacity with respect to the local load. The extra power

can then be injected back into the grid to obtain economic benefit. The grid interconnection allows reducing fuel operational costs by using the microgrid at night or at non-peak hours which can assist with the reduction of electricity costs.

The reasons of connecting a microgrid into a main grid have been stated above and the benefits of these microgrids include the following, optimizing the value of existing production and transmission capacity, incorporating more renewable energy and expanding the use of energy storage options, reducing carbon footprints and improving power quality, reliability, operational performance and the overall productivity of utilities. Micro grids also enable a two-way communication with consumers by giving them the ability to manage their energy usage (Sivachandran and Muthukumar, 2014)

2.3 RURAL TYPOLOGY

Classifying rural areas according to their economic activities can help solve many economic challenges that are being experienced in rural areas. The Eastern Cape has six district municipalities, and these regions are quite distinct from each other. This section of the study has adopted a simple categorisation of rural areas in order to assist with the developmental framework using micro-grids. According to the European Network for Rural Development (ENRD), the classification of rural areas is usually based on population density and distance to the nearest city. This study not only uses population and distance to determine typology, but it also uses the economic structure of the area to assist with categorisation.

The study makes mention of four type of typologies which include the following: agricultural regions, consumption countryside region, diversified region with strong manufacturing base and diversified region with strong market service. The agricultural region is considered as a region where the economy is mainly dependent on primary activities. A consumption rural region is where farming is on a small scale and has recreation and tourism as key activities. The diversified region with strong manufacturing base can be a combination of an agricultural region and a consumption region. The area is considered distinct because of its strong manufacturing base. Some areas can also have a combination of agricultural and manufacturing or a combination of manufacturing and consumption base. Lastly, another form of a diversified region consists of a strong market service. This region has an agricultural region with a string market service or a consumption region with a strong market service.

2.4 RURAL ECONOMY

An opening statement from the South African energy sector report (2019) states that energy is the lifeblood of the economy. It is an enabler for economic growth and stability, and as the country's economy continues to expand, it is crucial to ensure that there is access to affordable, reliable and sustainable energy sources while minimising adverse environmental impacts (Department of

Energy, 2019). The significance of energy in the development of rural economies cannot be over-emphasised. Renewable energy solutions as an energy provider for rural areas not only meet the criteria of being cost effective, effect and socially beneficial to the community but they also offer significant environmental conservation methods that will help these areas to retain their cultural sentimental value.

The rural economy consists of a farm sector, which is mainly agricultural, and a non-farm sector. Based on the scope of the research, the study looked at ways on how the non-farm sector can assist with the development of rural areas by using renewable energy implementation projects as a catalyst for these areas. According to Lanjouw (2001), the non-farm sector of the rural economy entails all economic activities in rural areas except agriculture, livestock, fishing and hunting. The sector comprises services, commerce and transport, construction, mining and manufacturing. Based on a study conducted by Lanjouw (2001), whether the potential contribution of non-farm activity to development is an activity that is efficient in converting resources into output relative to its urban counterpart or agriculture may also be a huge question of concern. This relative study has shown that from a theoretical point of view, that productivity of non-farm developmental activities can be measured by labour, capital and aggregate productivity. The lack of rural electrification for rural households has been found to be a discouraging factor for non-farm enterprises. Therefore, connecting a village to a grid could raise the likelihood of non-farm enterprise participation to the market by 13%.

From a study that was conducted in Sri Lanka by Satish (2007), it was found that lack of electricity is seen as the most important obstacle in the investment climate. The difficulties in extending the national grid to rural areas consist of factors such as high capital costs, the scattered nature of the area, low load factor, distribution and electricity losses and a lack of policy and legal framework (Sahu *et al.*, 2014). Studies have shown that utilising renewable energy technologies to generate electricity in rural areas can help bridge the gap of development. Thruner (2019) notes that renewable energy technology could assist rural areas in South Africa to convert sunshine into income. The author states that a flexible grid created by a decentralised energy system enables operators of the electricity system to balance demand and supply.

According to a study by Cabraal (2005) on the subject of productive use of energy, the most effective use of energy generated from renewable energy sources is create goods or services that have an impact of income or create value. Conventionally, the productive use of energy was narrowly defined and Cabraal et al. (2005) provided a broader understanding of the different impacts that energy services can have on rural economies, rural development, education, health and gender equality. The study shows that there is high degree of correlation between energy use, economic growth, and level of development. For rural development, the systematic view of productive use of energy is mainly connected with the provision of power for agricultural and industrial or commercial

purposes. The notion that energy on its own can bring about the desired socioeconomic impact in rural areas needs to be revised. In terms of the concept of rural development, the energy component was used for two distinct purposes, namely for residential use and for productive use.

The use of electricity for domestic purposes can improve and have a positive effect on the quality of life and standard of living in rural areas. The industrious use of energy in rural areas, on the other hand, can increase rural productivity and economic growth, which can reduce the high rate of unemployment in rural areas. A thriving rural economic which has high productivity, better revenues and low unemployment rate can assist with reducing the rate of migration from poor rural areas to urban areas. which will not only increase households' incomes but also reduce the migration of the rural poor to urban areas.

2.5 RURAL INFRASTRUCTURE

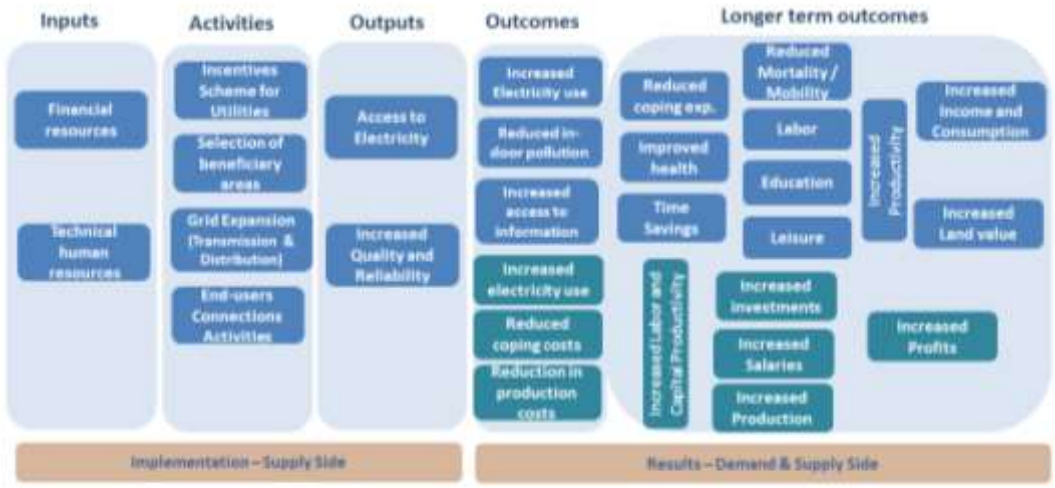
Infrastructure has been considered a major role player for the development of any economy. The adequacy or inadequacy of infrastructure can determine whether the economy will succeed or fail in its ability to increase production (Kumbhar, 2013). All infrastructure facilities are considered as a basic need for development and for the development process to take place in rural areas, the issue of not having proper and basic infrastructure needs to be resolved. Rural infrastructure is considered as an important factor for agriculture, agro-industries and the overall economic development of rural areas.

According to Satish (2007), the reason why little investment is made towards rural infrastructure is that the rural sector involves very high initial capital costs for investments, long development periods, high incremental capital output ratio, high risk and low rate of returns on investments. Since the primary activity in rural area is agriculture, agricultural infrastructure might be the dire need in these areas. This study, however, endeavours to create a comprehensive outlay of different infrastructures that could also be beneficial for rural areas. The development of these areas depends on the quality of infrastructure; therefore, there is a need for expansion on all types of infrastructure. The benefits of developing rural infrastructure include agricultural expansion by increasing yields, farmers' access to markets and availability of institutional finances, increased access to medical care and educational facilities, boosting of the economic climate in the rural economy and creating jobs and skills development for unemployed members of rural communities (Satish, 2007).

In most developing countries, the need to expand infrastructural services is regarded as an urgent matter to assist with integrating dispersed rural populations into the main economy. The mainstream economy is focussed on urban areas where economic activities have been most vibrant. The relation between infrastructure and economic growth has been a debated matter, as the quantity and quality of infrastructure are perceived to have an impact on growth (Cook,2011). Infrastructure development

has either a direct or an indirect correlation with economic growth; and the most evident direct form of growth is the productivity effect, which is captured through a production function framework.

According to Cook (2011), infrastructure will interact with physical characteristics to affect the comparative advantage of a region. Investments for electricity to assist these disadvantaged regions could change characteristics in order that these areas could be integrated with more prosperous parts of the economy. This can be illustrated by an example by the transport sector, where improved infrastructure in a poorer area may remove a natural trade barrier that was protecting the local industry and lead to a higher concentration of employment in a more successful region. Access to electricity in an underdeveloped area could lead to the inward migration of new enterprises to a lower cost region. The diagram below shows the natural flow of implementing renewable energy microgrids and how that can assist and create development in rural areas.



Sources: Adapted from Torero (2014), Gertler et al. (2011), and the literature review.

Figure 2.1: Casual grid from electricity to development

2.6 RURAL ELECTRICITY

Promoting rural areas to have access to modern forms of energy is important as it enables them to enhance their production, and improve their standards of living, incomes expenditure and educational outcomes. The process of rural electrification can bring electrical power to rural and remote areas. In the context of rural areas where the primary economic activity is agricultural farming, electricity is used not only for lighting and household purposes, but it also allows for the mechanisation of many farming operations, such as threshing, milking, and hoisting grain for storage. In areas facing labour shortages, this allows for greater productivity at a reduced cost.

2.7 RURAL ECONOMIC ACTIVITIES FOR DEVELOPMENT

According to Davis (2006), in the recent years, it has been recognised that the rural economy is not confined to the agricultural sector. Rural livelihoods are not limited to income derived from agriculture but may be derived from diverse sources. The rural non-farm economy is defined as all the activities associated with waged work or self-employment in income-generating activities that are not agricultural but located in rural areas. Rural non-farm activities include manufacturing or setting up small businesses. Gibson and Olivia (2010), state that non-agricultural activities are starting to emerge as substantial contributors towards the rural economy, these activities have influenced rural economic growth, creating of employment, livelihood diversification, and reduced poverty. The statistics based on that study showed that the combination of non-agricultural wage work, self-employment and fees contribute about 30-50% of the rural household income in sub-Saharan Africa. To expand the economic climate of rural non-farm activities, intervention to create rural infrastructure is needed. Proper rural infrastructure can assist the non-farm rural economy by reducing transaction costs. Like any other economy, the rural economy has three main sectors that contribute to the economy.

A study conducted in the UK by Department for International Development (DFID) shows that the rural economy has a primary sector, which consists of farming, and mining while the secondary sector includes the following activities, namely manufacturing, processing and construction. The tertiary sector includes transport, trade, finance, rent, and services. Each sector has the ability to help grow the economy. The rural economy is characterized with traditional artisanal skills, petty trading and manual labour. Entry levels are considered low and many of the non-farm activities are highly segmented by socio-economic class, gender, and ethnicity. The lack of economic assets such as capital, skilled labour and information is considered a key constraint towards the growth of the economy. The DFID study shows that rural non-farm income activities have the positive impacts such as the potential to tighten the labour market, complementing other activities by providing employment during agricultural off-seasons, providing part-time and home-based work which fits with women's domestic work and adding value to farm activities by providing opportunities to learn new skills, make new contacts or gain entry to new markets. The study also, shows the negative side of non-farm activities, which include income provided these activities might be considered too low for basic needs and they may have highly differentiated returns with strong sector segmentation producing structural inequality.

SUMMARY

Providing electricity to rural areas can improve the state of their economy. Rural areas are known for predominantly investing in primary activities such as agriculture, fishing, and mining. These areas do not invest in secondary and tertiary activities due to the lack of electricity. Creating a vibrant rural economy by investing in rural and non-rural economic activities leaves room for the improvement of infrastructure. The improvement of infrastructure in rural areas can lead to the enhancement and improvement of livelihood in rural areas. Residents in these areas can have access to proper roads, access to clean water, good quality health and education infrastructure.

CHAPTER 3
RESEARCH METHODOLOGY

INTRODUCTION

Research is a way of thinking which examines critically the various aspects of our everyday professional work, understanding and formulating guiding principles that govern a particular procedure. It questions what we do and has a systematic examination of examination of clinical observations to explain and find answers to what we perceive (Kumar, 2011).

3.1 RESEARCH PHILOSOPHY AND RESEARCH PARADIGMS

According to Saunders, Lewis & Thornhill (2009), a research philosophy focuses on various theories about the way in which one views the world. It is a system of beliefs and values about the advancement of knowledge. Research philosophy can be categorised into four distinct groups, namely positivist, interpretivist, pragmatism, and realism.

Positivist

According to Zukauskas (2018), the positivist research philosophy claims that the social world can be understood in an objective manner. The scientist is considered as an objective analyst and dissociates himself from personal values and works independently.

Interpretivist

The interpretivist research philosophy is known as the opposite of positivist research philosophy. It states that the social world can be understood in a subjective manner. This type of philosophy seeks to understand the ways through which people experience the world. It is based on the principle that a researcher performs a specific role in observing the social world and depends on the researcher's interests (Zukauskas, 2018).

Pragmatism

Zukauskas (2018) describes pragmatism as a research philosophy that deals with facts. This type of philosophy claims that the choice of research philosophy is determined by the research problem and therefore practical results are considered important.

Realism

The realism research philosophy is a research philosophy that is based on the principles of positivist and interpretivist research philosophies. This type of philosophy is based on assumptions that are necessary for the perception of the subjective nature of the human (Zukauskas, 2018).

Researcher's stance

According to the above-stated research philosophies, this study adopted an interpretivism research philosophy. Interpretivism is a philosophy that seeks to understand people's experiences through their own perspectives. It involves the idea of studying the subjective meanings that people attach to their experiences rather than stating facts (Saunders *et al.*, 2009:115). This study focused on three different municipalities to determine whether people in different geographical rural areas were experiencing similar problems regarding rural electrification. This meant that not everything about the population group and their surroundings would be same. Each municipality was treated in its own different context and the main objective of the research was to understand the different challenges faced by the population located in these various geographical locations. Interpretivism therefore became the best philosophical choice for this research as the context was more subjective, thereby creating less room for generalisation. The different social, cultural, economic and personal dynamics affecting each population group were also analysed, observed and understood.

Research paradigm

According to Zukauskas *et al.* (2018), a research paradigm assists with defining a scientific research philosophy. The paradigm can be characterized as a wide structure encompassing perceptions, beliefs, and awareness of different theories and practises that are used to carry out scientific research. Research paradigms are categorised into three distinct groups, namely epistemology, ontology and axiology.

Epistemology

The relationship between the researcher and the reality or how this reality is captured and known can be defined as epistemological philosophy. Epistemology is also defined as the claim on what knowledge is valid in research and therefore what can be considered acceptable sources of evidence and end results of knowledge (Don-Solomon, 2018). This type of philosophy deals with the classification of the different forms of knowledge: this means that epistemological assumptions are solely concerned with how knowledge can be developed, taught, and transferred. Zukauskas (2018) argues that epistemology is an excellent way to explore the real-world nature. Furthermore, the researcher is more interested in the examination of what separates a reasonable assurance from an opinion.

Ontology

The ontological paradigm is considered as the science of being and deals with the nature of reality. Its belief system is structured around the ideology of whether a social entity needs to be perceived as objective or subjective (Don-Solomon, 2018). Based on the above-stated definition, it can be deduced that an ontological philosophy deals with two main categorises, namely objectivism and subjectivism. Objectivism is also known as positivism and is an aspect of ontology that deals with

research from an objective perspective. Subjectivism is also known as interpretivism and is an aspect of ontology that deals with research from a subjective perspective.

Axiology

The axiological research paradigm deals with the philosophy that studies are based on the researcher's values. This paradigm argues that a human's value system is the guiding reason for all human action and that researchers demonstrate axiological skills by being able to articulate their values as a basis for making judgements about what research they are going to conduct and how they are going conduct it (Saunders *et al.*, 2009).

Table 3.1: Comparison of four research philosophies in management research

	Positivism	Realism	Interpretivism	Pragmatism
Ontology: *the researcher's view of the nature of reality or being.*	External, objective, and independent of social actors	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple	External, multiple, view chosen to best enable answering of research question
Epistemology: *the researcher's view regarding what constitutes acceptable knowledge*	Only observable phenomena can provide credible data, facts, focus on causality and law like generalisations, reducing phenomena to simplest elements.	Observable phenomena provide credible data, facts, insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or contexts.	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions.	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data.
Axiology: *the researcher's view of the role of values in research*	Research is undertaken in a value-free way, the researcher is independent of the data and maintains an objective stance.	Research is value laden; the researcher is biased by world views, cultural experiences, and upbringing. These will impact on the research.	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective	Values play a large role interpreting result, the researcher adopting both objective and subjective points of view.
Data collection techniques	Highly structured, large samples,	Methods chosen must fit the	Small samples, in-depth	Mixed or multiple method designs,

most often used.	measurement, quantitative, but can use qualitative	subject matter, quantitative or qualitative	investigations, qualitative	quantitative and qualitative.

(Saunders et al., 2009)

Researcher's stance

Based on the above-stated research paradigms, this study adopted an ontological research paradigm. This type of paradigm deals with the nature of reality and can be categorised from an objective perspective or subjective perspective. The study was complex in the sense that it is there is minimal information available regarding the areas that were being researched, and this can make it difficult to understand the nature of the realities faced by the population group. Adopting this research paradigm means being exposed to the realities of the population group. Based on each finding, it meant the study would adopt a subjective perspective.

3.2. RESEARCH APPROACH

3.2.1 Deductive approach

According to Saunders *et al.* (2009), the deductive research approach focuses on testing a theory that has already been developed or formulated. The approach explains a correlation between two variables and makes use of a structured methodology in order to facilitate replication. In a deductive approach, researchers need to be independent from the study being observed and the concept must be used in a manner that enables facts to be measured quantitatively. The sequential steps for this type of approach include deducting a hypothesis from theory. Once the hypothesis is derived, it is expressed in operational terms which proposes a relationship between two specific concepts or variables. Testing of the operation hypothesis occurs and the final steps include examining the specific outcome of the inquiry and modifying theory in the light of the findings (Saunders *et al.*, 2009).

3.2.2. Inductive approach

Saunders *et al.* (2009) describes the inductive approach as an approach that focuses on formulating a theory. It is used when a researcher wants to have a better understanding of the nature of the problem. The inductive approach is likely to have small sample size because it focuses on the context in which events take place. When using an inductive research approach, the main objective of the researcher is to make sense of the interview data that has been collected by analysing the data and the results acquired from the data analysis will then the formulate a theory.

The difference between the deductive and inductive approach to research is shown in Table 3.2:

Table 3.2: Difference between the deductive and inductive research approach

Deductive Research Approach	Inductive Research Approach
Scientific principles	Gaining an understanding of the meanings humans attach to events
Develops from a concept to facts and statistics	Develop an insight of the research framework
Describes the casual relationships between variables	Collects qualitative data
Collects quantitative data	Has a flexible structure to allow for any advancements on the subject matter as the research progresses
Applies principles to ensure validity of data	Researcher is part of the research process
Highly structured approach	Less concern with the need to generalise
Selects samples of sufficient size to generalise conclusions	
Researcher is independent from what is being researched	

(Saunders et al., 2009)

Researcher's stance

Based on the above stated research approaches, the study has chosen to adopt an inductive research approach. The objective of the study was to probe and find a deeper insight regarding the subject matter. As Saunders *et al.* (2009) states, the purpose of an inductive research approach is to put more emphasis on the context in which events occurs, which assists researchers to better understanding the nature of the research problem. The developmental challenges faced by residents in rural areas is common knowledge however there is minimal information as to what causes these challenges. The study sought to evaluate whether the challenges faced by residents in rural areas were causes by similar or different factors hence the inductive research approach was best suited for the study.

3.3 RESEARCH STRATEGIES

Saunders *et al.* (2009) defines a research strategy as a general plan of how the researcher goes about answering the research questions. The various research strategies include the following:

1. **Experiment**

   An experimental research strategy determines whether a specific treatment influences an outcome. The researcher conducts an evaluation by providing the exact treatment to one

group and withholding it from another and then determining how both groups have scored on an outcome. The two main types of experiments include true experiments and quasi-experiments (Creswell,2013).

2. Survey

The aim of this survey research strategy is to provide a numeric description of trends, attitudes or opinions of the population by studying a sample group of that specific population. Surveys can be included in cross-sectional or longitudinal studies by using a questionnaire or a structured interview for data collection (Creswell, 2013).

3. Case study

According to Saunders *et al.* (2009), a case study is a strategy for doing research that involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence. A case study is most suitable if a researcher wants to gain a deeper understanding of the context of the research and the processes being enacted.

4. Action research

This method focuses on solving an immediate problem or working with others to solve a particular problem or issue (USC, 2019).

5. Grounded theory

The ground theory research strategy focuses on developing theory based on data that is systematically collected and analysed. It deals with specific information and subsequently derives theories and reasons for the phenomenon being studied (USC, 2019).

6. Ethnography

Ethnography focuses on human interaction within communities by means of direct participation and observation within the community under study (USC, 2019).

7. Archival research

An archival research strategy makes uses of administrative records and documents as the principal sources of data. Since this type of strategy makes use of information that has already been recorded and archived, it cannot be considered as secondary data analysis. When previously collected data are used as part of an archival research, they are analysed as part of the day-to-day activities and are considered to be part of the reality of the study being studied (Saunders *et al.*, 2009).

Researcher's stance

The study has adopted grounded theory as its research strategy. The reason for this choice of research strategy is that grounded theory seeks to develop a theory rather than testing it. This type of strategy depends on inductive approaches which are appropriate for the theory development. Grounded theory focuses on conceptual and critical thinking. the main purpose of this theory is the idea of constant comparison. The researcher continues with a process of constant comparison until theoretical saturation is reached and no new concepts emerged (Khan, 2014). This study uses data to come up with theories based on the topic, leaving room for the development of more theories.

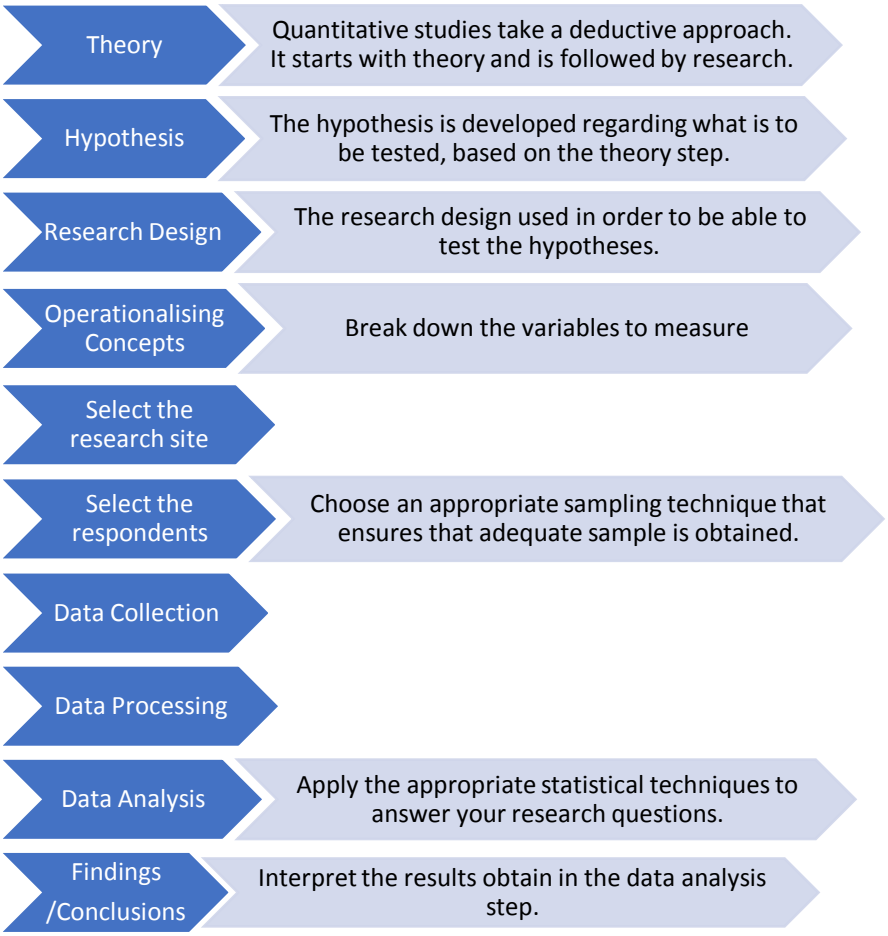
3.4. RESEARCH METHODOLOGY

Goundar (2012) explains research methodology as a science of studying how research is done scientifically. This involves the different steps that are usually adopted by researchers in studying a research problem and the logic behind it. Research involves three main types of methodologies, namely quantitative research methodology, qualitative research methodology and a mixed-method research methodology.

Quantitative research

A quantitative research method is an approach which tests theories by examining the relationship among variables. These variables can be measured so that the numerical data can be analysed using statistical procedures (Creswell, 2013). A quantitative research method consists of experimental and non-experimental designs.

According to Unit for Statistical Consultation (2019), the quantitative method process involves a deductive approach which starts with the theory and then followed by the research.



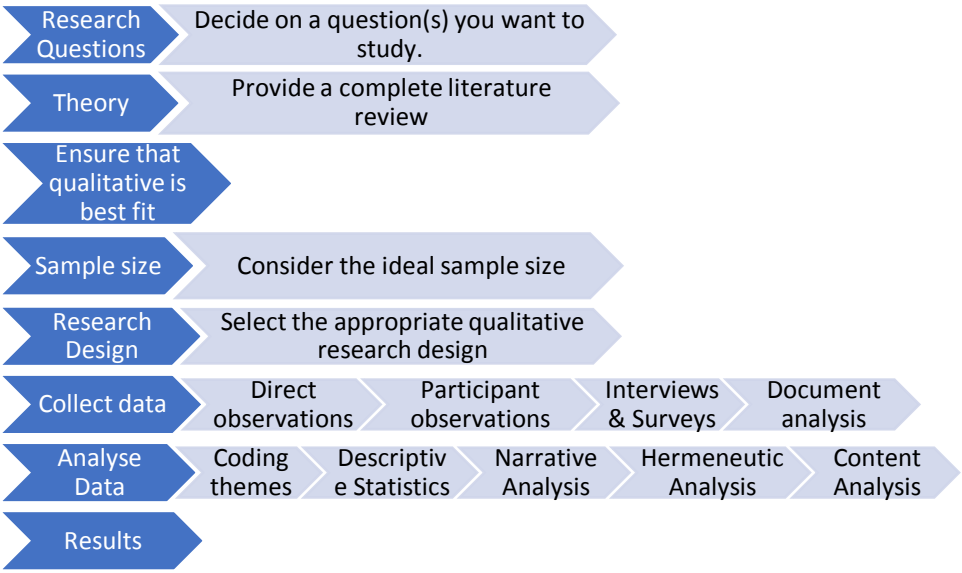
(USC,2019:13)

Figure 3.1: Quantitative method process

Qualitative research

The qualitative research method focuses on exploring and understanding the meaning individuals or groups ascribe to a social or human problem. This method involves asking questions and applying procedures that focus on the participants' settings (Creswell, 2013). This methodology consists of narrative research, phenomenology, grounded theory, ethnographies and case studies.

A qualitative research method process involves the following steps:



(USC,2019:14)

Figure 3.2: Qualitative method process

Mixed-method research

Tashakkori and Creswell (2007) define mixed methods research as research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative methods in a single study. The various types of mixed-method research studies include the following:

- Convergent design

Creswell (2012) states that a convergent research design occurs when a researcher intends to bring together the results of the quantitative and qualitative data analysis so that they can be combined or compared with one another. The principle of this design is to compare the two results with an intention of obtaining a more complete understanding of the problem, to validate one set of findings with the other one or to determine whether participants will respond in the same manner if the quantitative predetermines scales and if open-ended qualitative questions are asked.

The convergent design has the following four common variants that are found in the literature:

- Parallel-database variant

The parallel-database variant is the most common approach in which two parallel strands of data are collected and analysed independently and are brought together during the interpretation stage.

- Data-transformation variant

The data-transformation variant occurs when researchers implement the convergent design using an unequal priority. This entails putting greater emphasis on the quantitative strand and using a merging process of data transformation.

- Questionnaire variant

The questionnaire variant is used when the researcher includes both open-ended and closed-ended questions on a questionnaire and the results from the open-ended questions are used to confirm or validate the results from the closed-ended questions.

- Fully integrated variant

The fully integrated variant occurs when the quantitative and qualitative strands of the study interact with each other during the implementation instead of the researcher keeping them separate and independent.

- Explanatory sequential design

Explanatory sequential designs occur in two distinct interactive phases. The design starts with the collection and analysis of quantitative data. This phase is then followed by the collection and analysis of qualitative data in order to explain or expand on the first phase of the quantitative study (Creswell, 2012).

- Exploratory sequential

The exploratory sequential design begins with the collecting and analysis of qualitative data. Based on the exploratory results, the researcher conducts a development phase by designing a quantitative feature based on the qualitative result. The purpose of the quantitative feature may be to generate new variables, design an instrument, or develop activities for an intervention. Once the researcher has developed a quantitative feature, the findings from the quantitative approach need to be tested and interpreted (Creswell, 2021).

Researcher stance

This study has chosen to adopt a mixed-method research methodology. The reason for using this type of methodology is to identify the quantitative aspect of the study and then understand the meaning behind those numbers. This would make it easy to create theories and distinguish the findings according to the different factors affecting the causes. Since there is minimal research done in these areas and with this subject matter, collecting quantitative data only was not going to provide a complete understanding of the figures. The researcher therefore had to go on and investigate what caused these numbers and what these figures meant.

3.5 RESEARCH TECHNIQUES AND PROCEDURES DATA

Area of Study

The study was conducted in the Eastern Cape Province. The province has six district municipalities, and the data was collected from three district municipalities These three district municipalities are very distinct from each other. The differences are also used to distinguish the various factors that affect rural areas.

- Sarah Baartman District Municipality

  The SBDM is the biggest district in the Eastern Cape Province. The municipality is classified as a Category C municipality and comprises seven local municipalities.

- Nelson Mandela Bay Metropolitan Municipality

  The NMBMM is one of two metropolitan municipalities in the Eastern Cape Province. It is situated in Port Elizabeth (Gqeberha) and is classified as a Category A municipality. This type of municipality governs large densely urbanised regions that encompass multiple centres with close economic linkages.

- O.R. Tambo District Municipality

  The ORTDM covers 80% of what used to be marginalised homelands in the Transkei region. It is formed of five local municipalities and is classified as a Category C municipality.

Population

The target population for this study is the business owners in the rural areas of the Eastern Cape. The study targeted all the six district municipalities of the province and a sample of 10 participants was set to be interviewed from each district municipality.

Sampling

Sampling is the process of selecting a few participants (a sample) from a bigger group (the sampling population) to become the basis for estimating or predicting the prevalence of an unknown piece of information, situation or outcome regarding the bigger group (Kumar, 2011). Sampling is used to generalize from the sample to the population depending on the sampling technique that is being used. There are two general sampling techniques that are used, namely probability sampling and non-probability sampling techniques. Probability sampling means that every item or person in the population has an equal chance of being chosen within the sample. This type of sampling techniques allows for inferences to be made about the greater population. Non-probability sampling occurs when the research is focused on case studies or qualitative research. Non-probability sampling usually

accommodates small samples and intends to examine a real-life situation but not make statistical inferences to the larger population (USC, 2019:30).

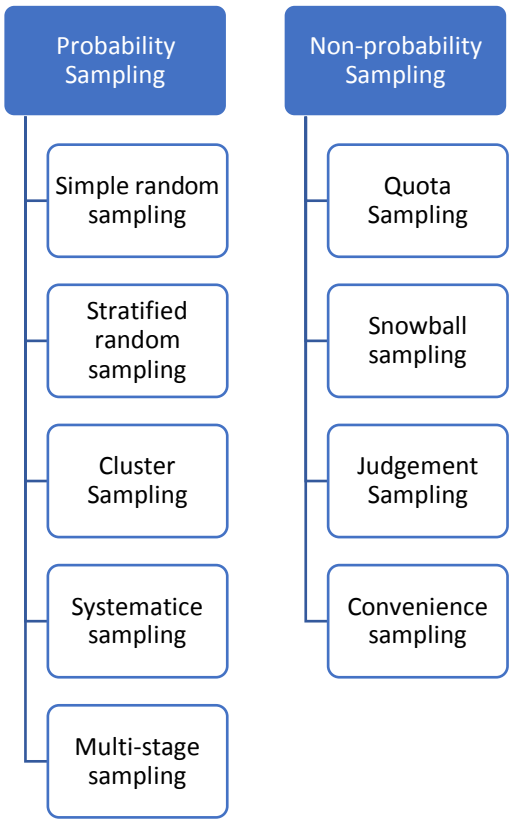


Figure 3.3: Sampling Techniques

Probability sampling

Simple random sampling

The simple random sampling technique assigns a number to each member of the population and then uses a random generator to select participants for the sample group.

Stratified random sampling

This technique identifies homogeneous sections in the population and takes a random sample from those identified sections.

Cluster sampling

A random sample is taken from all sections in a population and then a simple random selection is chosen from each of the selected sections.

Systematic sampling

The systematic sampling technique selects every n^{th} member of a population.

Multi-stage sampling

Multistage sampling uses a combination of all the above methods.

Non-probability sampling

Quota sampling

For this sampling technique, only members of a specific group which satisfies certain requirements are chosen for the sample.

Snowball sampling

In the snowballing method, the first member in the sample is asked to identify the next member.

Judgement sampling

Members of a population are selected on the basis of some specialised knowledge or experience they have.

Convenience sampling

For convenience sampling, the data collection is based on the availability of members in the population group.

Researcher's stance

For this study, non-probability sampling was used and the type of non-probability sampling method that will be used was quota sampling. The quota sampling only samples the members of a specific group which satisfies certain requirements chosen for the sample group.

Primary data

The primary data were obtained through an interviewer-administered questionnaire. The questionnaire consisted of open-ended and close-ended questions. The analysis from the open-ended questions allowed an in-depth analysis to provide better understanding on the subject matter.

Secondary data

The secondary data of the study were obtained from literature sources such as books, peer-reviewed journal article and conference papers.

Research instrument design

The questionnaire had four sections. Section A was the demographic section. This section was used to allocate the participants' research number, gender and current work role.

The second section, Section B, was used to determine the skills possessed by the participants in the respective areas and what kind of businesses were being conducted in these areas.

Section C dealt with the availability of resources. The section mostly dealt with electricity and infrastructure.

The last section, Section D, covered information relating to renewable energy knowledge.

Research instrument administration

Part 1 of the instrument administration was obtaining ethical clearance from the university. The process for obtaining approval from the ethics committed took longer than expected. However once approval was granted, the second phase of the data collection commenced.

Phase 2 of the data collection consisted of getting permission from the gatekeeper, which in this case was the Department of Rural Development and Land Reform (DALRRD). Permission was needed from the department because most of the participants reside on state-owned land.

Once permission had been granted by the department, a briefing session was held to inform the participants about the study as well as the risks involved in participating in the study and how the community can benefit from the study.

After 14 days, the researcher then went back to obtain consent from the participants and conduct the interviews.

Before the interviews commenced, the researcher had to read out all the instructions and information to the participants. After that had been done, verbal and written consent was obtained from the particapants. Once the participants had agreed to participate in the study both verbally and in paper, the interviews could proceed.

3.6. DATA ANALYSIS

According to Creswell (2018), data analysis in mixed-methods research consists of analysing separately the quantitative data using quantitative methods and the qualitative data using the qualitative methods. It can also include combing both databases and using approaches that mix the qualitative and quantitative data and results, which is known as mixed-methods analysis Procedure for analysing the quantitative and qualitative data includes the following:

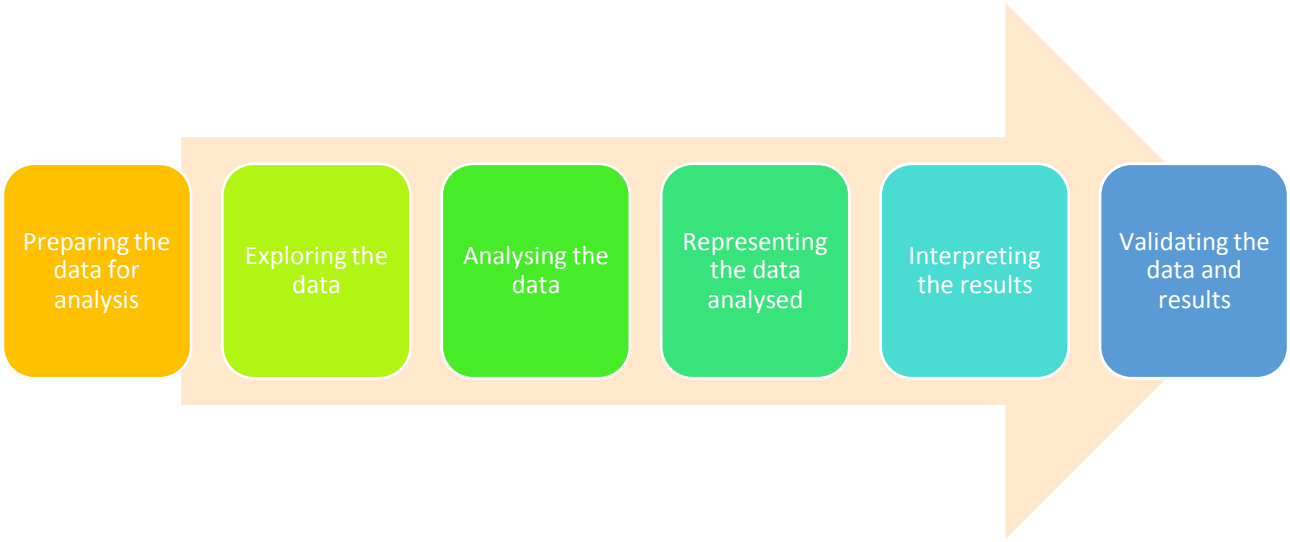


Figure 3.2 Procedure for analysing quantitative and qualitative data

The mixed-method interpretation involves looking across the quantitative and qualitative findings and assessing how the information addresses the mixed-methods question in the research study. This process is known as drawing inferences. Inferences are conclusions or interpretations drawn from the separate quantitative and qualitative strands of the study and meta-inference are drawn from across the quantitative and qualitative strands.

Quantitative data analysis

The quantitative research method deals with the testing of variables. The different types of variables include the following:

Interval/Ratio variables

For the ratio variable, the distances between the categories are identical across the range. The variables can be interpreted by using a mode, median and standard deviations for descriptive statistics (Matthews, 2017).

Ordinal variables

For an ordinal variable, categories are ranked in order but the distances between the categories are not equal across the range. The variables can be analysed using percentages and a median and quartiles for descriptive statistics (Matthews, 2017).

Nominal variables

Nominal variables have categories that cannot be ranked in order. The categories of nominal measurements are mutually exclusive and can analysed by using counts, percentages, and modes for descriptive statistics (Matthews, 2017).

Frequency tables

A frequency table provides the number of people and the percentage belonging to each of the categories for the variable in question. They can be used in relation to all the different types of variables.

Diagrams

Diagrams are used to display quantitative data and their main purpose is to provide easy interpretation and understanding of the data. For nominal and ordinal data, a bar graph and pie chart are the easiest methods to use while for an interval data set, the use of a histogram would be more appropriate.

Descriptive Statistics

Descriptive statistics is another method used to interpret and analyse quantitative data. It has the following two components:

(i) Measures of central tendency

The measures of central tendency include

Arithmetic mean – This is considered as an average. For this calculation, we add all the values in the distribution and then divide by the number of values.

Median- This is known as the mid-point in a distribution of values. To derive the median, all the values in a distribution must be arranged from the smallest to the largest and then find the middle point.

Mode – The mode is considered as the value that occurs most frequently in a distribution (Bryman & Bell, 2011).

(ii) Measures of dispersion

The measures of dispersion include the following:

Range – This is known as the difference between the maximum and the minimum value in a distribution of values associated with an interval variable.

Standard deviation – This is known as the average amount of variation around the mean. (Bryman & Bell, 2011)

Qualitative data analysis

The qualitative research method is very subjective in nature. The researcher becomes intimately involved in the research process and must seek relationships between various themes that have been identified.

The analysis of qualitative data usually goes through some or all of the following stages:

- Familiarisation with data through review, reading, and listening.
- Transcription of tape-recorded material.
- Organisation and indexing of data for easy retrieval and identification.
- Anonymising of sensitive data.
- Coding.
- Identification of themes.
- Re-coding.
- Development of provisional categories.
- Exploration of relationships between categories.
- Refinement of themes and categories.
- Development of theory and incorporation of pre-existing knowledge.
- Testing of theory against the data; and
- Report writing (Lacey and Luff, 2009)

Mixed-methods data analysis

Data analysis in mixed-method research consists of analysing the quantitative data using quantitative methods and the qualitative data using qualitative methods. It can also combine both databases using approaches that mix or integrate the quantitative and qualitative data and results. Data analysis can occur at a single point in the process of mixed methods research or at multiple points. As soon as the data analysis is complete, the researcher should do a mixed-method

interpretation which involves looking across the qualitative and quantitative results and assessing how the information addresses the mixed methods. The interpretations of mixed-methods research data are called drawing inferences and meta-inferences (Creswell, 2018). Inferences are conclusions or interpretations drawn from the separate quantitative and qualitative strands of a research study and meta- inferences are conclusions or interpretations drawn from across the qualitative and quantitative strands of a research study.

Researcher's stance

The study used a mixed-method data analysis; both quantitative and qualitative data analysis methods were used, and conclusions were drawn from across the two datasets. The study therefore used meta-inferences to interpret the data. For the closed-ended questions, the study used percentages, counts and some of the descriptive statistics such as the median and the mode. For the qualitative data, the study used themes and both analyses were used to reach a conclusion relating to the research questions.

SUMMARY

The study adopted a mixed-method methodology, which used a questionnaire variant. The use of the questionnaire consisted of open-ended and close-ended questions. The answers from the open-ended questions were used to validate the results from the closed-ended questions. The research philosophy that was used for this study was the interpretivism. The study also used a ontology research paradigm. The approach was inductive due to the nature of the area of study, not much research has been done in rural areas therefore the researcher wanted to get a better understanding of the nature of the problem and therefore used an approach that focuses on formulating a theory. The research study used grounded theory as research strategy and quota sampling was used as the sampling technique.

CHAPTER 4
RESULTS

INTRODUCTION

Figure 4.1 is a graphical representation of the six district municipalities and two metropolitan municipalities in the Eastern Cape province. The three municipalities interviewed for the study are listed below. The research was initially set to interview all six district municipalities; however, owing to time constraints and travel limitations due to the Covid-19 pandemic, the population group was reduced to four municipalities. Out of the four municipalities, only three municipalities were interviewed. The representative from the fourth municipality was unable to assist with the research at the set time. The data presented from this study is from the Sarah Baartman (SBDM), O.R. Tambo (ORTDM) and Nelson Mandela Bay (NMBMM).

Figure 4.1: District municipalities in the Eastern Cape

- Sarah Baartman District (SBDM)
- Nelson Mandela Bay Metropolitan Municipality (NMBMM)
- O.R. Tambo District (ORTMD)

4.1 RESPONSES

The study aimed at interviewing 10 participants per district municipality. Not all municipalities met the target owing to the ethical consent period. The data collection process was conducted according to following procedure:

- The researcher approached the DALRRD regarding rural areas with the relevant participants.
- Upon approaching the Department, it was found that the SBDM District and NMBMM were set up differently than the ORTDM. The participants in the SBDM and the NMBMM reside on farms which are state owned and therefore the gatekeepers had to be issued with letter requesting permission from the Department.
- Once permission had been granted, the Department selected participants and ethical consent had to be requested before the actual data collection could commence.
- Consent was requested from the participant two weeks before the actual data was collected.

Some of the participants who had agreed to partake in the study changed their minds at the time of the data collection. This caused the number of participants to differ in each municipality. The SBDM had 12 participants who agreed to partake in the study and signed the consent form. For the NMBMM, there were five participants who initially agreed to participate and then two participants dropped out on the day of the interview, leaving the district with three participants. The ORTDM had 10 participants who initially agreed and on the day of the interviews, two of the participants were unavailable on the day of the interview. The ORTDM ended up with interviews from seven participants.

The quantitative data recorded from all 20 participants has been represented below and is further analysed in Chapter 5.

The interviews consisted of participants from various local municipalities within the DM, namely

Sarah Baartman - Sundays River Valley, Blue Crane Route, Dr Beyers Naude, Makana Local Municipality

Nelson Mandela Bay- Gqeberha, Kariega

OR Tambo - King Sabata Dalindyebo, Mhlontlo and Nyandeni Local Municipality

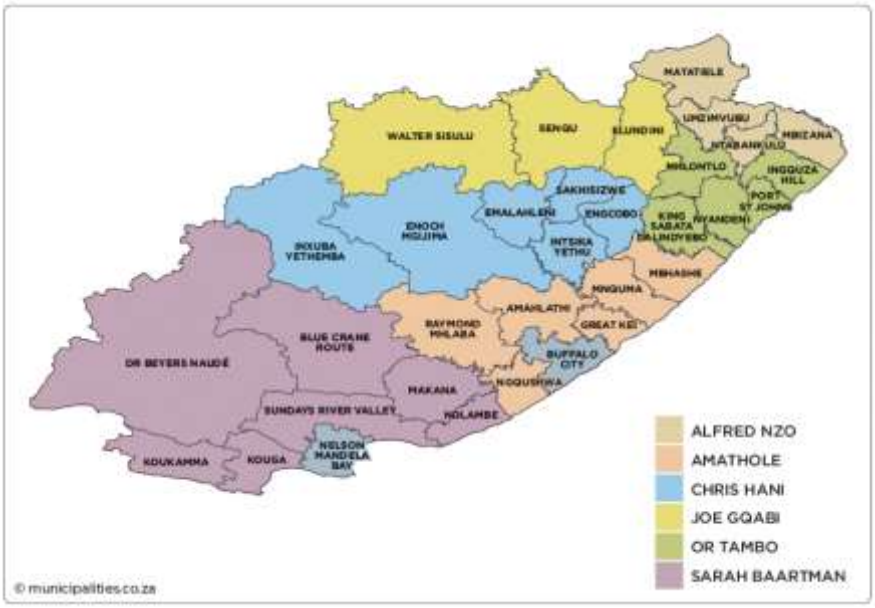


Figure 4.2: Local municipalities in the Eastern Cape

4.2 DEMOGRAPHIC PROFILES OF THE RESPONDENTS

The questionnaire was divided in four sections. Section A covered the demographic data of the participants. The information was represented in graphs and percentages. The participants' identities were anonymous, and each participant was allocated a random number for identity purposes. Section A was divided into the following categories:

- Participant number
- Gender
- Current work role
- District municipality

In NMBMM,100% participants that agreed to take part in the study were females. Other participants that had initially agreed to be part of the study fell under the male category. They asked to be withdrawn from the study on the day of the interviews. The data collected in the SBDM showed that 50% of the participants represented males and the other 50% were females. The third and final district was the ORTDM which was represented by 60% of the participants who were females and 40% of the participants who were males

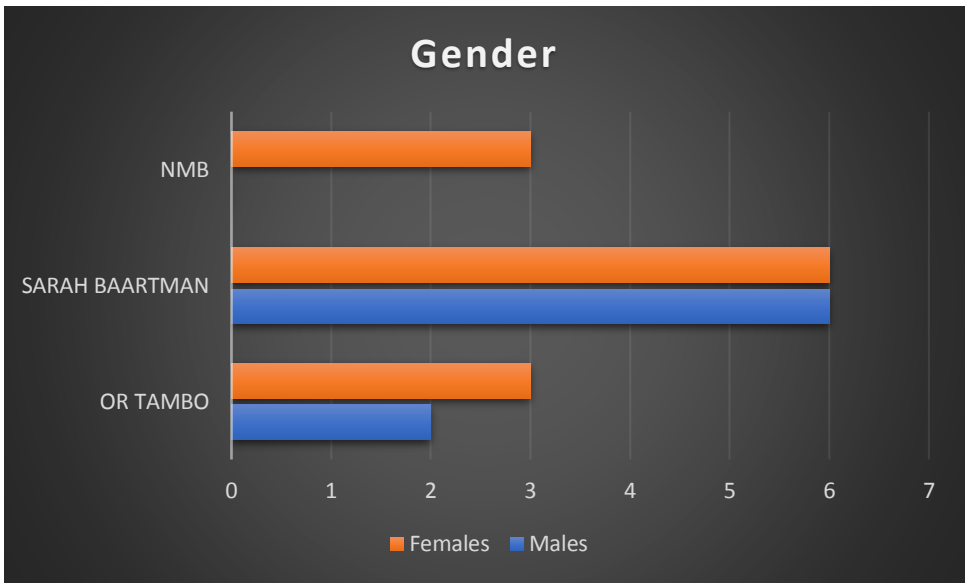


Figure 4.3: Participants' gender within the different district municipalities

As part of the study, the study sought to determine the current work roles of the participants. This was asked in order to determine whether the participants are currently employed or self-employed. Most of the participants indicated that they are self-employed. A total of 83% of the participants indicated that they are farmers and have no other job besides the farming business they are current involved in. Another 9% identified themselves as entrepreneurs. Their businesses varied from the listed types of businesses in the questionnaires. The remaining 8% indicated that they were employed as managers, either on a farm or with a service business that operates within the district municipality.

The data shows that 100% of the participants interviewed in the NMB metro currently work as farmers. These participants are self-employed and are not fully commercialised farmers.

In the ORTDM, 40% of the participants indicated that they are currently working as farmers and the other 40% identified themselves as entrepreneurs. These participants indicated that they do not focus on one industry of work.

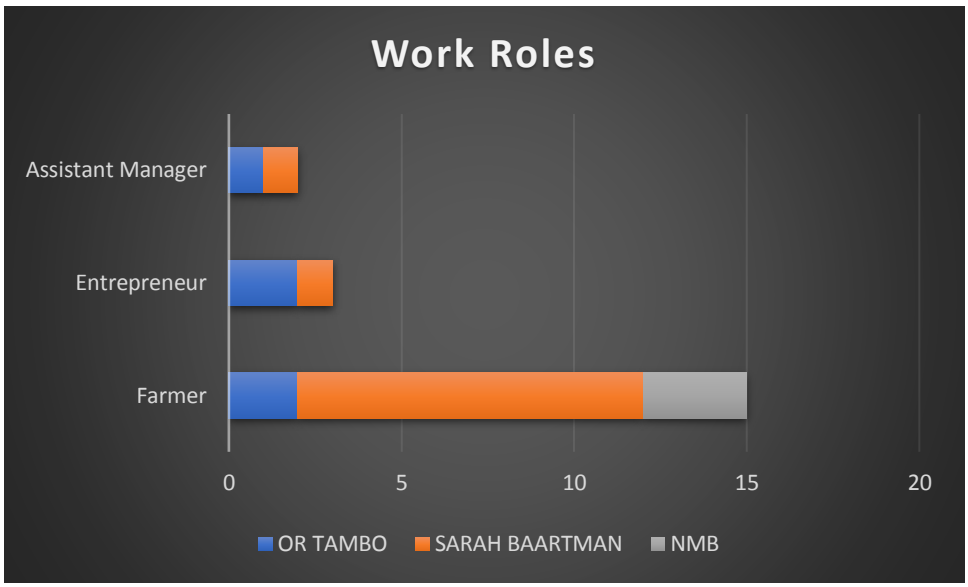


Figure 4.4: Participants' work roles within the different district municipalities

The study aimed at interviewing 10 participants per district municipality. From the three district municipalities, the target was 30 participants while the study only managed to interview 20 participants which is 67% of the targeted participants. The SBDM had the highest number of participants as 60% of the participants were from this district. The second highest represented district municipality was the ORTDM, with 25% of the participants. The NMBMM accounted for 15% of the participants that took part in the study.

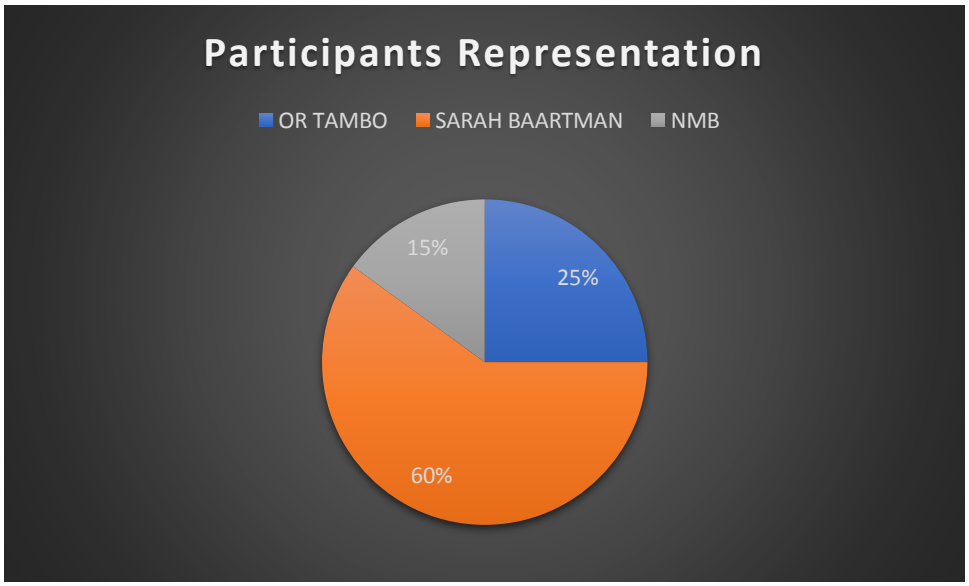


Figure 4.5: Participants' representation within the Eastern Cape

4.3 QUANTITATIVE RESULTS PER DISTRICT MUNUCIPALITY

SARAH BAARTMAN DISTRICT

From the SBDM, 12 participants were interviewed. The participants were from four local municipalities, namely Sundays River Valley Municipality, Blue Crane Route Local Municipality, Dr Beyers Naude Local Municipality and Makana Local Municipality.

The research also evaluated the types of skills people possess in this district. Figure 4.6 shows that majority of the respondents are involved in farming. Being an electrician or a mechanic ranked second highest on the listed skills. In third ranking was the Other category. The participants were asked to specify the type of skill possessed in the community if it was not listed during the interview. The participants in the SBDM stated the following skills:

- Brick laying
- Sewing
- Catering
- Dressmaking
- Plumbing
- Driving and
- Firefighting

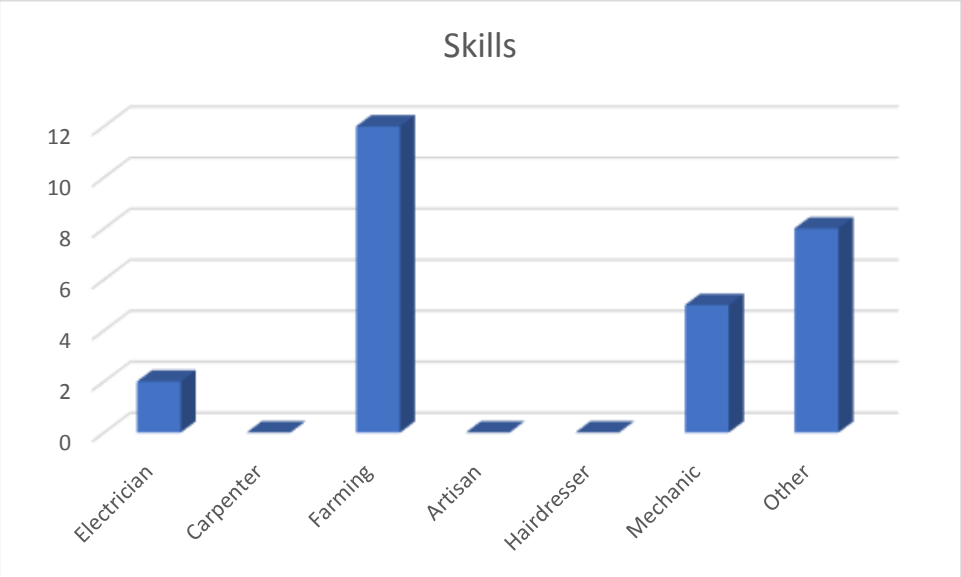


Figure 4.6: Participants'; skills in the SBDM

The study further investigated whether the current business that are owned by the participants are profitable. Figure 4.7 shows that a total of 58% of the participants indicated that their businesses are profitable and the other 42% indicated that their businesses were not doing very well. Despite 58% of the participants indicating that their businesses are profitable, they do not consider their businesses to be growing. Since the study used a mixed-method methodology, participants were asked to explain why their profitable businesses were not growing. The participants stated the following reasons:

- There is not enough money to balance between the business and their personal use. Because most of the participants are not formally employed, they have to use their business profits for household emergencies.
- The majority of their clients buy their products on credit and do not repay the money on time. When their clients decide to pay, the money is no longer used for its intended purpose.
- Business value is another major issue for these businesses. The returns that participants get from their businesses are too low and therefore do not create room for business expansion.

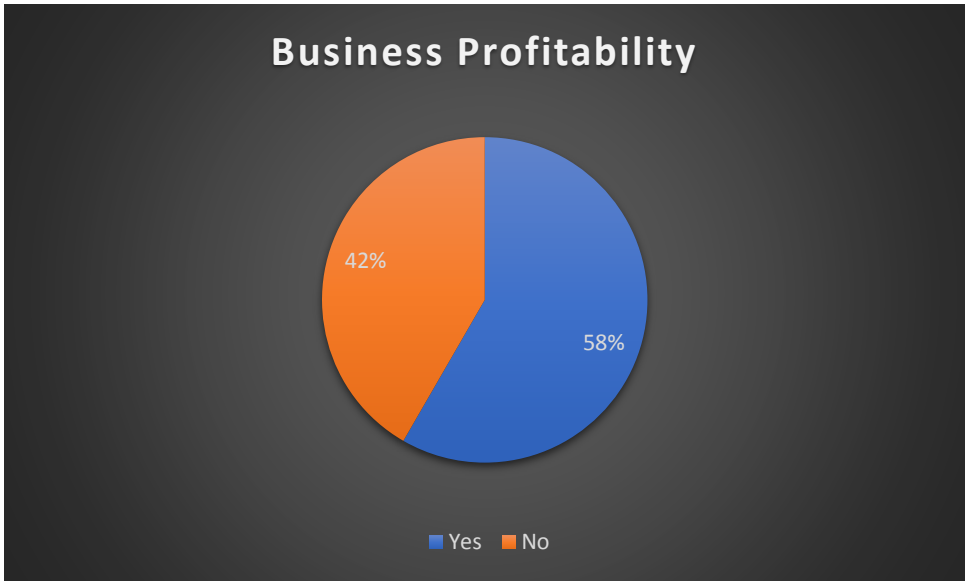


Figure 4.7: Business profitability in the SBDM

The study further investigated the daily operating challenges that are faced by the businesses in the rural areas of the SBDM. Each participant could choose more than one challenge they are faced with in their business. As shown on figure 4.8, electricity and finances were the highest ranked challenges at 23%. Water was determined as the second biggest challenge in the district municipality at 20% and the third biggest challenge the participants identified was issues relating to infrastructure. The least rated challenge in the SBDM was customers. All the participants in this district municipality

indicated that they did not have a challenge with their customer base even though they did not have a proper marketplace to sell their products. However, that had no correlation with the customer base.

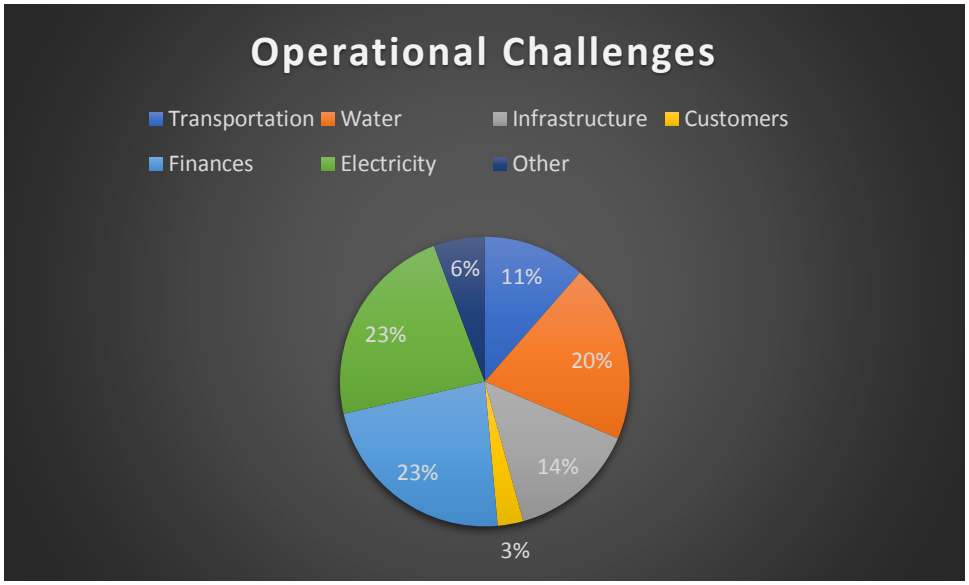


Figure 4.8: Business operational challenges in the SBDM

Even though majority of the participants complain about electricity being one of the major business operating challenges, figure 4.9 shows that 67% of the participants indicated that they had access to electricity. The other 33% indicated they had no access to electricity. When questioned why most of the participants who had electricity complained about electricity being a major daily operational challenge, they indicated that the effect of having electricity in the rural areas of SBDM is the same as not having electricity. The electricity problems experienced by the participant's businesses included the following:

Electricity cost

The participants stated that the cost of electricity was too high. Most of the money that is made from sales goes towards the Eskom electricity bill. Majority of the participants who complained about the high electricity bill were farmers. The amount of electricity needed to pump water for livestock was extensive.

Electricity stability

As shown in figure 4.9, two thirds of the participants indicated that they had access to electricity and besides it being expensive- it was also not unstable. The participants indicated that they experienced load shedding and that some days they would not have electricity without any reason.

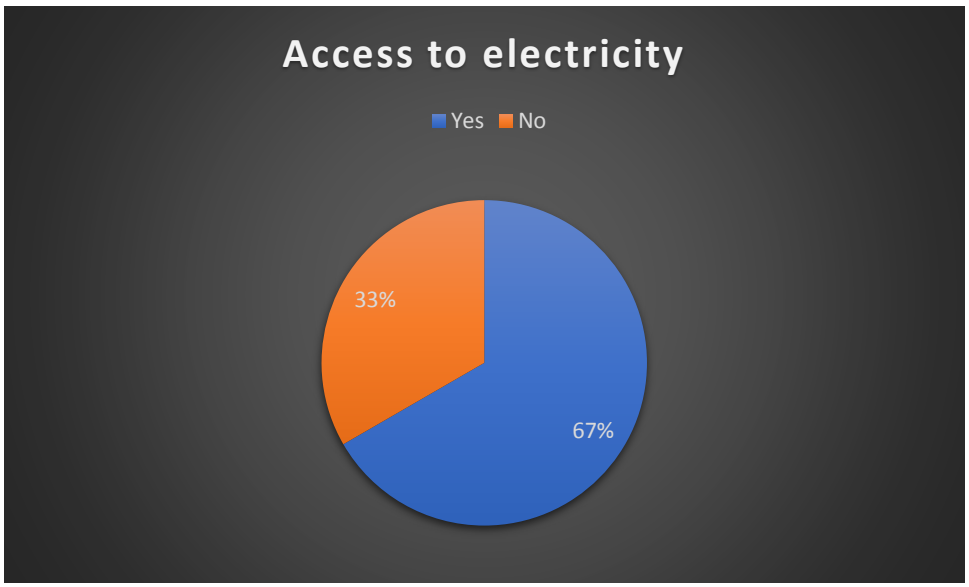


Figure 4.9: Participants' access to electricity in the SBDM

Infrastructure was ranked as one of the top three daily operating challenges facing the businesses in rural areas of the SBDM. Only 17% of the participants stated that their infrastructure was in a good condition for business. A total of 33% indicated that they had poor infrastructure for their business while 50% indicated that their infrastructure was in an average condition and needed major renovations. The participants were requested to explain how the condition of the infrastructure was affecting the business. The reasons provided by the participants included in the following:

- Minimal mass production
    - For crop farming - storage and packaging
    - For clothing – They cannot reach potential maximum production capacity owing to having only a few staff members.
- High mortality rate of stock (especially for poultry and piggery)
- Poor water and civil infrastructure (Ineffective water irrigation systems)
    - Poor road conditions
    - No water for crops and animals

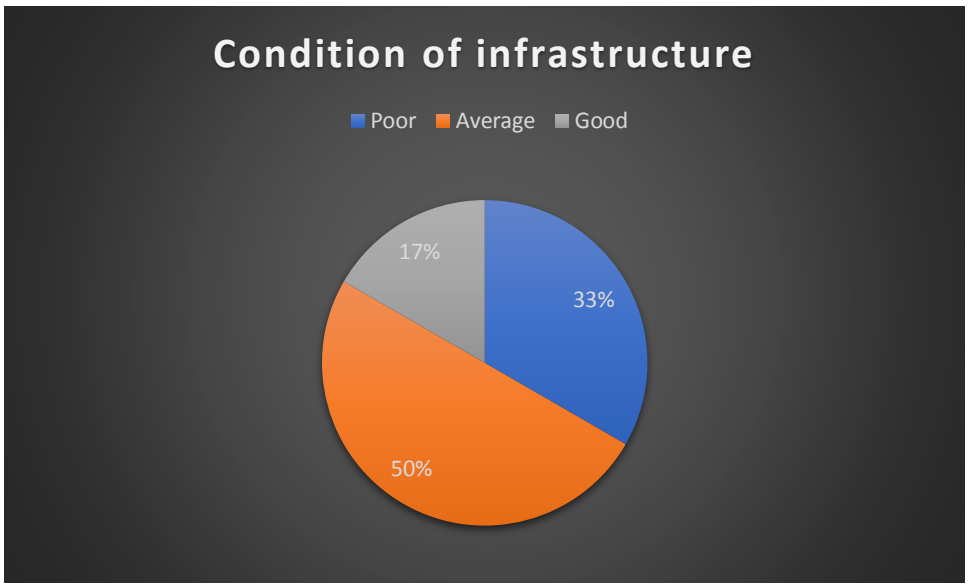


Figure 4.10: Condition of participants' infrastructure in the SBDM

From the findings, it was evident that most of the interviewed participants in the SBDM had access to electricity; however, they were no different from the percentage of participants who had no electricity. The study therefore investigated whether they were aware of the concept of renewable energy. With electricity being at the top of their challenges, the study wanted to investigate whether the population was aware of an alternative energy source which could alleviate their electricity problem. A total of 50% of the participants indicated that they had very limited knowledge about renewable energy. Another 42% indicated that they had average knowledge about the concept. This group was relatively aware of what is meant by renewable energy and had an idea of some of the renewable energy sources. However, they indicated that they have no knowledge of the renewable energy technologies and how they operate. Only 8% indicated that they were well informed about the concept.

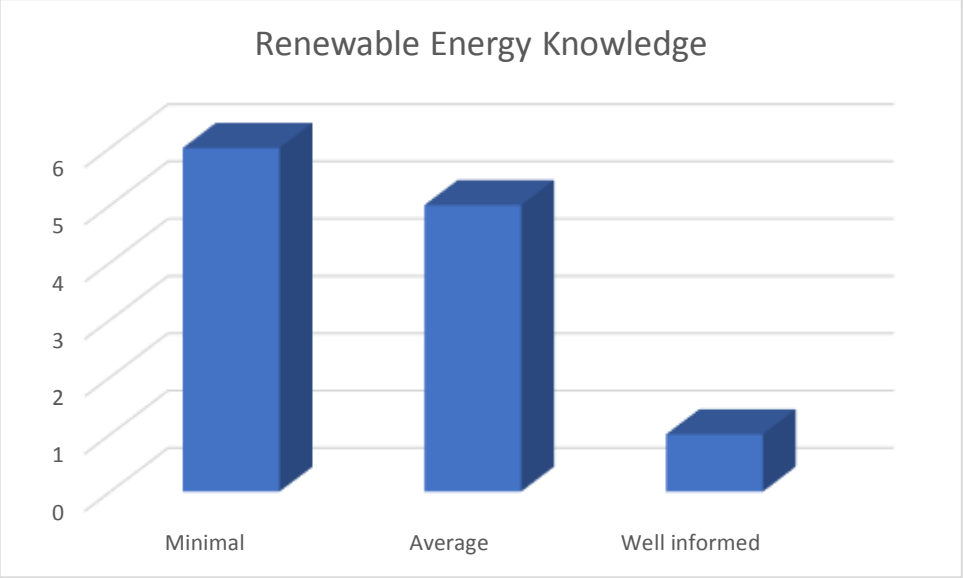


Figure 4.11: Participants' knowledge about renewable energy in the SBDM

Once it had been established how many of the participants were aware of the renewable energy concept, the concept, technologies and the advantages and disadvantages of using renewable energy to generate electricity was explained to them. For the purpose of the study, the main focus was on solar PVs. From the information that was presented about solar PVs, figure 4.12 shows that 92% of the participant indicated a high interest in using it as an alternative energy source to generate electricity.

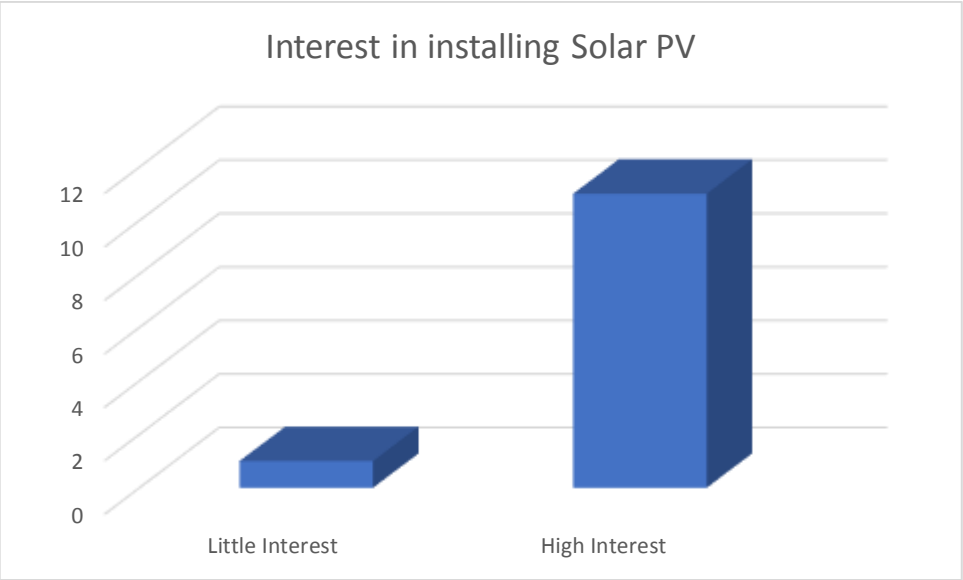


Figure 4.12: Participants' level of interest for installing solar PV in the SBDM

NELSON MANDELA BAY METROPOLITAN MUNICIPALITY

The NMBMM was the second district municipality that was interviewed. The municipality had different findings compared to those of the SBDM. Both municipalities cover the Gqeberha and Kariega regions and are classified into two distinct categories. There is a significant correlation between the different categories and the findings from the study.

Unlike the ORTDM and the SBDM, the NMBMM rural areas do not show a variety of residents' skills. Most of the participants indicated that they only specialise in farming. This was an interesting finding as this district consists of a metro and the markets are very competitive. Therefore, having one set of skills can either be good for the community or it could be the reason why most businesses in the area are not performing well.

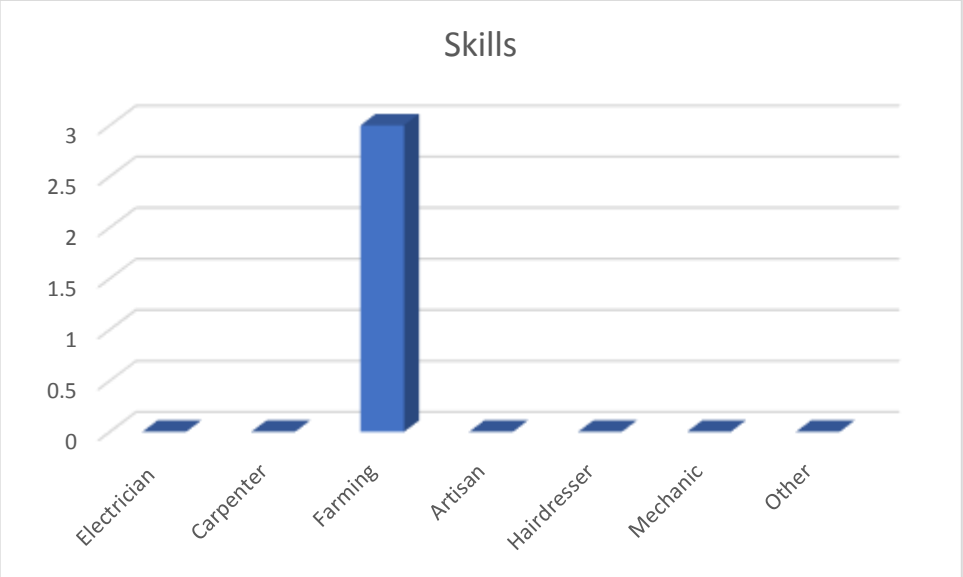


Figure 4.13: Participants' skill in the NMBMM

Another finding that was questionable in this district municipality was that the majority of the farmers focus on the poultry farming. The effect of this concentrated skill and market production will later be correlated with one of the major daily operation challenges in the district. The indication that poultry farming is a dominant type of farming in the district also influences the business profitability. Even though this dominant skill affects the profits and operations of the businesses, it could be a positive element for the infrastructure challenges faced by business owners in this district.

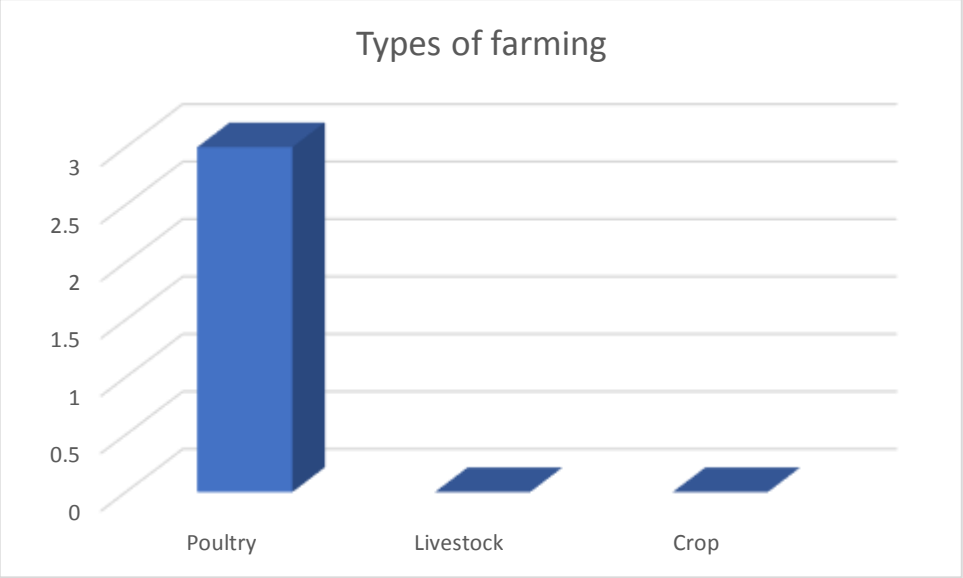


Figure 4.14: Various types of farming available in the NMBMM

According to figure 4.15, 67% of the participants indicated that their businesses are not profitable for the following reasons:

- Concentrated/competitive market owing to monopolistic practices
- Minimal land available
- Poor condition of infrastructure

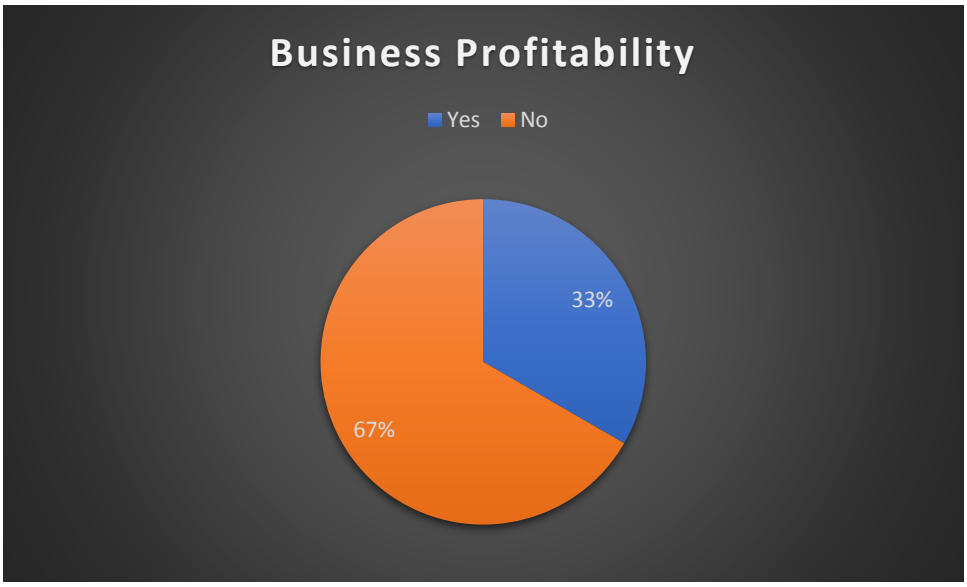


Figure 4.15: Business profitability in the NMBMM

The daily operational challenges were also another interesting finding in this municipality as the findings were completely different from those of the ORTDM and SBDM. The NMBMM shows customers as one of the biggest obstacles in their business industry. The highest ranked challenge

is transportation, followed by water, customers and Other. Infrastructure and electricity do not seem to be a challenge in the NMBMM.

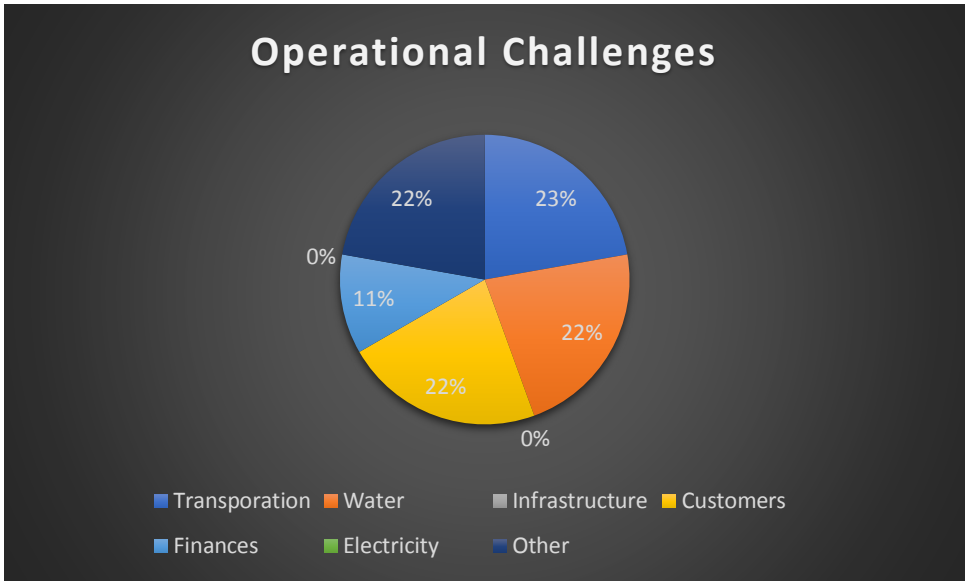


Figure 4.16: Business operational challenges in the NMBMM

All the participants indicated during the interviews that they had access to electricity. The data also shows that participants in the NMBMM rural areas do not have any challenges relating to electricity.

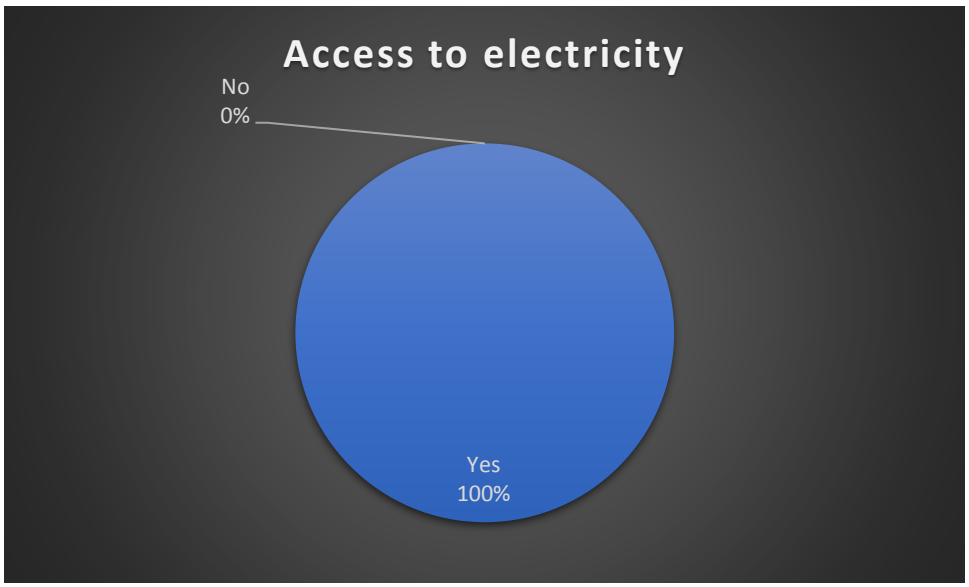


Figure 4.17: Participants' access to electricity in the NMBMM

Figure 4.18 shows that a total of 67% of the participants indicated that the condition of their infrastructure is poor while 33% indicated that the condition of their infrastructure is good. Even though the data shows that the infrastructure is not one the major challenges in their daily operations, the condition of the infrastructure has an indirect effect on the profitability of these businesses.

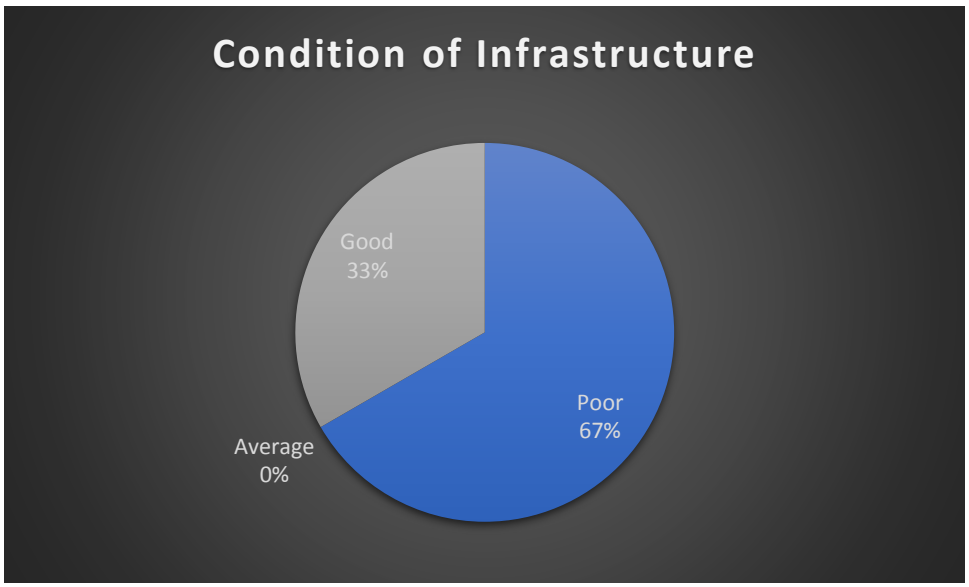


Figure 4.18: Condition of participants' infrastructure in the NMBMM

Figure 4.19 indicates that all the participants indicated that they have very little knowledge related to renewable energy. The concept, technologies and the advantages and disadvantages of using renewable energy to generate electricity was explained to them. After that information had been shared with the participants, all the participants indicated that they have a high level of interest in installing solar PVs as shown in figure 4.20.

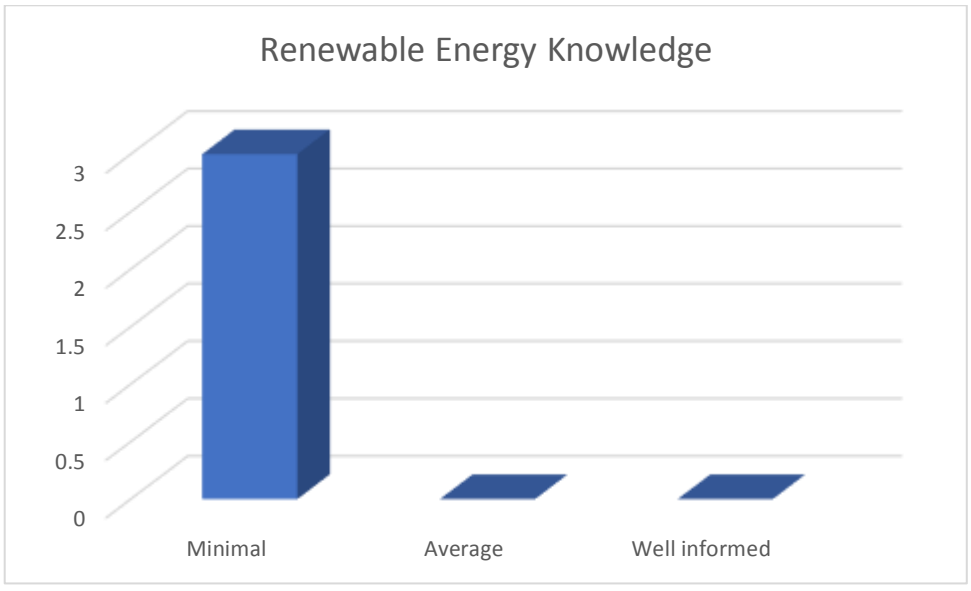


Figure 4.19: Participants' knowledge about renewable energy in the NMBMM

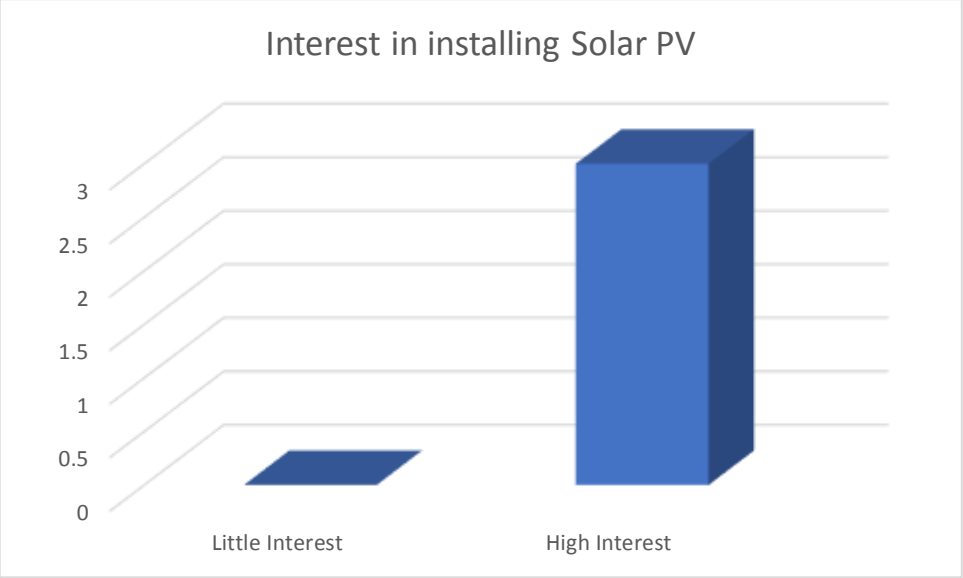


Figure 4.20: Participants' level of interest in installing solar PVs in the NMBMM

OR TAMBO

The OTDM was one of the participating district municipalities in the study. The district had seven participants. Even though the ORTDM is classified in the same category as the SBDM, the geographical settings are different. Both municipalities comprise rural areas which are geographically different. The ORTDM is made up of 80% of homelands whereas the SBDM is mainly farmlands. Despite different geographical set-ups, these two municipalities seem to be experiencing similar challenges.

According to the data, participants in the ORTDM have various skills within their communities. The main participant skill is farming at 63% while 12% of the participants have electrical or carpentry skills. The second highest ranking option was the Other which constituted up to 13% of the participants. These 13% indicated that they are involved in the construction industry.

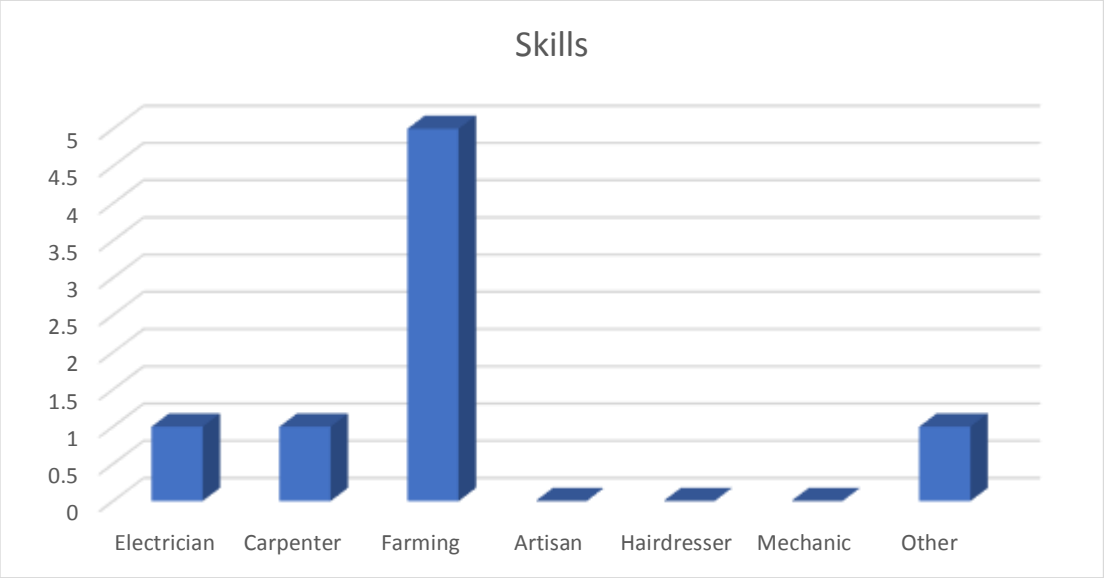


Figure 4.21: Participants' skills in the ORTDM

Since farming was the dominant skill in the district, the study further investigated the type of farming in this district municipality. Unlike the SBDM and NMBMM, in the ORTDM crop farming is dominant in with 57%. The second highest type of farming in the district is poultry farming at 29% while livestock is in the third place with 14%.

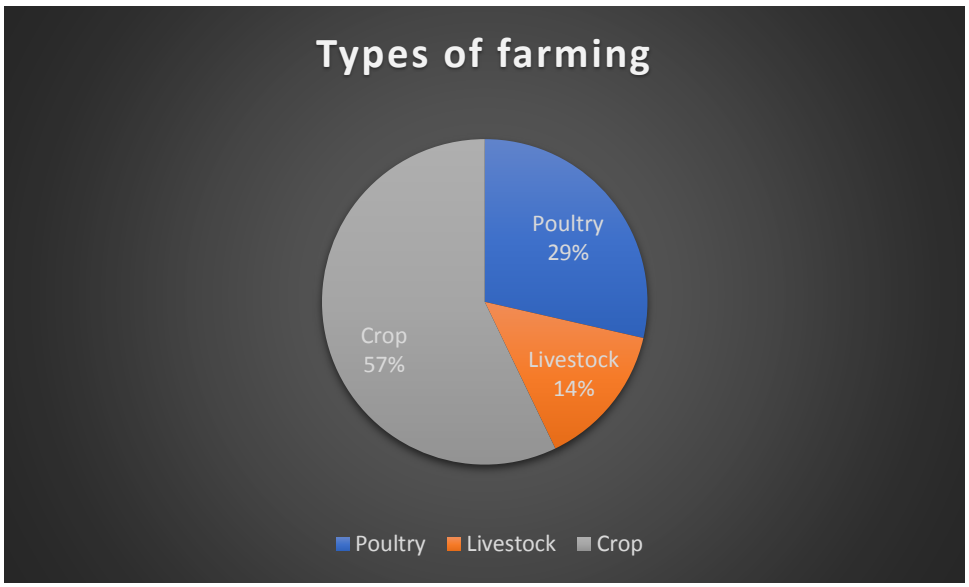


Figure 4.22: Various types of farming available in the ORTDM

As indicated in Figure 4.23, all the participants in the ORTDM affirmed that their businesses were profitable. The data relating to profitability is different for all three districts despite the districts' experiencing the same challenges when it comes to business growth and productivity.

Figure 4.23: Participants' business profitability in the ORTDM

The participants indicated that water, electricity and infrastructure were the biggest challenges experience by their businesses. A total of 60% of the participants indicated that they do not have access to electricity in the ORTDM while the second ranked operating challenge is electricity. The highest-ranked challenge for the businesses in the ORTDM is water at 34% and the third highest ranked challenge is infrastructure at 17%.

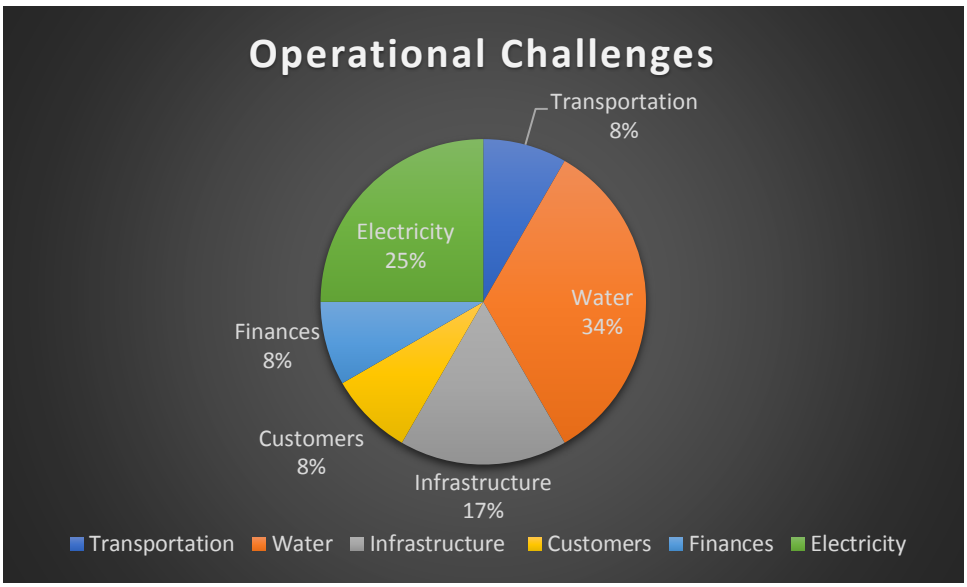


Figure 4.24: Business operational challenges in the ORTDM

At least 40% of the participants indicated that their infrastructure was in a good condition and another 40% indicated that their infrastructure was in a poor state. Furthermore, 20% of the participants indicated that their infrastructure was in an average condition.

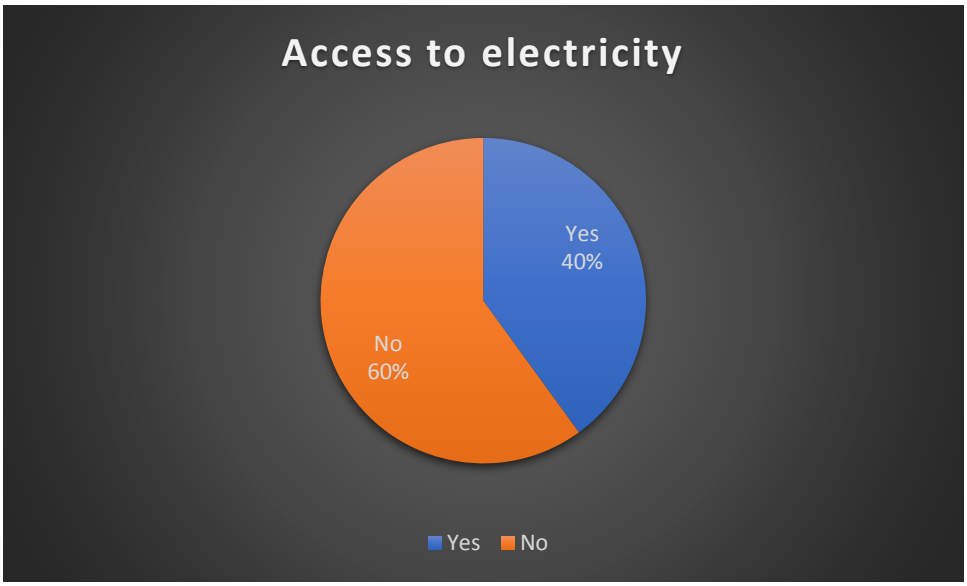


Figure 4.25: Participants'' access to electricity in the ORTDM

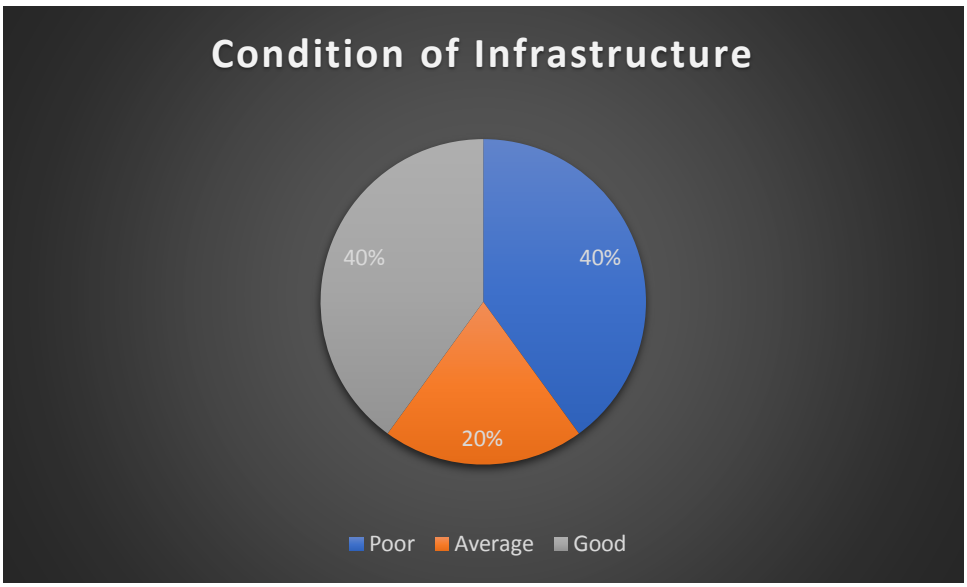


Figure 4.26: Condition of participants' infrastructure in the ORTDM

There was a significant knowledge gap between the less informed and well-informed participants. A total of 80% of the participants in the ORTDM indicated that they have little knowledge about renewable energy. Similar to those in the NMBMM and SBDM, the majority of the participants had a high level of interest in installing solar PVs.

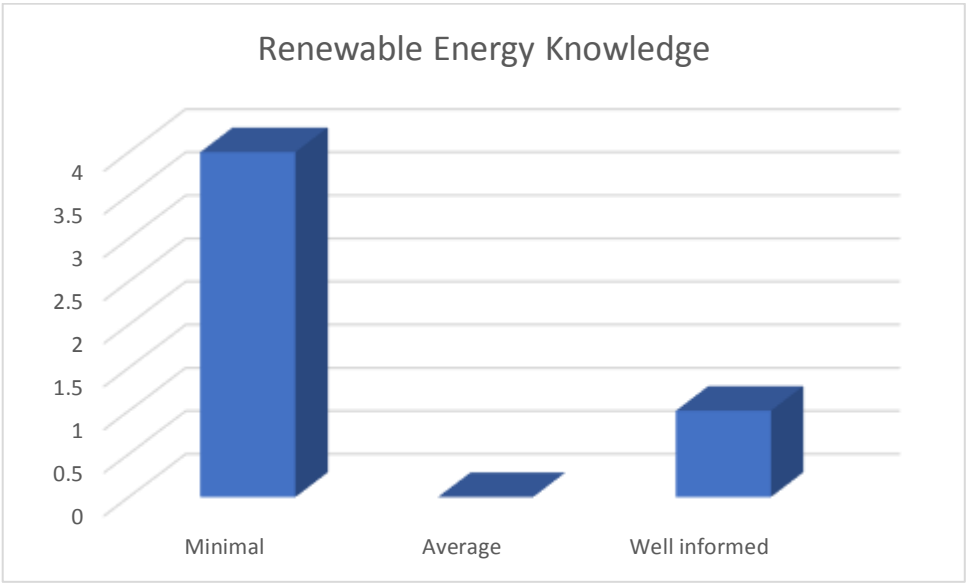


Figure 4.27: Participants' knowledge about renewable energy in the ORTDM

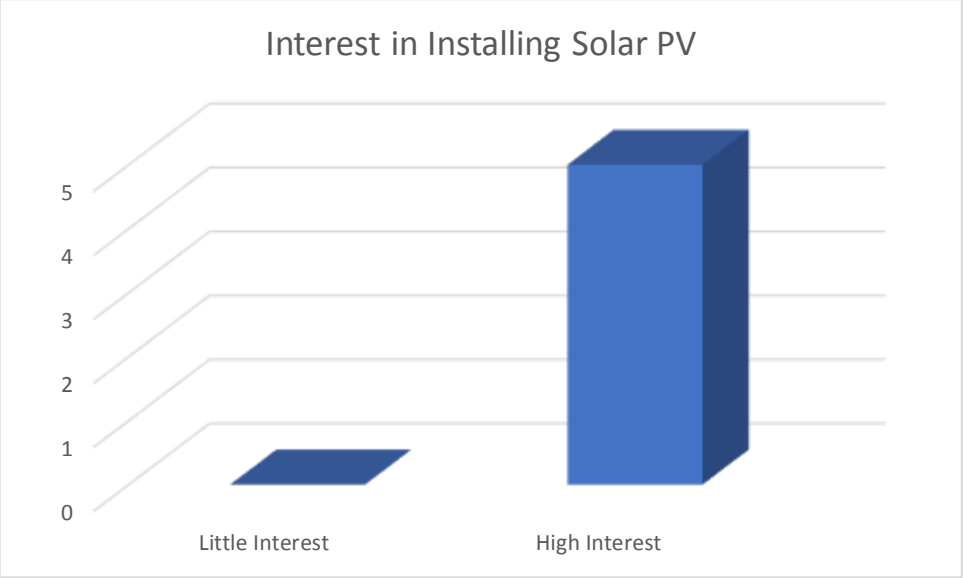


Figure 4.28: Participants' level of interest in installing solar PVs in the ORTDM

SUMMARY

All three districts have indicated that they have a problem with electricity. Municipalities like the NMBMM have access to electricity however it is not sustainable. With the ORTDM, most of the areas do not have access to electricity. The businesses operating in these municipalities have shown to be rather struggling with profitability and as much as they are situated in different geographical location, these businesses are experiencing the same operating challenges but at different intervals.

CHAPTER 5
ANALYSIS AND INTERPRETATION

The data results for the study are analysed using an integration method. Meta-inferences are used across the data analysis. For the quantitative analysis, graphs and percentage representations are used while for the qualitative analysis codes and themes are used.

5.1 HYPOTHESIS 1: SUSTAINABLE ENERGY SUPPLY

Hypothesis 1 stated renewable energy microgrids can provide sustainable energy for rural areas. To test this hypothesis, participants owning businesses in rural areas were asked about the availability of electricity in their areas and to identify the biggest operational challenges that their businesses are faced with daily. The responses were used to determine whether the current energy supply was effective and sustainable.

Results

The data shows that 65% of the participants in the Eastern Cape have access to electricity while 35% do not have access to electricity. NMBMM district have satisfactory electricity followed by the SBDM and ORTDM. With the Metro being categorised as a category C municipality, it is anticipated that rural areas situated within it will have access to electricity. The SBDM is the closest district municipality to the NMBMM. Most of the local municipalities in the SBDM are situated near Gqeberha. Figures 5.1 and 5,4, show a trend, namely that as each municipality moves further away from the NMBMM, there is an increased chance of not having access to electricity. The ORTDM is situated further from the two metro municipalities in the Eastern Cape Province and according to the research findings, most of its participants are without electricity.

Secondly, there is a huge difference between the SBDM, NMBMM and ORTDM geographical set-ups. A total of 80 % of the ORTDM consists of homelands while the SBDM and rural NMBMM comprise farms. All the participants that were interviewed in the SBDM and the NMBMM are settled on stated-owned land. These participants received the land as part of the land reform programmes from the DALRRD. For some of the farms, electricity was installed by the previous owner and for some, the Department installed electricity as part of their reform programmes. The opposite can be said of the ORTDM. This district is made up of 80% of homelands and the electricity should be installed by Eskom. According to the participants, 40% have access to electricity while the remaining 60% does not. With the supply-demand issues currently facing Eskom, it is unclear as to when these participants will be gaining access to electricity in their locations.

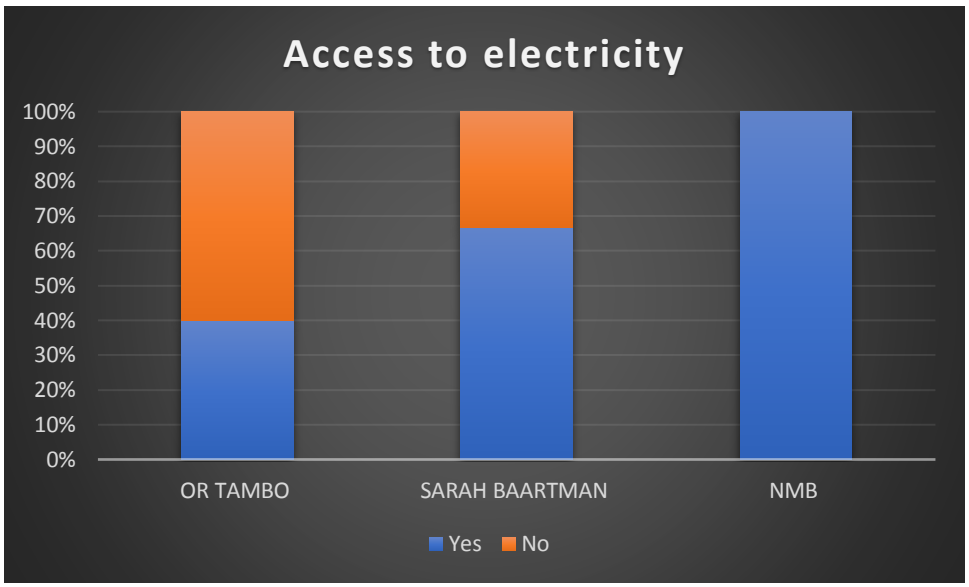


Figure 5.1: Participants' access to electricity in the various district municipalities

Having electricity might not be a luxury that all rural areas in the Eastern Cape can enjoy. Even though the majority of the participants in the SBDM indicated that they have electricity in their farms, the main operating challenge in their businesses is electricity.

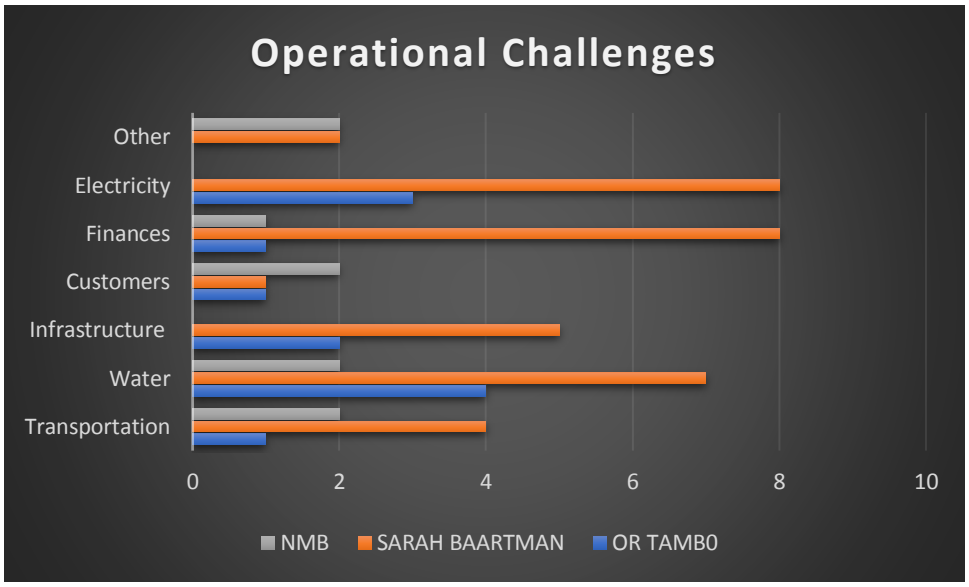


Figure 5.2: Business operating challenges in the various district municipalities

As part of the study, the participants were asked to elaborate on how electricity was a challenge in their businesses. These follow-up questions were open-end, analysed using qualitative methods such as themes and coding.

Theme 1: Availability of inefficient electricity

Participants with electricity indicated that they have load shedding which affects their businesses significantly. One of the participants who does poultry farming indicated that when his poultry stock is still very young, the shed needs to be very warm. In winter, he experiences a huge loss because once the load shedding hits for two or more hours, his chickens are cold. By the time the electricity comes back, some of them would have died. Therefore, during load shedding, he must make use of an alternative option such as wood or paraffin heaters to create heat so that they do not feel the cold in the shed. Other participants also indicated that when it is very windy, especially in the ORTDM, the electricity can go off and it can take days before Eskom fixes the issue. Therefore, they go for days without electricity, which forces them to make uses of other alternative methods to generate electricity for cooking and lighting.

5.2 HYPOTHESIS 2: INCREASED ECONOMIC OPPORTUNITIES

Hypothesis 2 stated that increased economic opportunity leads to a reduction in poverty and inequality. To test this hypothesis, the participants were asked to choose from the list types of skills sets that are available in the businesses. The data was then used to identify the various types of skills available in these areas and whether they could provide economic opportunities for the participants.

Results

According to the data, 52% of the participants in all the three districts are farmers. All the districts had farming as the highest ranked skill. The second highest ranking at 24% was the Other category. Participants were asked to specify the type of skill they or one of the community members possessed that was not listed in the questionnaire. The following skills were stated by participants from all three districts:

- Construction
- Brick laying
- Catering
- Plumbing
- Dressmaking
- Plumbing
- Driving

The data shows that the skills of being a mechanic and electrician were ranked in third and fourth position with percentages of 13% and 8%, respectively.

The literature shows that there is a high level of migration from rural areas to urban areas in South Africa. Stats SA (2006) has shown an increasing number of people migrating from rural areas to urban areas to find better living conditions. One of the biggest concerns with rural-urban migration is that most of these people are unskilled for the types of jobs available in the cities. Figure 5.3 shows that most people in rural areas are farmers. However, there is minimal farming activities that take place in urban areas. This means that most of these people who move to the cities to find greener pastures will contribute to an increase in the unemployment rate.

It is expected that underdeveloped areas would have limited skills resources. Electrifying rural areas and making sure that these areas are provided with sustainable energy to produce electricity can promote rural economic development which requires a different skill set. In terms of technological development, it is necessary to have technological skills that will assist with the functioning of this development. It would be correct to say the same principle would apply to the electrification of rural areas. The use of renewable energy microgrids in rural areas would challenge the status quo of the skills available. It would create a few skills set that are currently unavailable in rural areas and this could have a huge impact on the economic growth.

Based on the skills data, the possibility that participants in these areas choose jobs and businesses that require minimal use of electricity cannot be eliminated. Operating a hair salon and running a carpentry or artisan workshop are some of the jobs that require stable electricity. The data shows that even though some of the participants have carpentry skills, they cannot utilise them. To be able to boost the rural economy, it is necessary to provide various types of skills for their economy. It cannot be overlooked that farming has the potential to sustain the rural economy; however, the downfall of solely depending on farming as a dominant economic factor is that farming is seasonal, and it requires time. Any type of farming requires time and while people in rural areas are waiting for their crops or livestock to grow, it is questionable as to how their economy is going to survive. Creating skills that do not require patience and are not seasonal can assist the development of the rural economy. These skills, however, will need good infrastructure and stable electricity, which is something that is not currently available in rural areas.

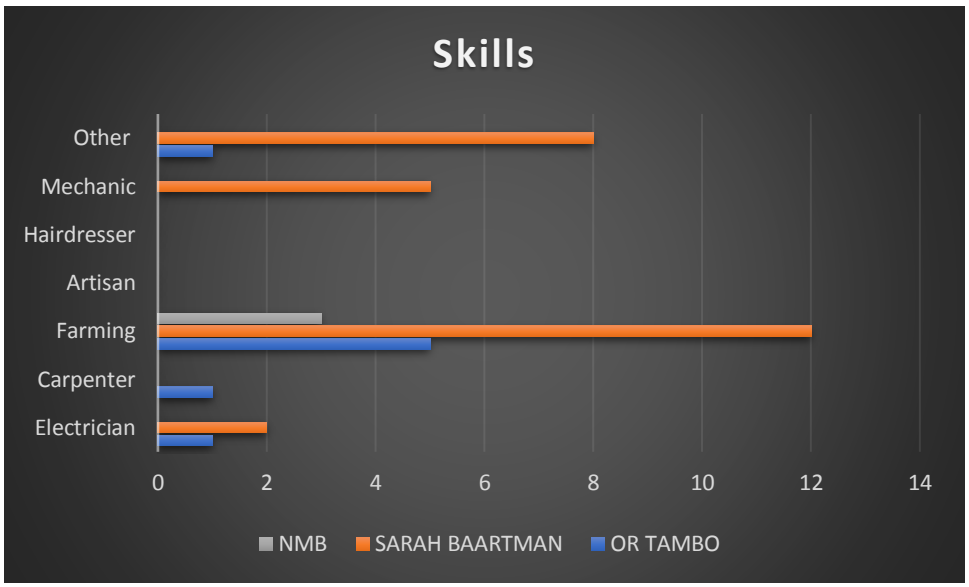


Figure 5.3: Participants' skills from various district municipalities

5.3 HYPOTHESIS 3: MICROGRIDS PROVIDE A COST-EFFECTIVE ENERGY SUPPLY

Hypothesis stated that microgrids provide a cost-effective energy supply. To test this hypothesis, participants were asked to state the reliability of the electricity from the grid in their areas. They were also asked to disclose what other alternative energy source they use if their electricity is not reliable.

1.3.1 Results

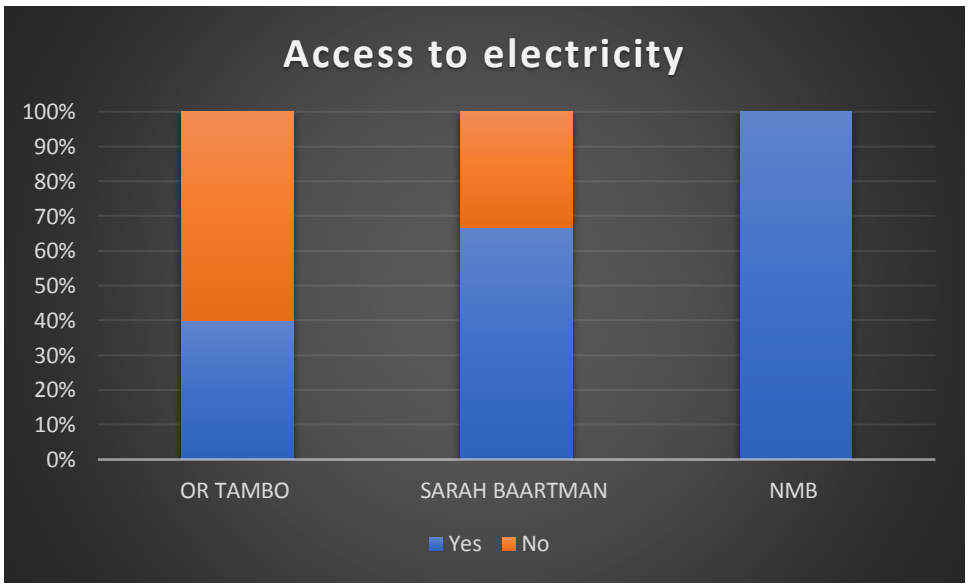


Figure 5.4: Participants' access to electricity in the various district municipalities

Theme 2: Electricity Expenditure

Participants were asked how the reliability of electricity in their locations affected their businesses and daily operations and what alternative sources they have to utilize to generate electricity. The participants stated that electricity was not reliable owing to load shedding, weather conditions and sometimes price increases. They stated that increases in electricity prices were negatively affecting their businesses and that the use of paraffin and diesel-powered generators was not cheap either. Participants stated that sometimes they would use only electricity for household use and then use generators for their businesses. However, this strategy is also not cost effective because of the increasing fuel prices. The alternative options available to these participants are not cost effective and do not help with the growth of their businesses. The literature states that renewable energy provides remote rural regions with the opportunity to produce their own energy rather than importing conventional energy from external sources. Moreover, being able to generate reliable and cheap energy can trigger economic development (OECD, 2018).

5.4 HYPOTHESIS 4: INCREASED RURAL DEVELOPMENT

Hypothesis 4 stated that microgrids would enable increased economic development in rural communities. To test the hypothesis, the participants were asked to indicate the condition of their infrastructure used for production in their businesses. The participants had to indicate whether they considered their infrastructure is in a good, average or poor condition. Once they had rated their infrastructure, open-end questions were asked to determine how the condition of the infrastructure was affecting their business.

Results

The data indicated that at least 75% of the infrastructure in all three districts is not in a good condition. The participants indicated that 40% of their business infrastructure is in a poor condition and 35% is in an average condition. The remainder of the 25% was deemed to be in a good condition. Analysed separately, the NMBMM is the district with the poorest business infrastructure at 65%. The second highest ranking district municipality with poor infrastructure is the ORTDM with 40%. In the SBDM, 50% of the participants indicated that their infrastructure was in an average condition. Despite not having a high ranking for poor infrastructure, the condition of having average infrastructure does not guarantee that the businesses are performing to the best of their abilities.

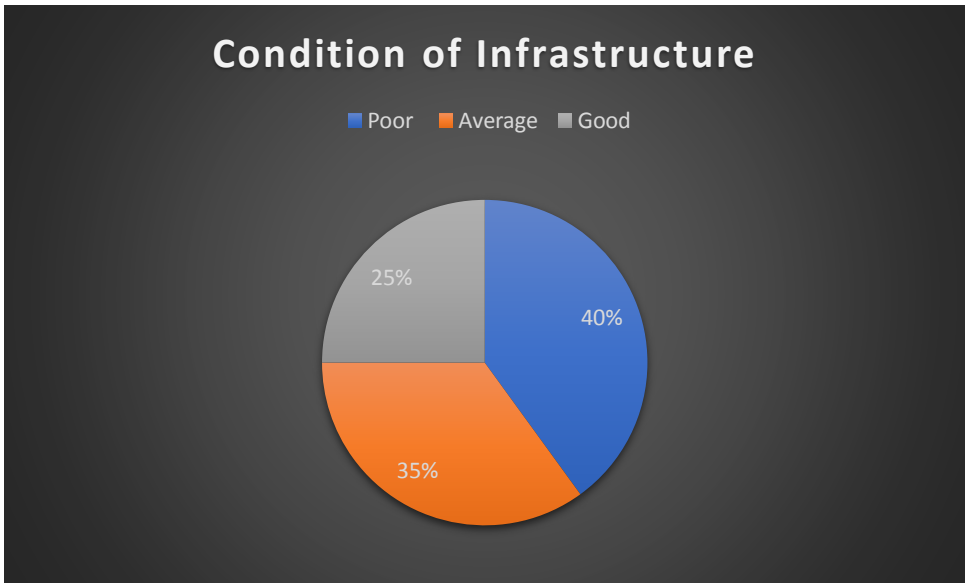


Figure 5.5: Overall condition of infrastructure in the various district municipalities

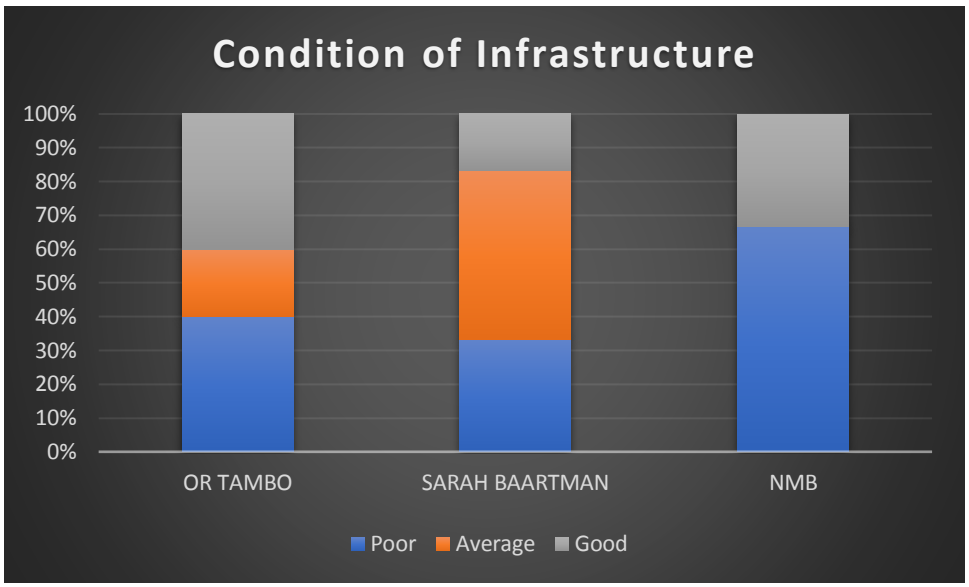


Figure 5.6: Condition of participants' infrastructure in the various district municipalities

Participants were asked how the condition of their business infrastructure was affecting their business performance. The aim of the study was to establish whether there was any correlation between the business infrastructure and profits. The data has shown different business profitability results for the various districts. Data in the NMBMM has shown poor performance in business profits and business infrastructure. From this it can be deduced that infrastructure issues might have a direct impact on business profit. The possibilities could be either those businesses are unable to meet production targets or that production targets are met. However, the businesses experience high mortality rates with their stock due to the poor infrastructure conditions which can negatively impact their profits.

The NMBMM is the only municipality where the participants indicated that they all have electricity, and it is also the only municipality in which the participants indicated that they are all involved in the poultry business. It would appear that these businesses are not profitable whereas they have access to electricity but poor infrastructure. The link for the businesses not performing well could be found between the infrastructure and electricity. The poultry business requires a certain level of thermal comfort to be achieved for the stock to grow properly and with a minimal mortality rate. If this district had proper infrastructure but no electricity, they would be a high probability of the escalated mortality rate amongst the poultry stock. In this case, the district has electricity but poor infrastructure which could be hindering production. To achieve that satisfactory thermal comfort for poultry farming, the business needs to have electricity and proper infrastructure which will reduce the mortality and therefore increase profits.

- However, there is a third factor that could affect the NMBMM's profits besides electricity and infrastructure. Analysis has shown that one of the biggest operational challenges for NMBMM is customers. The rural areas situated in the NMBMM are closer to the cities and

therefore investing in farming businesses might not be a good investment decision. According to ENRD (2018), the rural area typology is divided into four types, namely agrarian regions, consumption countryside regions, diversified regions with a strong manufacturing base and diversified regions with strong market services.

Based on these four types of rural typology, it is clear to see that the NMBMM has invested in agrarian activities which is not a strategic business decision closer to the cities. Changing the type of business investments in this district can assist with development. If the district could adapt a suitable typology, which is in this case the consumption countryside region, it could attract suitable investment that can boost not only profits but also its infrastructure, leading to increased development in the region.

The SBDM has shown that the majority of its infrastructure is in an average condition and most of the participants indicated that their businesses are profitable. A direct correlation can be deduced from this municipality. There is a high possibility that businesses operating in this district can meet their production targets if infrastructure could be improved which could improve profits. An increase in profits could mean that businesses are growing and as businesses start to grow in these areas, they can create more opportunities for development.

The ORTDM has shown interesting results. In this district the majority of the participants did not have access to electricity. The data shows that the district also has poor infrastructure, yet the opposite could be said about business profits. The majority of the participants from this district indicated that their businesses were profitable. Increased levels of developments in this district could be possible because of the high levels of profitability. The data has shown that an investment made in the ORTDM is guaranteed to yield returns which is a good strategy for economic growth. Even though there is no correlation between electricity, infrastructure and profits in the ORTDM, one can deduce that there is a positive correlation between profits and a good market. When discussing the daily business operating challenges, the least of the challenges that participants in the ORTDM indicated was customers. This could mean that in this district, there is a good market for business and businesses owners always find means of delivering to their clients. This can be seen from the good profitability response despite the lack in proper infrastructure and unavailability of electricity.

Theme 3: Infrastructure development

After the participants indicated the condition of their infrastructure, they were asked to state the type of infrastructure they needed to increase production and grow their businesses. The responses from the participants included the following:

- For the NMBMM- Most participants stated water infrastructure and the renovating and upgrading of their existing poultry infrastructures as being necessary.
- The ORTDM participants indicated that water infrastructure, roads, storage facilities and poultry structures are the type of infrastructure development they need to assist their businesses.
- In the SBDM, participants indicated that they needed civil infrastructure (water and roads) and storage facilities for infrastructure development that could positively impact on their businesses.

5.5 HYPOTHESIS 5: REDUCTION OF INVESTMENT RISKS IN RURAL BUSINESSES

Hypothesis 5 stated that microgrids would reduce investment risks in rural businesses. To test the hypothesis, the business profitability and daily operation challenges experienced by the businesses were considered. If microgrids could create better investment environments, this could assist with reducing investment risks. Participants were asked to indicate the most impactful challenges they experience daily. The lack and instability of electricity was one of the most challenging aspects of operating a business in the rural areas. A correlation analysis was conducted to determine whether the availability of energy in rural areas could create a good investment climate.

Results

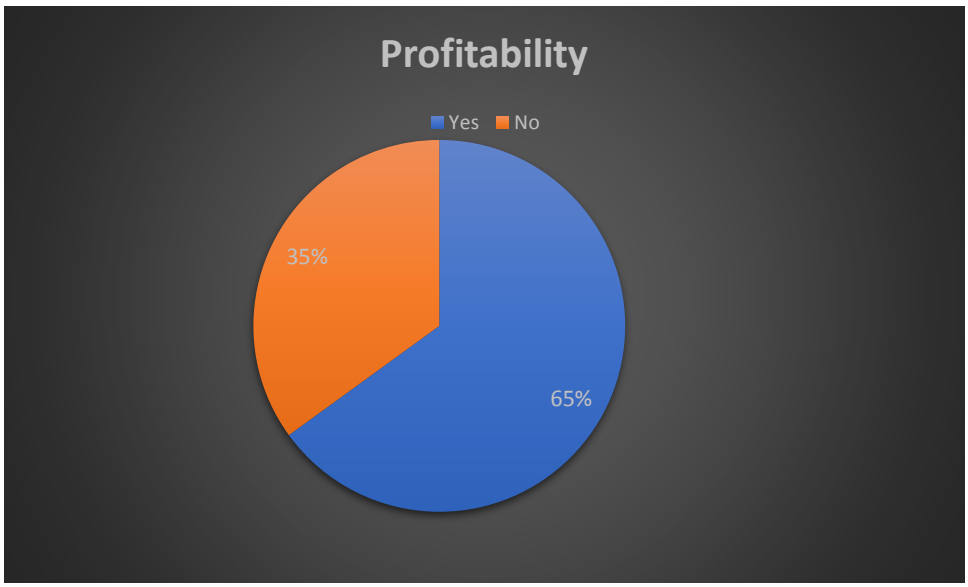


Figure 5.7: Overall business profitability between the various district municipalities

The provincial data shows that 65% of the businesses are profitable while 35% of the businesses are not profitable. Despite the challenges faced by many of these businesses, the indication that most of these businesses are profitable can create a good investment climate for businesses in the rural areas.

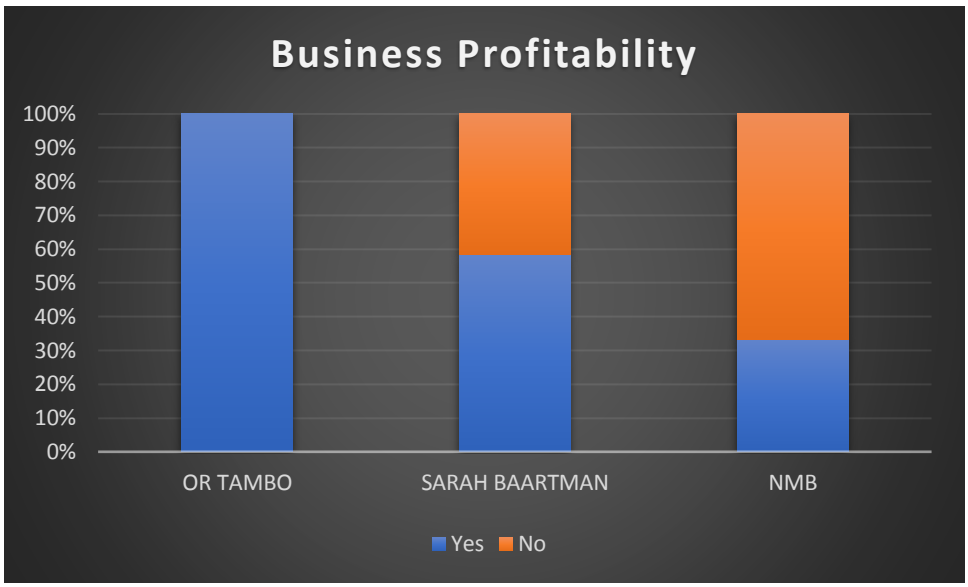


Figure 5.8: Participants' business profitability within the different district municipalities

The different municipalities have shown different results. Most of the businesses that are non-profitable are in the NMBMM, where only 35% of the businesses indicated that they are profitable. On the other hand, the ORTDM has shown high levels of businesses profitability amongst all municipalities. All the businesses that were interviewed as part of the study indicated that they were profitable. Investing in businesses that are already profitable could be a good development strategy for rural areas. Businesses in rural areas have high investment risks. One can deduce that businesses operating in the ORTDM are suitable for the typology of this district.

SUMMARY

Improving the condition of the infrastructure and providing electricity in rural areas can assist with overcoming some of the operational challenges faced by businesses in these areas. Participants in rural areas can also be able to invest the secondary and tertiary business activities.

CHAPTER 6
SYNOPSIS, CONCLUSION AND RECOMMENDATIONS

6.1. SYNOPSIS

The aim of the study was to identify opportunities for the use of renewable energy microgrids to provide electricity to rural areas of the Eastern Cape enabling the creation of economic opportunities. The data has shown that the municipalities surveyed experience similar challenges to rural electrification and development. The intensity at which these challenges are experienced vary from one district municipality to the another. The study has found that businesses in the rural areas are predominantly in the agricultural sector; they are either invested in crop farming, poultry or livestock farming. The study showed that most businesses are profitable; however, despite being able to make profit, these businesses were not growing owing to many operational challenges. The businesses had been faced with various challenges such as the poor condition of infrastructure, lack of reliable electricity, increasing electricity and petrol prices for businesses using generators, lack of water as well as decent water and road infrastructure. Even though some businesses had the basic resources to run their businesses, they have issues that were related to customers, marketing and business finances.

Very few businesses had businesses in the secondary and tertiary sector, and this can be seen as one of the reasons why the rural economy is not growing. Participants must wait for long periods of time before they start seeing a profit. There is nothing wrong with their choice of businesses; however, they need to have a balance. By providing reliable and affordable electricity to these areas, residents are able to create jobs in the secondary and tertiary economic sector. These require a steady supply of electricity in order to be able to operate. Most of the participants indicated a high level of interest in using renewable energy sources to generate electricity; however, accessible funding and knowledge are some of the barriers with which these participants are faced. The Organisational for Economic Co-operation and Development (OECD) 2011 report also shows that the deployment of the renewable energy in rural areas can bring new revenue sources, new job and business opportunities, capacity building and community empowerment and affordable energy.

6.2. CONCLUSIONS

The need for stable electricity in rural areas cannot be overly stated. The study initialled aimed at identifying opportunities for the use of renewable energy microgrids to provide electricity in the rural areas of the Eastern Cape enabling the creation of economic opportunities. It has shown how the lack of electricity affects economic growth and how a stagnant economy negatively influences development, infrastructure, education and the livelihoods.

6.2.1 Objective one – Sustainable electrical energy supply

Literature defines sustainable energy as the product of renewable energy and energy efficiency. Sustainable energy supports economic and human development needs, and the same time can preserve the environment and reduce climate change risks (Prasad, Radhakrishnan, Kumar & Kannojia, 2019). There are two distinct points that can be concluded from the study about the current state of electricity in these rural areas. Firstly, most areas do not have access to electricity, and this has made residents to look for alternatives sources to generate electricity like diesel-powered generators and wood. Secondly, even though some areas do have access to electricity, it cannot be considered sustainable. Eskom is the main electricity supply for these areas and most of this electricity is generated from coal. Electricity is a significant challenge in rural areas. If majority of the residents without electricity were to have access to electricity, using renewable energy sources to generate electricity would be a good decision not only for the residents but also for the environment. Literature states that at least 18% of the generated electricity is lost through distribution (Khonjelwayo and Nthakheni, 2021). With challenges such as climate change and energy loss through distributions, renewable energy micro grids can provide a sustainable energy supply to rural areas. Renewable energy micro grids have a greater degree of local control and autonomy, and they create smaller generating uses which are efficient and less polluting towards the environment.

6.2.2. Objective two - Economic opportunities to increase employment rate

Any economy needs to participate in all the three main sectors for it to thrive. The data has shown that majority of the participants in rural areas mostly participant in primary activities such as agricultural farming, both crop and stock farming. There are minimal economic activities taking place in the secondary sector and tertiary sector therefore rural areas have a high level of unemployment. Most of the participants do not have another skill they can use to generate a second stream of income. There is business potential in rural areas. Assisting these areas with solutions to overcome their operational challenges could create a healthy and vibrant rural economy. It is also very difficult for participants in these rural areas to participate in economic activities in the secondary and tertiary sector because these activities require stable electricity. Providing stable and sustainable electricity

to rural areas will create more economic activities in the secondary and tertiary sector and therefore increasing the rate of employment. The study has shown that some residents have skills in services offered in the tertiary sector and have not utilised those skills to form their own businesses, they are still focused on farming.

Participants also complained about not having enough financial resources to expand their businesses. Most of their businesses are not profitable and if they are profitable, the profit goes towards taking care of their personal needs, neglecting the business and its potential to grow. Another economic growth restriction that was identified by the participants is the lack of relevant markets and in some other areas customers. Participants indicated that they spend so much time and money producing their products but have travel far distances to sell their produce or get local customers who will buy products on credit and not pay on time. This has a negative impact on the business because they are unable to go and buy stock to keep the business moving. The creation of jobs in other economic sectors will allow the participants to focus on more than one business which can have a positive impact on the cashflow. Services such as hairdressing do not allow customers to buy on credit so participants can be able to control the amount of money that goes towards credit customers.

6.2.3 Objective three- Cost-effective energy supply

Objective one addressed the issue of sustainable energy supply, and it was noted that some of the participants indicated that they had access to electricity. Despite it not being sustainable, it also does not come cheap. They complained about how much money their businesses were making and how much money was going towards purchasing electricity. The participants indicated that their electricity bills were increasing month after month which makes it difficult for them to keep up with purchasing electricity. They used alternatives such as a diesel-powered generator to generate electricity so that they farms can keep working. Literature states that electricity costs from renewable energy have dropped drastically over the past few years. Electricity generated from the renewable energy technologies has become the new least-cost option for most countries in the world (IRENA, 2019). Most participants are unaware of cheaper alternatives they can use to generate electricity and the increasing cost of electricity places a huge financial burden on businesses in rural areas.

6.2.4. Objective four – Reducing economic migration through rural development

The data has shown that from all three district municipalities, participants mostly possess the skill of farming. Farming is in the primary sector and there are very few participants who also possess a skill in the secondary or tertiary sector. This gap between the different economic sector has created a challenge where rural people migrate to the cities to get a job. Rural areas are underdeveloped and at the moment there is plenty of room for rural infrastructure development. Having decent and adequate rural infrastructure could sustain their economy and make any type of investment worthwhile. Having more than one skills set can create more jobs in the manufacturing and services market. This will not only assist the current residents in the rural areas to find work, but it will also assist cities faced with overpopulation and high unemployment rates.

6.2.5. Objective five- Stable infrastructure framework for rural economic development

The study found that one of the major challenge hindering business growths in the rural areas is infrastructure. Almost all the businesses interviewed do not have the proper infrastructure for the business they are operating in, and if a particular business has the correct infrastructure- it is not in good condition. This challenge has comprised a lot of businesses in the rural areas. A study conducted by Cook (2011), also states the importance of infrastructure towards rural economic development. The study indicates that it is now seen as an urgent need to expand infrastructural services as widely as possible to integrate dispersed populations in rural areas into the mainstream economy. Participants in these rural areas do not have access to building and civil infrastructure such as roads, bridges, and water system. As a researcher who was travelling to some of the rural areas in the Eastern Cape, it was difficult to reach other areas due to poor road condition and non-existence of bridges to cross over to the next village. Whilst we focus on providing these areas with electricity generated from renewable energy, it is also imperative to consider infrastructure development. Solar PVs can either be on the ground or mounted on rooftops, having proper infrastructure that can accommodate roof solar PVs means an increase in the electricity that can be generated. This can also create buildings which are self-sufficient.

In conclusion, the disappointing progress towards providing sufficient rural electricity has partly attributed to the failure to raise the incomes of rural households and effectively design tariffs and adapt regulatory systems that can make electricity more affordable to communities (Cook, 2011).

6.3 RECOMMENDATIONS

The aim and objective of the study have been achieved and the use of the renewable energy sources to generate electricity could have positive impacts such as local job production, local revenue, innovation, and affordable and reliable energy in rural areas. The study has provided the following recommendations these areas:

6.3.1 Alternative energy sources

The study has shown how the participants either use electricity supplied by Eskom or diesel-powered generators to generate electricity. There was also a high indication that participants are not informed about alternative renewable energy sources. These participants can use alternative energy sources to produce electricity in rural areas. To accommodate the dispersed areas of rural areas, they can use the concept of micro grids to avoid electricity loss through distribution. The literature has shown how microgrids are an ideal solution to the electricity problems in the remote areas. These microgrids would need to be powered by renewable energy sources because of the challenges in South African with non-renewable energy sources and global warming.

One of the positive impacts of renewable energy is innovation. Some of the innovative ways that electricity generated from alternative renewable energy sources can have on rural areas include:

- Using solar-powered boreholes and irrigation systems to provide water.
- Creating renewable energy substations which will supply electricity to new manufacturing facilities that can be developed in rural areas.
- Supplying sustainable electricity to residents and businesses in the rural areas.

Other alternative renewable energy sources beside solar power that can used to generate electricity in rural areas include wind power, biomass, biofuel, and hydropower.

6.3.2. Harness new skills sets

Participants can create a diverse set of skills which can create more opportunities in the market and not only boosting the rural economy but also offering employment opportunities to many people in the rural areas who do not have jobs. The Stats SA report has shown that many people in the rural areas migrate to urban areas in pursuit of better job opportunities. Most people in rural areas focus on primary sector activities; however, research has shown that there are plenty of other opportunities that can arise from secondary and tertiary activities.

- These rural areas do not have areas with manufacturing facilities. Investing in manufacturing firms and factories will not only assist with infrastructure development but it will also assist with broadening the skills base available in rural areas.

- Participants that focus on crop farming can create storage and packaging facilities which will brand and package their products for the market.
- Participants that focus on animal farming can create clothing manufacturing facilities where they can use animal fur and pelts to create clothes. For examples, sheep need to be shorn regularly and the excess wool can be used to create clothes.
- Participants can also create their own manufacturing plants for dairy products. All the machinery that will be operated in these factories will need electricity and renewable energy can assist with generating electricity.

- Literature has indicated various types of rural typology and the activities that take place in each typology. By focusing on businesses that are suitable for the type of geographical typology in which the businesses are situated can improve the profitability of many of the businesses in rural areas. Most of the business in the NMBMM and SBDM are not profitable. Since the NMBMM is closer to the city, if businesses in rural areas in the district can shift their focus from farming to supplying a service, they might see some improvement in their profits. The typology which could be suitable for the NMBMM is a consumption countryside region; however, participants in this district have invested in agriculture. Although their focus is on agrarian activities; this type of region is mostly suitable for tourism. People in the cities are always looking to travel to the countryside and disconnect from the busy life of the city.

6.3.3. Attract new business investments

Municipalities should focus on investing in existing businesses which are profitable and have a high potential for growth within a short period of time. Almost all the businesses in the rural areas in the Eastern Cape need to be funded; however, the funding needs to be done in a strategic manner. Funding business that has many challenges and face many financial risks can create further challenges when it comes to investment. Investors must first invest in businesses that will generate a return over a short period of time and then they will be able to assist businesses that yield results over a long period of time. The rural areas focus more on agrarian activities which take longer to provide returns. There are few businesses that provide services. This is not a good investment climate for investors because while farming is seasonal, businesses must wait until products are produced. If there was a focus on and a balance between secondary and tertiary activities, then the rural economy would survive. This means that instead of only focusing on agricultural infrastructure, investors can also focus on development infrastructure, which is suitable for salons, dressmaking, car mechanic workshops, and brick laying.

Investing in electric vehicles such as busses, cars and agricultural vehicles. Once people in the rural areas invest in EVs, it will be necessary to develop charging infrastructures. The investment in EV

will not only improve infrastructure such as buildings (for charging stations) and roads but it can assist residents to create another source of income. If the community creates a central charging point, they can charge people for charging their cars and this can boost their economy. The model of their central charging station can be similar to the petrol station model. Petrol stations have shops for food and restaurants. Participants can create food trucks and traditional hand craft artwork so that while customers are waiting for their vehicles to charge, they can have something to eat and support the arts and crafts businesses.

6.3.4. Promote education and develop skills training centres

Investing in secondary and tertiary sector business activities will create more skills in rural areas; the more diverse skills these areas have, the greater the need for education. Investing in renewable energy can create better education facilities which will help residents to boost their economy and become better at their craft without having to relocate to urban areas where most of their income is spent on accommodation and transport instead of uplifting their standard of living.

Once new developments and skills have been introduced in rural areas, it will be imperative to also create skills training centres where people can learn about mechanisms or renewable energy technology, and other machinery and equipment that will be used in the manufacturing factories.

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Sibulelokuhle Xulaba
MSc in Built Environment (Project Management)

An implementation framework for micro grids to uplift rural communities

Interview Protocol
Interviewer: Miss Sibulelokuhle Xulaba

1. Section A: Demographic Data

1. Participant Number

2. Gender

Male	Female

3. Current work role

2. Section B: Skills Development and Businesses

1. What skills do the members of the community possess?

Electrician	Carpenter	Farmer
Artisan	Hairdresser	Mechanic

If Other, please specify: _____

2. Are the community involved in any local business projects?

_____

_____

_____

3. If yes, what are the types of these businesses?

_____

_____

4. Can you consider the businesses to be profitable?

_____

_____

5. If the businesses are not considered profitable, what are the reasons for the businesses not being able to make enough returns?

_____

_____

6. What are the challenges faced by the businesses in the daily operations?

Transportation	Water	Infrastructure
Customers	Finances	Electricity

If Other, please specify: _____

7. If the community is not involved in any business, would you as local residents be keen to develop new businesses?

_____

_____

8. If yes, what type of businesses would the community be willing to start operating in?

_____

_____

3. Section C: Availability of resources (electricity and infrastructure)

1. Does the community have access to electricity?

Yes	No

2. If no, how does the effect of not having electricity affect day-to-day operations?

3. If yes, what is the reliability of electricity in the area? Do you encounter any problems that force you to use alternative sources to generate electricity?

4. What is the condition of the infrastructure in the community?

Poor	Average	Good

5. If in bad condition, do you think the inadequacy of not having proper infrastructure has an effect on local businesses?

6. What type of infrastructure is needed by the community to boost its economic capacity?

7. What lack of other resources are hindrances to the growth of local businesses?

4. Section D: Renewable energy knowledge

1. How well informed are you about the concept of renewable energy?

2. Have you considered the use of energy from the sun to generate your electricity?

3. What is your level of interest in making use of solar energy to generate electricity?

4. The benefits of using solar PV to generate electricity includes the following (but not limited to):
    - Increased productivity and additional income.
    - Improvement in education systems and
    - Improved health care systems

5. Which of the following communal property is situated at a close proximity?
    - Local school
    - Church
    - Clinic
    - Hospital

6. After the above stated reasons, would the community be interested in using this technology to generate electricity, assisting the generation from the main grid?